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The causes and consequences of depopulation

Guest Editors: Zuzanna Brzozowska, Ekaterina Zhelenkova, Stuart Gietel-Basten, Michael Herrmann, Klaus Prettner and Miguel Sánchez-Romero

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Special issue on
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Population decline: Towards a rational, scientific research agenda

***Zuzanna Brzozowska*[1,2,*], *Ekaterina Zhelenkova*[3] and *Stuart Gietel-Basten*[4,5]**

Abstract

While the global population continues to rise, many regions are experiencing population decline due to low fertility, outmigration or, most often, a combination of the two trends – and many more are forecast to do so in the future. Economic and demographic theories have so far been unable to offer an unambiguous prediction regarding the consequences of population decline. The 2023 volume of the Vienna Yearbook, "*The causes and consequences of depopulation*", provides a wide variety of perspectives on population decline, illustrating that it is a highly multifaceted issue, and that there are no simple theoretical or empirical applications for understanding its causes and consequences, or the potential responses to it. The *Debate* contributions provide a broader view of and reflections on population decline, while also highlighting the benefits and opportunities associated with it, and ways to manage population changes globally. In contrast, the research articles tend to focus on the challenges of shrinking population that are experienced at a local level. This *Introduction* gives an overview of the contributions in this volume and the different perspectives they offer.

Keywords: population decline; depopulation; ageing; migration

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1 Introduction

The global population clock consistently shows that an ever-increasing number of people are living on the earth with each passing year. But beneath the frequent discussions about our planet's perceived "overpopulation" and the challenges that it poses in the form of environmental degradation and resource allocation problems lies the reality that many regions are experiencing population decline – and many more are forecast to do so in the future. While population decline has certainly occurred in the past, the current moment is likely the first time in human history that this trend is not being driven by violence, natural disasters or forced migration. Instead, in recent years, population decline has largely been the result of low and falling fertility levels as well as extensive, generally voluntary migration.

Much of the contemporary debate on population decline, however, is framed in rather stark, oversimplified terms. In much the same way as population growth was presented as a threat to human existence in the second half of the 20th century, population decline is often presented as an existential threat to populations, and even to "civilisations". Conversely, some observers have characterised population decline as an unmitigated good; i.e., as a panacea for the challenges associated with resource allocation constraints, climate change and inequality.

There have been extreme rhetorical expressions as well. According to the so-called *"great replacement"* theory, which has gained traction among the far-right, the relative decline of certain groups of the population is a tool to "defenestrate" white people while empowering a globalist elite. Some observers have expressed concern that such rhetoric could lead to conspiracies, violence and even mass shootings. At a more mundane level, populist-nationalist politicians are keen to stoke fears of a threat to "civilisation" posed by low fertility in their own countries coupled with the in-migration of "others". In this sense, population decline is presented as a threat to cultural and national ethnic identities (for more on this issue, see Gietel-Basten, in this volume). Indeed, in such discussions, the switch from the macro to the micro level is seamless. The threat of "extinction" is a very real rhetorical tool used by politicians the world over – although especially by those in East Asia – as a crude way to encourage women to have more babies. For example, in Taiwan, single women are described as being a "threat to national security" – presumably because of their failure to contribute to national reproduction (Gietel-Basten, 2019). Again, this has clear echoes of the tendency to "blame" women in the Global South for "over-reproducing" and contributing to the "population bomb" of the 20th century.

When left unchecked, these nihilistic "demographic imaginaries" (Armitage, 2021) that regard population decline as an unmitigated threat to humanity – or, alternatively, the fantasies that population decline is an unambiguous good that will solve all of the world's problems – can be used (and abused) to misrepresent and obscure the real challenges that lie ahead of us (see also Gietel-Basten's *Debate* contribution in this volume). Of course, it goes without saying that economic and demographic theories still fall short of offering an unambiguous prediction regarding the consequences of population decline (van Dalen and Henkens, 2011).

As such, not only does our standing on the frontier of a new demographic paradigm represent an exciting time to consider the challenges and opportunities that might arise, there is also a strong need to reorient the "debate" on population decline towards a more rational, scientific perspective. This is not, of course, the first volume to attempt to systematically address this issue, as population decline has been a central focus of studies emanating from various disciplines over many years. Macroeconomists have pondered the implications of population decline for economic growth; regional and urban planners have considered its potential effects on how services are provided to human settlements; and rural sociologists have expressed concerns about whether communities in the countryside can adapt to having a sparser and older population (Bloom, 2020; Hollander et al., 2009; Johnson and Lichter, 2019). Worries about the effects of population decline on culture, language and intrinsic cultural heritage have been expressed by historians, linguists and anthropologists. Demographers have also considered the implications of population decline, and have debated the extent to which it should or should not be a cause for concern. Meanwhile, environmental researchers have tended to focus on the positive aspects of population decline, given that it *could* be associated with lower rates of natural resource consumption and greenhouse gas emissions (Casey and Galor, 2017; O'Neill et al., 2012).

Population decline is, therefore, a complex phenomenon, and it should be addressed in a holistic manner. However, the existing literature on this topic seems to demonstrate that economic and demographic theories fall short of offering an unambiguous prediction of the consequences of population decline. To explore this question further, "*The causes and consequences of depopulation*" was chosen as the theme of the 2023 volume of the Vienna Yearbook of Population Research. From the outset, the editors of this special issue emphasised that the authors should approach population decline not just in the context of demography, but in an interdisciplinary manner. We are, therefore, delighted to report that the papers in this volume cover a wide variety of perspectives: demographic, economic, environmental, urban/regional planning, sociological, historical and linguistic. The issue is also global in scope, but is sensitive to the different issues and challenges that arise at various spatial levels, including the regional, district, and even town and village level.

This volume features 18 articles that present research on population decline in a range of article categories: in addition to *Research Articles,* shorter and empirically focused *Data & Trends* and more broadly focused *Perspectives* and *Review Article* are represented in the journal. Seven invited *Debate* contributions discuss the topic of population decline from many different angles, including by exploring the fears and hopes associated with population decline, its drivers and consequences, and the possible adjustments to it – while often suggesting that worries about the consequences of depopulation might be overblown.

2 The global perspective

The principal criticism advanced by environmentalists with regard to population growth hinges on the over-exploitation and misuse of environmental resources, thereby creating a perception that population decline would be an apt solution to counter environmental degradation. A *Debate* article by Rees (in this volume), observes that the current size and growth rates of human civilisation are anomalies, and that the continued expansion of the population poses significant dangers to the integrity of the ecosphere, and to its life support functions that are critical to human survival. He proposes looking at the ecological overshoot as “a meta-problem that is the cause of most symptoms of eco-crisis, including climate change, landscape degradation and biodiversity loss”, and that is directly driven by “excessive energy and material ‘throughput’ to serve the global economy” (p. 21). Consequently, among the major obstacles to sustainability are rising incomes and the consumption levels that accompany them. The author presents relevant eco-footprint data, from which he concludes that the maintenance of the ecosphere’s integrity calls for a contraction of the human population.

The *Debate* contribution by Lutz (in this volume), pointedly specifies how this contraction could be achieved: namely, by prioritising universal education, especially female education. The author contends that greater resilience and the capacity to mitigate and adapt to climate change will emerge as a result of a smaller desired family size, better family health and poverty reduction – all of which are likely occur with improvements in education. The *Debate* article by Skirbekk (in this volume), convincingly summarises the benefits of low fertility, arguing that a declining population would reduce the pressure on resources, and could enhance the quality of life for those who remain. He observes that environmental degradation, increased competition for resources, and declining quality of life are exacerbated by population growth. Skirbekk also points out that the spread of low fertility has been accompanied by economic success, allaying fears that low fertility would lead to economic decline and collapse. As low fertility is unlikely to be reversed, societies need to invest in human capital, reform their labour markets and family policies and pursue many other adaptations to a new world with fewer children.

These commentaries attempt to highlight the more optimistic and positive sides of population decline, emphasising the benefits and opportunities associated with this trend, and potential strategies for managing the changes in the global population. From a global perspective, population decline is, according to Rees, Lutz and Skirbekk, an advantageous phenomenon that will have predominantly positive effects, although the transition period could be rife with challenges. At the same time, however, the local perspective on population decline might be far less optimistic.

3 The regional perspective

In the necessary juxtaposition of "the global" and "the local", population decline can be seen as a double-edged sword, as despite its positive impact when framed globally, its effects may be far less beneficial when viewed from the local level. Several contributions look at the wide range of challenges associated with shrinking population at the municipal or the national level. The *Data & Trends* article by Gagauz et al. (in this volume), maps the demographic trends and explores the socio-economic downsides of population decline in Moldova. Using a comprehensive set of data on migration, fertility and mortality indicators, as well as demographic projection, the authors describe the detrimental effects that the sharp decline in the population driven by outmigration (or "brain drain") is having on the country's prospects. They also discuss some ways to mitigate the negative consequences and to prevent further human capital losses.

The hard realities and bleak perspectives are also the focus of a qualitative study conducted in 2021 in eastern Ukraine by Perelli-Harris and Hilevych (in this volume). Since the 1990s, Ukraine has been experiencing a triple burden of population decline: low fertility, high mortality and substantial emigration. In their contribution, the authors report the findings from online focus groups carried out in the conflict zone before February 2022 on both the territory occupied by Russia since 2014 (Donetsk) and the Ukrainian side (Mariupol and Kharkiv, and rural areas). The residents of the shrinking villages and Donetsk, as well as of Mariupol and Kharkiv, both of which had grown rapidly since 2014 due to the large number of internally displaced people they received after the Russian annexation of Crimea, were asked about their perspectives on depopulation. While the study participants were mostly occupied by their day-to-day problems and worries, they were also well aware of the negative consequences of population decline, including rapid ageing and a shrinking labour force.

The *Debate* piece by Loichinger and Spiess (in this volume), documents how migration has helped countries such as Germany to counteract population decline at the national level. The authors discuss the challenges associated with the proportion of older people in the population increasing while the working-age population decreases, and stress the importance of addressing these challenges by promoting ongoing human capital development across the life course and across socio-economic and migrant groups. Loichinger and Spiess argue that investments in early education are particularly important, as they have positive effects on fertility, female employment and the integration of parents with a migration background.

Many of the individual country studies highlight a common challenge fuelled by the changes in fertility and migration. Population ageing has proven to be an unavoidable outcome that countries in the post-transitional stage have been trying to manage. However, these countries have so far had little success in doing so for various reasons, including unfavourable labour market conditions, conflicts, limited infrastructure and emigration. Using the example of Italy, a *Research Article* by Reynaud and Miccoli (in this volume), shows that demographic changes can lead to a vicious circle in which population decline and population ageing feed on each other. The authors explain how negative growth rates relate to subsequent population ageing, and show that higher population growth was associated with slower population ageing in different time periods and in different geographic locations.

A *Research Article* by Benassi et al. (in this volume), also looks at population decline in Italian municipalities, pointing to notable differences in the trends in population change across the country. Their analysis reveals the imprints of various socio-economic and demographic dimensions, such as the presence of school facilities and the proximity to these facilities; the presence of students and foreigners; and female labour force participation. The authors' investigation of the diffusion process and the determinants of average annual population growth confirms the need for and the relevance and applicability of analyses of the spatial dimension and local heterogeneities. Evidence from local municipalities in Spain is presented in a *Research Article* by Gil-Alonso et al. (in this volume). In examining urban/rural population change, the authors underscore the importance of factoring in not just geographic location, but also municipal population size in the "post-crisis" period of 2014–2020 (i.e., after the latest Great Recession) and the COVID-19 pandemic, as well as international and internal migration flows. Moreover, they argue that leveraging political impulses, such as creating supplemental governmental bodies or implementing special policies aimed at closing the urban-rural divide and improving rural inhabitants' access to the welfare state, could help to improve the quality of life and opportunities of rural inhabitants, which might, in turn, help to counteract population decline.

Academic scholarship has provided strong support for the claim that policies are the driving force moderating population shrinkage and influencing population distribution. In addition to the policy approaches formulated on global and regional platforms, local policy and planning arrangements are likely to set the tone for the dynamics of shrinking societies, and should not be overlooked. This important point is elucidated in a *Review Article* by Huntington (in this volume), in which he presents observations about the residential segregation of different population groups and the spatial concentration of vulnerable groups in European cities, which have been caused by population decline in urban areas. Huntington's review posits that the governance of shrinkage may be more complicated than the governance of growth. He also argues that greater attention to the complex interdependencies of population change, residential mobility and urban inequalities could help to mitigate those urban inequalities, which might, in turn, lead to more spatially just cities and greater social cohesion in general. Moreover, he observes that the struggle to protect populations from the negative consequences of population decline calls for, and requires, the exercise of good governance. Whether a challenge is turned into an opportunity will largely depend on the seamlessness and foresight of future political decisions, which should be based on socially equitable planning agendas and approaches to tackling urban shrinkage and residential segregation.

4 The importance of political decisions

The importance of identifying the problem correctly when weighing political action is stressed by Sigle in her succinct *Debate* contribution (in this volume), in which she urges population experts to be aware of their (potential) role in shaping "the way that policymakers and citizens subsequently think and behave" (p. 17), and, consequently, to be very careful when interpreting demographic indicators, especially the unfavourable ones. Sigle contends that these indicators should be taken for what they actually are – a symptom of a problem to be targeted, and not a problem per se. Thus, she argues, population decline should never be fought by restricting emigration and reproductive rights. Instead, efforts should be made to identify and address the reasons why people emigrate and/or do not have (more) children. In line with these observations, Vanhuysse (in this volume) demonstrates that in the post-state-socialist countries of Europe, the steady decline in population has been largely the result of policies that focus on the needs and interests of the elderly (i.e., pensioners), while neglecting the needs of young people, including children and their parents.

In his *Debate* piece, Vanhuysse argues that in the early phases of the transition to a market economy, most governments in East Central Europe (ECE) tried to buy social peace and avoid mass-scale unemployment by creating retirement and disability pension schemes for people of working age. "This politically 'pushed', rather than demographically 'pulled', boom in pensioner numbers set in motion powerful new electoral dynamics [...] leading to the emergence of pensioners' democracies or gerontocracies". This happened at a time when the ECE societies were still demographically much younger than the already ageing societies in other parts of Europe. But instead of using that "demographic window of opportunity" to prepare for their inevitable demographic ageing, the ECE countries irreversibly entered the path of "pro-elderly policy bias". This resulted in the "young exit" from ECE to the "old" European Union (EU) countries in the 2000s, after the EU enlargement. Now that the large-scale outmigration of people in their twenties and thirties coupled with three-decade-long (very) low fertility levels have evolved into a dynamic of rapid population shrinkage, the ECE countries are entering the process of demographic ageing unprepared, as they lag behind other European regions in terms of their investments in health, education and technology.

The implementation of an alternative policy approach with a pro-youth bias, as well as the difficulties associated with measuring its effectiveness, are described by Schorn (in this volume) in her article in the *Perspectives* section, in which she analyses four rural regions, two in Germany and two in Austria, that have been affected by the outmigration of mostly young and educated people. Over the last two decades, the four regions introduced a series of measures with the aim of reversing the negative net migration trend by encouraging young people to stay, to come back or to resettle from another region. As promoting youth-oriented regional development cannot be regarded as a single measure, but as a diverse approach in which different measures are integrated, the policies embraced not only improving and advertising local labour market opportunities and strengthening local social ties, but also, depending on the region, investing in transport, culture and leisure activities and affordable housing, or intensifying participation in local policy-making. Following the implementation of these measurers, net migration did indeed increase mostly due to growth in in-migration levels, while out-migration levels remained stable. However, as the net migration trends in the four analysed regions mimicked the general trends observed in rural areas of both Austria and Germany, they could not be unambiguously attributed to the effects of the policies. Thus, Schorn concludes, "more research is needed to evaluate the actual impact of youth-oriented measures". As with any demographic evaluation, adequate indicators and "what-if" projection scenarios are needed.

5 To make the right decisions you need to know your (potential) options

A perfect example of such an indicator is provided by Parr (in this volume) in his *Research Article,* in which he calculates the net migration replacement level for each of the 20 analysed European countries, and finds that net migration above and below this level leads in the long run to a population increase and a population decline, respectively, assuming constant fertility and mortality. Thus, he shows that despite the negative natural increase in many countries, only some of them, mostly in post-state-socialist Europe, are expected to experience a population decline, while the rest are likely to either grow or maintain their current population size thanks to net migration above the net migration replacement level. Parr's method has the advantage of conveying "the implications of the net migration level for long-run population growth, (. . .) [without the] need to refer to (or to run) projections" (p. 204). In addition, the method can be used to simulate the net migration replacement level under different assumptions about fertility and mortality.

The "what-if" scenarios of migration are also the main focus of Tonnesen and Syse's analysis (in this volume). In their *Research Article,* the authors examine the potential consequences of hypothetical changes in the level of emigration – a perspective that is rarely taken in population projections of countries with positive net migration. In Norway, out-migration levels are far below in-migration levels, and have remained lower than those in other European countries in recent decades. However, the effects of the hypothetical halving of out-migration on ageing – measured as the old-age dependency ratio – and on population size are larger than might be expected. The authors compare the effects of changes in various demographic indicators, and find, for example, that reducing the emigration rate by 50% would slow down population ageing to the same, rather modest extent as raising fertility by 0.25 children per woman, but would lead to a larger increase in the population size than in fertility. While the performed computations are purely hypothetical, "a comparison of different scenarios can be useful for demographers and policymakers, and can, more generally, inform the public debate on the relationship among emigration, population size and population ageing" (p. 226). The analysis corroborates the conclusion of past studies that there are no demographic "solutions" to ageing.

The most likely developments in migration trends rather than in different migration scenarios are the focus of the *Research Article* by Vanella et al. (in this volume). The authors offer a novel approach to the regional forecasting of both international and within-country migration flows by age group and gender. Their model "addresses a significant shortcoming in the regional migration projection literature by comparing the performance of different modelling approaches and suggesting a stochastic strategy, thereby stimulating the improvement of the projection approaches commonly used by both researchers and statistical offices" (p. 392). Compared to the official population projections until 2040 published by the German Statistical Office Destatis, the proposed model assumes a higher level of in-migration, but predicts a similar overall pattern of population development: namely, that the migration trends observed in Germany in recent decades will continue and persist, at least until 2040.

6 Conclusion

Earlier in this commentary, we observed that economic and demographic theories have so far been unable to offer an unambiguous prediction regarding the consequences of population decline. We have certainly not been able to produce such an integrated theory in this issue. However, it is perhaps better to have done nearly the opposite: i.e., to have shown that population decline is, indeed, a highly multifaceted issue, and that there is no simple theoretical or empirical application for understanding its causes and consequences, or the potential responses to it. Population decline is an increasingly prominent demographic trend that will require the attention of researchers and policymakers alike, and that will inevitably pose new challenges and present new opportunities. Which of these become more salient very much depends on how we respond to future scenarios today.

We should concede that at the end of this exercise, we probably have more questions than we do answers. Nonetheless, the process of further investigation enhances our understanding of this critically important issue. Rigorous investigation combined with a new set of demographic indicators, methodological approaches and policies will be needed to inform the efforts of countries to anticipate and respond to demographic change, and to build societies and economies that are resilient to, and that are capable of thriving amidst, the demographic changes that are unfolding.

The eagle-eyed reader might have observed that while the call for papers of this special issue used the word "depopulation" in the title, in this commentary, we have mainly used the terms "population decline" and "population shrinkage". This is because in the process of exploring this issue more systematically, we came to believe that the latter terms are more scientifically appropriate (see the discussion in the *Debate* piece by Gietel-Basten). It is precisely through more investigation and in-depth discussion that we can hone our understanding of population decline, and question our assumptions about it.

We are proud to be able to offer this set of papers to you, and hope that it will make an important contribution to our understanding of population decline, while also informing the (often fractious) debate on its consequences, and how best to respond to it.

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DEBATE

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Like high cholesterol, population decline is a problem, but not in the way you might think . . .

Wendy Sigle[1,*]

Abstract

The prospect of population decline in Europe is commonly understood to be an important policy problem. Discussions and research typically focus on the level and the trend of demographic indicators. Can policies be designed which, by targeting the constrained optimisation of rational individuals, cause the indicators to change in the right direction? In this intervention, I argue that like a surrogate marker in medicine, a demographic indicator is not a meaningful endpoint: something that is a direct measure of health or, analogously, a healthy society. Treating population indicators as meaningful endpoints can, as history has shown, lead to great harm. In my view, it is this misconception that makes population decline a truly serious and terrifying problem. So yes, population decline is a problem, but not in the way you, or the people who pose this sort of question, might think.

Keywords: population decline; fertility; institutions; surrogate marker

A few years ago, I was invited to participate in a plenary debate at the IUSSP conference in Cape Town. Specifically, I was asked to respond to the question: "Is very low fertility good or bad for the family, gender and society?" Because very low fertility is the main driver of population decline, my assessment of very low fertility as 'good' or 'bad' relates directly to whether I understand population decline to be a direct indicator of a problem. At first, I thought it would be fairly straightforward to make the case for the 'bad' position. But the more I thought about the question, the more I realised that I needed to think critically about what 'very low fertility' actually means. As Neyer (2011, p. 227) reminds us, "demographic measures are subject to interpretation and are not immutable facts of reality . . . it is demographers, politicians, the media, or other groups of people or public institutions who produce the perception that fertility levels are too 'low' or too 'high' or 'normal'. Likewise,

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it is they who construct the social, economic, and political consequences of fertility levels by transforming demographic measures into ostensibly negative outcomes for the future”. I eventually concluded that it was important to be careful to distinguish between cause and consequence.

As has been demonstrated in previous research (see, for example, the contributions in Rindfuss and Choe, 2016), very low fertility, and, relatedly, population decline, is often the consequence of institutional rigidities in the face of change. When other things that remained or had become incompatible with having children could not be (successfully) altered, it was childbearing behaviour that (eventually) had to adapt. For example, in South Korea and Japan, where the institution of heterosexual marriage has been slow to change and where non-marital childbearing remains stigmatised, women have retreated from or postponed traditional marriage, as evidenced by the growing popularity of ‘single weddings’ for people who want the portrait and the party but not the husband (Newman, 2019; Qian, 2019). Population decline can be understood as one of many consequences of rigidities in gendered institutions in those countries. The issue, as I understand it, is whether there are specific negative consequences that I can attribute to population decline itself. How does one approach this question?

As I sought to clarify my understanding of the issue, I got some inspiration from a trip to the grocery store. Walking through the aisles, I was struck by the number of products that promise to reduce cholesterol levels. The marketing success of these products relies on an important error in thinking. If your doctor tells you that your cholesterol is high, we know it is something to worry about, so a product that can reduce cholesterol must make us healthier, right? Well, not exactly . . .. High cholesterol is a *surrogate marker*, “a laboratory measurement . . . that is used . . . as a substitute for a clinically meaningful end point . . . and that is expected to predict the effect of therapy” (Temple, 1999, p. 790). Low-density lipoprotein (LDL) cholesterol is not a direct measure of heart disease, but an easy-to-measure laboratory value, an indicator of poor health behaviour and a predictor of an eventual bad outcome.

When surrogate markers are validated for a particular therapy, they are meaningful. But there is no evidence that reducing your cholesterol by drinking cholesterol-reducing drinks will reduce your risk of a heart attack. While misplaced efforts to ‘treat’ the surrogate might be a waste of money, in some instances, they can also be harmful. A drug called Torcetrapib substantially reduces LDL cholesterol levels in patients, but it also increases the risk of death and cardiovascular morbidity (Barter et al., 2007). In the world of medicine, Kirsch (2010) cautions that: “Surrogates often take on a life of their own, far removed from the actual disease they represent.” We shouldn’t care if ‘surrogates’ are improving, but should instead look for evidence of whether and when “surrogate improvement means better health”. Like high cholesterol, I think that very low fertility is often an indicator that something is unhealthy or ‘bad’ in society. I can see population decline resulting in harm when the fertility trends that lead to population decline are treated as a policy target; i.e., when, like high cholesterol, they are ‘treated’ as a meaningful endpoint.

To treat population decline or very low fertility as a meaningful endpoint is to assume that achieving a reversal by almost any means is a good outcome, and that the treatment (policies) that achieved such a reversal can be interpreted as a success. This thinking can be used to motivate and justify policy interventions which prioritise particular population outcomes at the expense of individual rights or individual well-being. Just as lowering LDL cholesterol with Torcetrapib can result in poorer health, targeting population decline might do more harm than good. Think, for example, of some of the efforts to respond to the 'threat' of global population growth that unabashedly dismiss or minimise the well-being of the people whose fertility needed to be 'controlled' (Connelly, 2008), or of the infamously coercive pronatalist regimes that we saw in Romania only a few decades ago (Kligman, 1998). While I don't think many people would advocate these kinds of overtly coercive policies, a more passive disregard for individual well-being is not uncommon, especially when countries are first confronted with the 'crisis' of low fertility. For example, Mishtal (2012) describes how policymakers in Poland restricted access to birth control and sex education in the years after fertility fell to very low levels. Increasing fertility by making it more likely that people would be unsuccessful in averting the births of children they didn't feel ready to have or were unable to afford, even as economic insecurity and inequality were growing and (previously generous) support for families was being cut, is not something I would interpret as a success. Similarly, while restricting the emigration of working-age adults, a significant source of population decline in some countries of eastern Europe,[1] might restrain population decline and population ageing, I am not at all sure that this change would imply a healthier society.

When the emphasis lies on changing the behaviour of people (quickly), without much reflection or concern about whether the effect of the intervention is beneficial to the people whose behaviour is being targeted, the damage can be difficult to reverse. Efforts to justify the manipulation of fertility behaviour through policy often target women, depicting them in not very flattering ways: women are irrational or ignorant, and their behaviour is pathological or dangerous. The result may be the development of mistrust in the government by people who feel angry and scapegoated by its narratives. As research carried out by my former PhD student Joanne Marczak suggests, once trust in policymakers has been eroded, it may be difficult to win back, even if the problem representation (low fertility is the fault of stupid and/or selfish women), and the associated policy strategy, change (Marczak et al., 2018).

When we, as experts, seek to explain and reverse population decline, we may shape the way that policymakers and citizens subsequently think and behave (Sigle, 2021). I worry that our research methods can reinforce the impression that broad institutional change is not an option. To identify the ever-elusive causal effects of policy on fertility, our statistical models of childbearing, and the proposed levers we often test, typically hold constant the wider institutional constellation of policies

[1] Thanks to Tomas Sobotka for reminding me of this fact.

in an effort to approach quasi-experimental comparisons. Such conceptualisations implicitly legitimise a focus on 'silver bullet' interventions, even as our cross-national comparative research documents just how different conditions are elsewhere (Sigle, 2016, 2021). As impressed as I am with the success of the 'use it or lose it daddy leave' in the countries that developed this intervention, I am not convinced that importing this 'best practice' would have much impact in the Polish context as described in Mishtal's study (2012), in which women reported being asked during job interviews to take pregnancy tests and to sign agreements not to get pregnant for two to three years after starting employment. Indeed, recent research by my PhD student Zuzana Dancikova showed that in Slovakia, there was a very delayed, and then rather unintended response to the introduction of one of the world's most generous parental leave policies for fathers. As Chanfreau (2022) has recently demonstrated in an historical analysis of the UK, the wider gendered and classed context reflected in and reproduced by previous policies cannot be ignored.

When we use micro-economic models of rational decision-making (childbearing decisions are the outcome of a cost-benefit analysis), we depict a world of constrained optimisation, in which bearing and raising children is always and inevitably going to be costly and disruptive for women and employers (see, for example, Gustafsson, 2001). Taking the constraints of the economy and labour market as more or less given, good parents and good employees are expected to 'choose' the right time to have children, and to bear the costs of any poor choices. Against a backdrop of rising inequality and economic insecurity, our expert discourses construct a high-stakes game in which the *victory condition* (stable employment and some level of economic security) is compromised by childbearing, and preparing children for their own high-stakes competition in the future requires high levels of investment in their quality. Eventually, as Mishtal argues happened in Poland, very strategic thinking about the timing of family events and having only one child becomes a marker of responsible parenthood and middle-class status. Rather than challenge the child-unfriendly environment, the only option is to (continue to) adapt to it. And, as higher status women make these adaptations and justify their behaviour as rational and universally optimal, their adaptations may well be taken up more widely. When we see family and childbearing behaviour as part of a competitive strategy, with the risks of getting it wrong attributed to the bad decisions of individuals, I worry that a sense of social solidarity and a sense of collective responsibility for children will be eroded: your children; your (good or bad) decision; your responsibility. Policies that are framed as an attempt to expand choice sets by targeting the costs of childbearing discursively reinforce this individualistic cost-benefit framework, and make it more likely that people will internalise this way of thinking.

Similar to the way the Varieties of Capitalism (VOC) model is used to explain discrimination against women workers in Coordinated Market Economies (CMEs) as rational and profit-maximising (Rubery, 2009), the rational actor logic and framework vindicates employers who avoid hiring or retaining employees with care responsibilities. The marketing campaigns of egg freezing services and the statements of global corporations that subsidise their costs suggest that the optimal strategy for 'smart women' and 'good employees' is to freeze your eggs and displace your reproduction to a more economically unproductive stage of the life course (Browne, 2018). A society in which caring and family responsibilities are viewed as so inconvenient and incompatible with the labour market is not really one that gets my vote, regardless of its population indicators.

To summarise my argument, it is not sufficient to interpret population decline as a problem. It is necessary to understand how and why it is a problem. In my view, the very low fertility and high rates of emigration that lead to population decline are consequences of institutional rigidities that merit attention. Population indicators represent consequences, the causes of which are obscured as the wider context is held constant. Furthermore, while population decline can have additional detrimental consequences, this is often *because* it is understood and targeted as the problem. When population decline is treated as a meaningful endpoint, something that needs to be changed by whatever means necessary (coercion, egg freezing, etc.), we lose sight of what the meaningful endpoint should be: the kind of society that we want to live in. Although I expect that improvements in people's economic security and time demands would very likely be reflected in people investing more in family life and being less likely to emigrate, population growth or decline is not itself a meaningful endpoint. When the circumstances that led to population decline are left unaltered, made more invisible or taken for granted, the negative consequences of the institutional rigidities that resulted in very low fertility in the first place will persist, and have the potential to do more and lasting harm.

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The human eco-predicament: Overshoot and the population conundrum

William E. Rees[1,*]

Abstract

The human enterprise is in overshoot, depleting essential ecosystems faster than they can regenerate and polluting the ecosphere beyond nature's assimilative capacity. Overshoot is a meta-problem that is the cause of most symptoms of eco-crisis, including climate change, landscape degradation and biodiversity loss. The proximate driver of overshoot is excessive energy and material 'throughput' to serve the global economy. Both rising incomes (consumption) and population growth contribute to the growing human eco-footprint, but increasing throughput due to population growth is the larger factor at the margin. (Egregious and widening inequality is a separate socio-political problem.) Mainstream approaches to alleviating various symptoms of overshoot merely reinforce the *status quo*. This is counter-productive, as overshoot is ultimately a terminal condition. The continuity of civilisation will require a cooperative, planned contraction of both the material economy and human populations, beginning with a personal to civilisational transformation of the fundamental values, beliefs, assumptions and attitudes underpinning neoliberal/capitalist industrial society.

Keywords: overshoot; eco-footprint; carrying capacity; sustainability; population; contraction

1 Introduction: Contrasting approaches to population

My thesis in this paper is that modern techno-industrial (MTI) society is in a state of dangerous ecological overshoot—i.e., that there are too many people consuming and polluting too much on a finite planet. It is not too late, however, to take a lesson

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in sustainability from the tiny tropical island society of Tikopia. Hardly anyone has ever heard of Tikopia, but its history should be known by everyone who cares about the future of Earth. Tikopia is the remnant of an extinct volcano in the south-west Pacific Ocean with an area of less than five square kilometres, 80% of which is arable. First settled by people about 900 before the Common Era, the island has been occupied continuously for nearly 3000 years (Wikipedia, 2021). Most remarkably, for perhaps two millennia, Tikopians have practiced as many as seven forms of birth control and employed other means of harmonising their life-styles with local ecosystems. In short, *by cultural tradition*, Tikopians have managed continuously to maintain their population in the vicinity of 1200 individuals, or about 300 people per square kilometre of arable land. Even today, islanders explicitly assert that their contraceptive and other regulatory behaviours are practiced to prevent the island from becoming overpopulated (Diamond, 2005).

Contrast Tikopia with the modern global community. Planet Earth is also an island in space with a limited productive land area, but it is threatened by rampant ecological degradation (including accelerating climate change), continuous conflict over habitable territory, evidence of incipient energy and food shortages, and growing numbers of political and ecological refugees who can already be counted in the millions. Nonetheless, there are no national or global plans for population management. On the contrary, those few high-income nations whose populations have stabilised or fallen are worried about the expected negative consequences of this trend for economic growth, political influence and social stability; some world religions explicitly consider contraception to be intrinsically evil; and advocates of population policy are often vilified as being neo-Malthusian, anti-human, eco-fascist or racist (Kopnina and Washington, 2016).[1] In short, the 'population question' is still largely a taboo subject in official MTI policy—and even popular—circles. It should therefore be no surprise that in 2022, Earth's population of 7.9 billion people is still growing by more than 1% (80 million people) per year (Worldometer, 2022). Indeed, some authorities suggest that the rate is closer to 90 million per year, and that UN demographers tend to understate population growth for political reasons. According to O'Sullivan (2022), "Where *World Population Prospects 2022* [see UN, 2022] should have been a call to action, it makes an explicit call to inaction".

Against this as background, my aim in this paper is to demonstrate that the present size and continued growth of the human enterprise are anomalies, that population growth is the major contributor to dangerous degradation of the ecosphere at the margin, and that the largest potholes on the road to sustainability are the global spread of consumer life-styles and resistance to family and national population planning.

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[1] For a recent example that attacks and misrepresents me and my co-author, see Kaufman (2022).

1.1 The material roots of overshoot

Continuous, rapid population growth is a recent phenomenon. For most of our species' time on Earth—including most of the agricultural era—humanity's natural propensity to expand has been held in check by negative feedback; e.g., by food and other resource shortages, disease and inter-group conflict. Circumstances changed with the scientific/industrial revolution, and particularly with the increasingly widespread use of fossil fuels (FF) abetted by globalisation and trade. *Homo sapiens* had been around for perhaps 250,000 years before our population topped one billion early in the 19th century, but it took only 200 years (1/1250th as much time!) for it to balloon to nearly eight billion by early in the 21st century. While improvements in medicine, public sanitation and population health contributed, it was mainly the consumption of coal, oil and gas that made this spectacular expansion possible (half the FF ever used have been burned since 1990.) Fossil fuels are the energetic means by which humans extract, transport and transform the prodigious quantities of food and other material resources needed to support our burgeoning billions all over the world (Rees, 2020a). In short, science and fossil energy enabled *H. sapiens* to eliminate or reduce historically normal negative feedback and let positive feedback take over. For the first time in human evolutionary history, the scientific and industrial revolutions enabled our species to exhibit its full biological potential for geometric growth on a global scale (Figure 1).

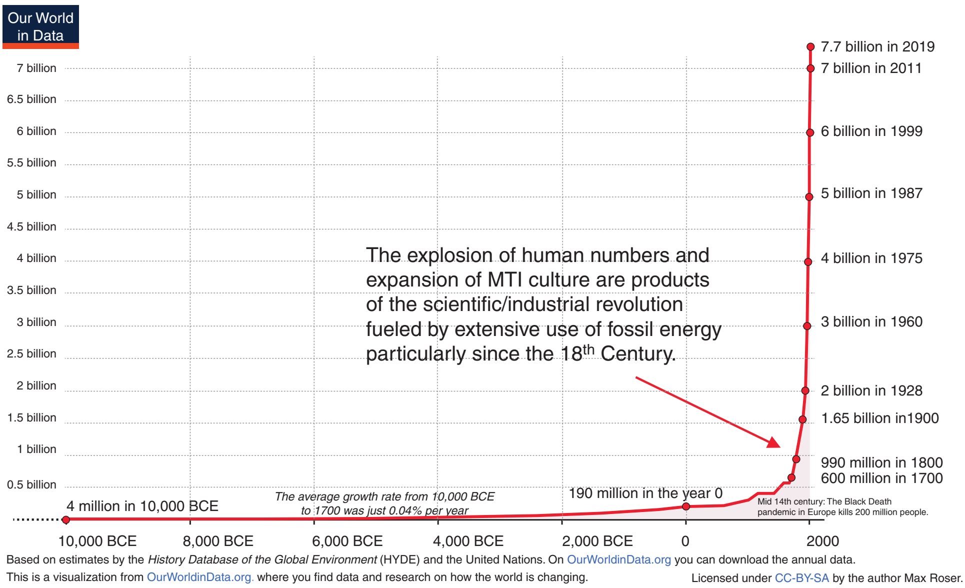
The 1300-fold increase in fossil energy use also drove economic growth. Between 1800 and 2016, Earth experienced a 100-fold increase in real global GDP; i.e., a 13-fold surge in average per capita incomes (25-fold in the richest countries) (Roser, 2019). Material consumption and pollution expanded accordingly. As William Catton wryly observed, the world was being asked to support not only more people, but ecologically larger people (Catton, 1982).

The explosion of the human enterprise is truly an unprecedented phenomenon. A mere glance at Figure 1 should be enough to convince anyone that only the most recent 10 generations of perhaps 10,000 generations of *H. sapiens* have witnessed sufficient global population and economic growth in their lifetimes to even notice such trends. Growth rates that modern techno-industrial society has come to accept as the norm actually define the single most *anomalous* period in human evolutionary history.

Unfortunately, Earth has not become any larger. Thus, the immediate consequence of unconstrained population and economic growth is that *H. sapiens* is well into a state of *ecological overshoot*. Overshoot means that the human enterprise is consuming even renewable resources faster than ecosystems can regenerate them, and is producing more waste than the ecosphere can assimilate. This is the very definition of biophysical unsustainability.

Overshoot is a meta-problem: climate change, ocean acidification, over-fishing, tropical deforestation, plunging biodiversity, soil/land degradation, falling human sperm counts, pollution of everything, etc., are co-symptoms of overshoot. *No major co-symptom can be fully addressed in isolation, but all can be solved by eliminating overshoot.* Mainstream efforts to slow climate change through the adoption of modern

Figure 1:
The growth of human numbers over the past 12,000 years



Source: Adapted from Roser et al. (2019) (CC BY-SA 4.0).

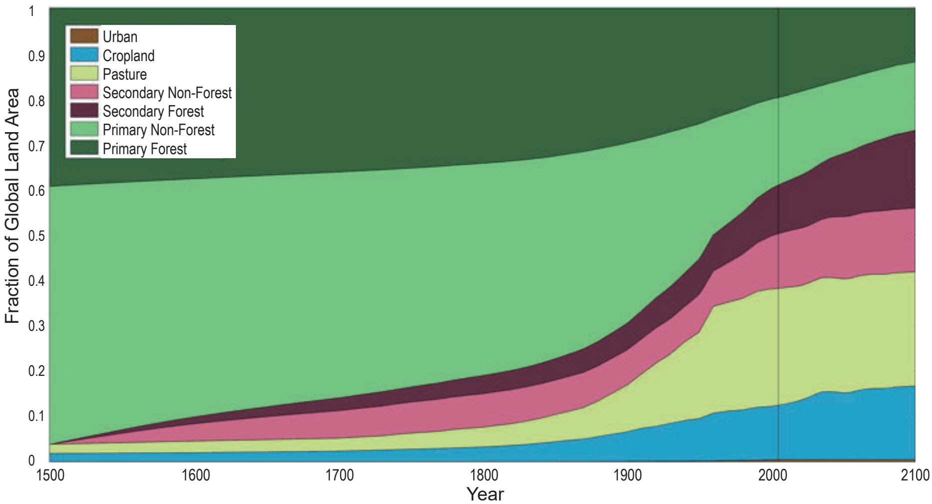
renewable energy technologies, for example, will not solve the climate problem, and can only exacerbate overshoot (Seibert and Rees, 2021).

The growing list of so-called ‘environmental problems’ is empirical evidence that we humans are literally depleting and contaminating the biophysical basis of our own existence. We are the problem. The destruction of essential natural capital erodes the functional integrity of the ecosphere and undermines life-support functions vital to human survival. The long-term costs are incalculable. Ecological economist Herman Daly has suggested that overshoot coincides with uneconomic growth; i.e., with growth that impoverishes rather than enriches (Daly, 2014). Overshoot is ultimately a terminal condition. The acceleration of climate change is merely the most popularised single symptom. (Humans tend to think in simplistic, reductionist terms.)

2 Humanity’s competitive displacement of nature

Beginning with the dawn of agriculture (perhaps the most ecologically damaging of human technologies) 10,000 years ago, humans have gradually become the major

Figure 2:
Changes in relative distribution of terrestrial ecosystems since 1500 (projection beyond 2000 assumes a low emissions scenario and global warming <2 C°) Note the rapid acceleration associated with the use of fossil fuels and increasing population in the 19th century



Source: Adapted from Hurtt et al. (2011) (CC BY-NC 2.0).

geological force changing the face of the Earth. Consider alone the human takeover of ecologically productive landscapes and the displacement (or extinction) of non-human vertebrates and other species from their habitats. In the past millennium, about 75% of Earth's land area has been affected by human activity, 50% in just the past 300 years (Figure 2). In the process, up to a third of the world's forests have been permanently converted, mostly to agriculture, which now appropriates about 30% of the land surface. Tens of millions of square kilometres of land have been lost to production or are recovering from degradation (Hurtt et al., 2006, 2011; Ritchie, 2021; Winkler et al., 2021).

The increase in human numbers *on a finite planet* necessarily 'competitively displaces' wild species. Habitats and food sources appropriated by humans are irreversibly unavailable to other life forms. Thus, the massive conversion of productive ecosystems from their natural state to serve ever more people has had a proportionate effect on the distribution of biomass among land-dwelling vertebrate species. *H. sapiens* accounts for only .01% of Earthly biomass, but the conversion of global ecosystems to support human expansion has eliminated 83% of wild animal and 50% of natural plant biomass. Scientists estimate that Palaeolithic humans represented less than 1.0% of mammalian biomass. However, with the agricultural and the more recent industrial revolutions, we now constitute 36%, and our domestic livestock another 60%, of the planet's (much expanded) mammalian biomass. All wild mammals combined now comprise only 4% of the mammalian total. Nor have birds been spared. Wild populations of many species are in freefall, and domestic poultry now represent 70% of Earth's remaining avian biomass (Bar-On et al., 2018; see also Smil, 2011; OP, 2022).

The story is being repeated at sea. Fossil-powered commercial fishing competes directly with marine birds and mammals for food-fish. Gremillet et al. (2018) report that seabirds suffered a 70% community-level population decline between 1950 and 2010 as their natural food sources were redirected to human consumption. In general, the World Wildlife Fund documents a 68% average decline of monitored birds, amphibians, mammals, fish and reptiles since 1970, which points to a dramatic loss of the health and resilience of ecosystems (WWF, 2020). There is little question that the inexorable increase in human numbers and related resource extraction are the cause. Fowler and Hobbs (2003) found that humanity's technology-aided material demands on exploited ecosystems often dwarf those of competing species by orders of magnitude—in 22 of 31 tests, human demands lie outside the 99% confidence limits of variation among those of dozens of other ecologically similar species, often at the expense of the latter. Bottom line: The growth of human populations and material consumption is driving the 'sixth extinction' (Kolbert, 2014; Shragg, 2022). Fowler and Hobbs (2003) even ask: *Is humanity sustainable*?

3 The population factor in overshoot

We can estimate the extent of overshoot using eco-footprint analysis (EFA). A population's ecological footprint (EF) is defined as: *the area of productive ecosystems required, on a continuous basis, to produce the renewable resources that the population consumes and to assimilate its carbon wastes* (Rees, 2013). In effect, a population EF is the product of average per capita consumption/carbon assimilation multiplied by total population, converted to a corresponding ecosystem area. EFA uniquely enables rough but informative comparisons of humanity's demand on the ecosphere (population EFs) with nature's supply (biocapacity).

We should note that for methodological reasons and due to data limitations, published EFA data generally *underestimate* human demand. For example, while EFA may compile a population's use of arable land, forest, carbon sinks and fishing-grounds, the method cannot reflect whether the appropriated ecosystems are being used sustainably (which they often are not). Nor does EFA account directly for the effects of most forms of pollution.

Even with these limitations, in 2017, the human EF (20.9 billion hectares) was *at least* 73% larger than available biocapacity (12.1 billion productive hectares) (GFN, 2022). The excess of demand over supply represents humanity's *ecological deficit* and provides a rough estimate of overshoot. Any eco-deficit underscores the fact that the maintenance and growth of the human enterprise is being 'financed' not only by the annual production by ecosystems, but also by the liquidation/pollution of the ecosphere. (Climate change is, in part, a pollution problem—carbon dioxide is the greatest single waste product by weight of industrial economies.)

The human EF nearly tripled from ~7.0 billion to 20.9 billion global average productive hectares (gha) between 1960 and 2017 (GFN, 2022). While both rising per capita incomes (consumption) and increasing populations contribute to material growth, we can use EFA to show that the ballooning human EF is caused primarily by swelling populations, particularly in middle-income countries (Figure 3).

We begin by considering high-income nations. Wealth-driven growth in material consumption has historically outstripped population growth in wealthy countries to produce per capita EFs averaging ~6.0 gha in 2016. This is 2.2 times the global average of ~2.7 gha in that year. On average, the wealthy demand almost four times their proportional share (1.6 gha/capita) of global biocapacity.

The total eco-footprint of high-income consumers increased by 3.2 billion gha (from 3.6 billion to 6.8 billion) between 1961 and 2016. The 2016 figure equates to 34% of the total human EF and a grossly inequitable 57% of global biocapacity. Because of their elevated consumption and outsized EFs, the addition of just 0.4 billion high-income people (5.4% of world population) added 2.4 billion gha (12%) to the 2016 total human EF. In short, the 54% increase in high-income population since 1961 accounts for ~75% of the 3.2 billion gha increase in high-income consumers' demand on nature (data from the upper-left quadrant of Figure 3)

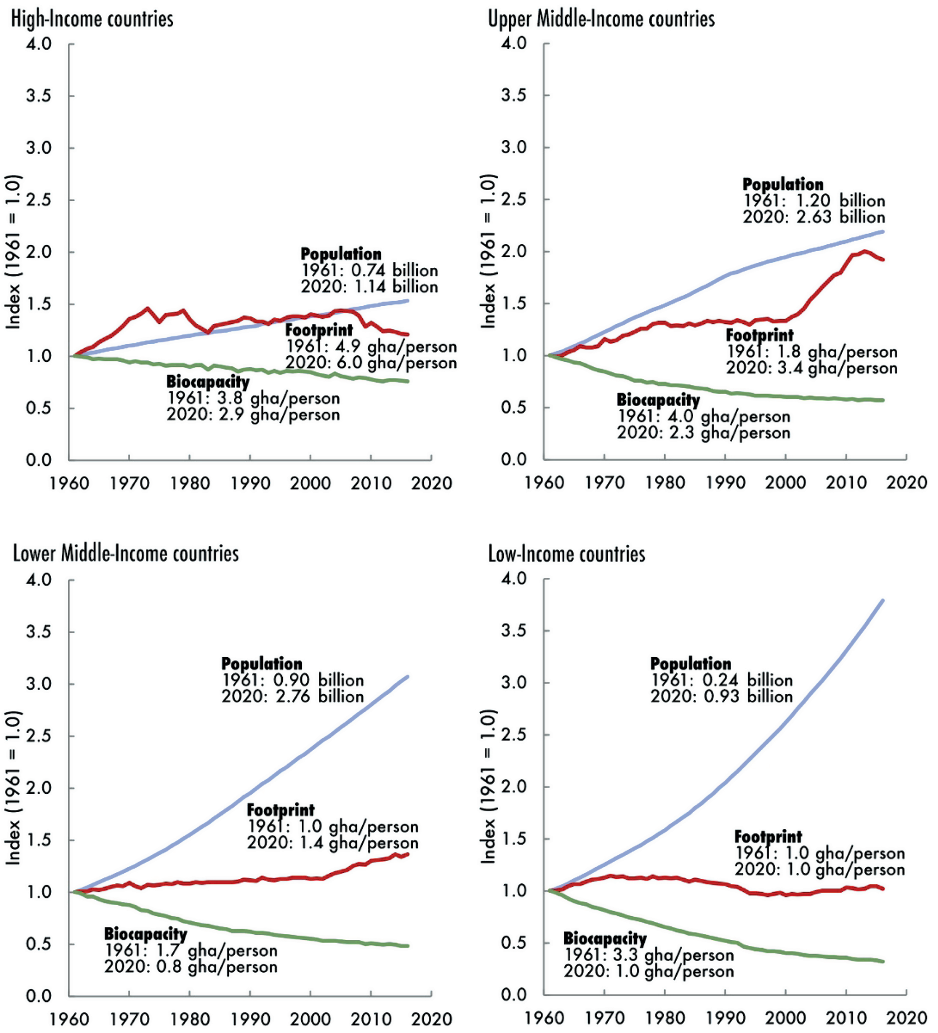
Turning to upper-middle-income countries, per capita EFs nearly doubled to 3.4 gha and the population more than doubled to 2.63 billion between 1961 and 2016, for a >four-fold increase in impact. The total EF of upper-middle-income consumers increased by 6.7 billion gha (from 2.2 to 8.9 billion). The additional 1.43 billion people accounted for 4.9 billion gha, ~73% of the increase and 55% of the upper-middle-income total. This increase alone contributed 24% to the total human EF (Figure 3, upper-right quadrant).

In the lower-middle-income countries, the average EF expanded by only 40% to 1.4 gha between 1961 and 2016, but population increased more than three-fold from 0.9 to 2.76 billion. Lower-middle-income demand on nature increased by 2.96 billion gha (from .90 to 3.86 billion gha), of which the 1.86 billion increase in population accounted for 2.6 billion (88%). This increase added 13% to the total 2016 human eco-footprint (Figure 3, lower-left quadrant).

Finally, low-income countries saw no increase in their average 1.0 gha footprints between 1961 and 2016, while their populations ballooned almost four-fold from 0.24 to 0.93 billion people. The population increase of 0.69 billion neutralised any benefits of GDP growth, but accounted for the entire ~0.69 billion gha increase in the total low-income EF to 0.93 billion gha (still only 4.6% of the global total) (Figure 3, lower-right quadrant).

Summing the above estimates shows that, between 1961 and 2016, the addition of ~4.4 billion human consumers contributed ~10.6 billion gha to the growing consumption-based human eco-footprint. The total EF in 1961 was about 7.0 billion

Figure 3:
Ecological footprint, biocapacity and population for high-income, upper middle-income, lower middle income and low income countries, 1961–2016



Source: Reproduced with permission from Wackernagel (2020).

gha, expanding to 20.2 billion gha in 2016, an increase of 13.2 billion gha (GFN, 2022). Thus, *population growth accounted for ~80% of the increase in the total human EF* above what would have accrued had populations remained constant while income/consumption and per capita EFs increased, as shown in Figure 3.

4 What it all means: Population and sustainability on a finite planet

We can draw several lessons from these data. Most important, while over-consumption and population growth have long been recognised as co-drivers of overshoot (Ehrlich and Ehrlich, 2014; Ehrlich and Holdren, 1971), population growth is currently the major contributor to total consumption growth and associated negative ecological impacts in all four income categories. Those who object to serious discussion of the relationship between population growth and the human eco-crisis must confront this reality. That said, it is crucial to recognise that EFs per capita differ greatly among income groups—increasing the population of an upper-income country by one average citizen imposes *at least* the same ecological load on Earth as a six-person increase in a typical low-income country (remember, EFs, particularly among high-end consumers are generally underestimates).

This fact serves, first, to underscore the egregious, inexcusable, yet still increasing material inequality between rich and poor people and nations in today's world. Globalisation and unfair terms of trade in world markets enable the citizens of wealthy countries to appropriate legally, by commercial means, several times their equitable share of Earth's biocapacity from other countries and the global commons. Many wealthy importing countries are running large eco-deficits. Figure 3 shows that available biocapacity per capita is declining in all income quadrants. However, remember that 1.14 billion rich consumers (15% of the human population) lay claim to 57% of global biocapacity, and that forms of eco-degradation not captured by EFA (e.g., soil depletion, overfishing, non-carbon pollution, ocean acidification, etc.) are everywhere disproportionately driven by consumers in the richest nations. Since the human enterprise is in overshoot and is rapidly eroding its own ecological foundations, *any effort to achieve sustainability within global carrying capacity must address the fundamental inequities generated by the present world economic order*.

Second, these data show that 'peak population' and subsequent population decline in high-income countries should be cause for celebration. Population growth in the richest nations generates almost an order of magnitude greater demand for biocapacity than an equivalent numerical gain in low-income countries. Even greater income disparities are revealed by studies of national 'material footprints'; i.e., the total quantity of raw materials extracted to meet a country's final consumption demands. The per capita 'material footprint' in high-income countries (26.3 tonnes/capita) is more than 13 times the 2.0 tonnes/capita generated by low-income countries (UN, 2019; Wiedmann et al., 2013). Again, it follows that the most *ecologically* significant macro-level gains from policies to reduce populations would come from accelerated population decline among high-income consumers.

But this does not mean we can ignore population growth in middle-income and poor countries. There are both socio-economic and ecological reasons for concerted non-coercive population reduction policies. First, despite the 3.9-fold increase in the total EF (consumption) in the most impoverished countries, the material well-being of the average person in these countries has remained unchanged. Ballooning populations have negated any gains from increased GDP among ordinary citizens. It follows that the most significant *social* benefits from stable populations would accrue at the micro level to the low-income families of poor countries who would enjoy larger slices of the economic pie. At the very least, a falling population would empower the poor by giving them more bargaining power in national labour markets.

Second, as was previously emphasised, humanity is already in overshoot and running a massive ecological deficit; the world community is financing aggregate population and economic growth by liquidating essential natural capital. Clearly, mere income/wealth redistribution would not correct this problem.

Nor can eco-deficit financing continue. Like a rocket, the human enterprise can accelerate only to the point that it runs out of fuel, and humanity's fuel gauge is already in the yellow zone of over-fishing, disappearing tropical forests, plunging biodiversity, receding glaciers, falling water tables, degraded soils/landscapes, incipient energy and resource shortages, etc. In particular, there are now fewer than .18 ha/capita of arable land on Earth (Ritchie and Roser, 2019; World Bank, 2022) (which compares poorly with .33 ha/capita on Tikopia, *a ratio that the island's stable population has maintained for centuries*). Population growth only further drains the global tank and shortens the time until the reckoning. Arable land/capita is declining globally, and the productivity of even our remaining .18 ha/capita is dependent on the continued use of dangerously polluting fossil fuel derivatives (pesticides and fertilisers), and on climate-wrecking fossil-powered irrigation, cultivating and harvesting equipment. What is our fall-back if we abandon FF?

In this context, consider the scale of the sustainability challenge. Let's first assume we could at least stabilise world population, Tikopia-like, in the vicinity of 2022's eight billion people. Eight billion is already ~73% too high at the global average eco-footprint of 2.75 gha (2017 data), and with rising incomes/consumption and the spread of consumer culture, everyone is striving to match the six gha ecological footprints of today's average high-income consumers. This is an impossible scenario that would fatally gut the ecosphere. Total demand would exceed 48 billion hectares on a planet with only ~12 billion productive hectares. In short, we would need the bio-capacity equivalent of three additional Earth-like planets to supply the demands of just the present population sustainably. As some wag once remarked, "good planets are hard to find". And, of course, there are no plans to hold the population constant—demographically at least, we're headed toward ~10 billion by 2050, and perhaps 11 billion by century's end.

Alternatively, the present world community might strive to live *within* global carrying capacity—to work toward achieving 'one-planet living'. This would require a reduction in the aggregate human eco-footprint of at least 42%. Assuming we would also choose to capture the benefits of greater equity (Wilkinson and Pickett, 2010), we might begin by redistributing the stock of global biocapacity equally among the human population. (For illustration's sake, we ignore the needs of non-human species.) Based on this criterion, each person alive today would be entitled to 1.5 global average hectares (12 billion ha/8 billion people)—that is, everyone would have to learn to live off the productive output and waste assimilation capacity of just 1.5 gha (~3.8 acres), and *this assumes no further population growth*.

Since the consumer lifestyles of residents in high-income countries demand, on average, the productivity of 6.0 gha/capita, the world's wealthy would have to reduce their eco-footprints by ~75%. While the lifestyle changes implied by this requirement seem impossibly extreme and would be strenuously resisted, this estimate is quite conservative for the methodological reasons previously noted. Indeed, as early as 1993, the Business Council for Sustainable Development reported that: "Industrialised world reductions in material throughput, energy use, and environmental degradation of over 90% will be required by 2040 to meet the needs of a growing world population fairly within the planet's ecological means" (BCSD, 1993, 10). Several recent estimates of necessary rich country reductions fall within the same ballpark (e.g., Bringezu, 2015; IGES, 2019). (These analyses typically fail to explore the need for population reductions.)

On the positive side, global sustainability with justice would mean that citizens of low-income countries would theoretically be able to *increase* their consumption by 50%. Their materially improved life-styles would increase their one gha EFs to the targeted 1.5 gha/capita.

This analysis makes clear that without the equity provision and significant population reductions, the world community could achieve sustainability *only* if its impoverished billions remain poor and the presently wealthy greatly reduce their material consumption.

5 The lesson of population ecology: What goes up will come down

In the real world, of course, the population is still growing and there is zero international interest in sizing the global economy to fit within carrying capacity or to share the world's bounty more equitably.

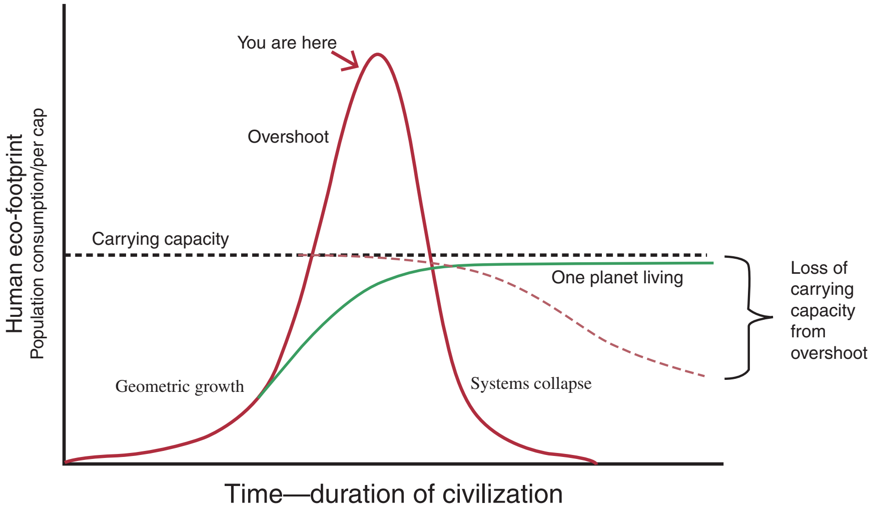
Perhaps this is to be expected. Despite our much-vaunted high intelligence, *H. sapiens* is not primarily a rational species. We tend to be foolishly short-sighted and are prone to selfishness (Pratarelli, 2008); emotions, instinct, cognitive dysfunction and acquired habits—often operating beneath consciousness—dominate personal and political behaviour (Damasio, 1994; Wexler, 2006). For example, humans share with all other organisms the inherent propensity to expand to fill all accessible habitats and to use up available resources, but with the major difference being that our technological prowess is constantly upgrading the resources that are 'accessible' and 'available'. (Even Tikopians eliminated much of their island's original fauna before being forced by their self-created circumstances to control their numbers). To complicate matters, MTI culture's natural propensity to expand (nature) is being reinforced by a neoliberal econo-cultural narrative (nurture) centred on continuous material growth propelled by technological innovation. The result is that, in many respects, humanity's expansion and depletion of Earth are analogous to a bacterium species' colonisation and depletion of nutrient broth in a Petri dish (Rees, 2020a, 2020b).

Human population dynamics are similar to those of non-human species in other ways. All living organisms, when exposed to a temporary abundance of some previously limiting resource, have the capacity to respond with a rapid population outbreak that leads to overshoot. In such cases, the inherent ability to reproduce exponentially (positive feedback) is released from the resource shortage that previously kept it in check (negative feedback). Some species in simple ecosystems exhibit regular cycles of outbreak followed by collapse, with the outbreak sometimes being called the 'plague phase' of the cycle. Whether cyclical or not, population outbreaks invariably end when resources run out or other forms of negative feedback (e.g., disease, predation) emerge and re-establish balance (Rees, 2020b).

There is no reason to think that *H. sapiens* is exempt from this phenomenon. Figure 1 shows the explosive expansion of the human population enabled by public health improvements, and particularly by the extraordinary resource abundance afforded by extensive use of fossil fuels. We are well into overshoot. As was previously emphasised, the sheer size of the human enterprise now threatens its own long-term survival as we deplete various essential biophysical resources and undermine vital life-support services (e.g., the Holocene climate). Meanwhile, poverty is again increasing; epidemic disease is becoming more common; climate change and food shortages portend famine and mass migrations; and political strife and violence, including competition for limited habitable land, is increasing. Indeed, the available evidence supports the hypothesis that modern humans may well be nearing the peak of an unprecedented and likely one-off plague-like global population outbreak affecting virtually the entire planet (Rees, 2020b). Such an outbreak invariably ends in contraction or collapse (Figure 4).

The pattern described above and in Figure 4 is consistent with the thesis of various authors that civilisations follow a common, inexorable developmental trajectory from youthful vibrancy and resilience to brittle maturity that is characterised by political corruption, material inequality, failing institutions, ecological decay and, finally, decline or collapse (e.g., Ophuls, 2012; Tainter, 1988). This thesis is also wholly compatible with the business-as-usual or 'standard run' scenario of the (in)famous *Limits to Growth* analysis (Meadows et al., 1972), in which population peaks around mid-century, then rapidly declines (see also Heinberg, 2022; Herrington, 2020; Turner, 2008). There seems to be something in human nature and patterns of socio-political organisation that drives societies toward self-destruction. As they grow and complexify, they eventually overshoot the competence of crumbling governance structures and social institutions to cope with cumulative socio-cultural disorder, resource shortages and ecological decay.

Figure 4:
The one-off human population outbreak



Source: Adapted with permission from Rees (2022).
Note: The human population, at present average levels of consumption, exceeds the carrying capacity of the ecosphere and is well into overshoot, as revealed by eco-footprint analysis and myriad other data (solid red line). However, consumption continues to grow, depleting resource stocks and undermining remaining biocapacity. A truly rational species would have maintained its population below carrying capacity (solid green line), consistent with one-planet living (as on Tikopia). This option is no longer available. As we near peak population, the global community must choose between cooperation to manage a controlled population contraction within the remaining regenerative capacity of the ecosphere (dashed red line) or enduring a violently chaotic systems collapse in which billions will suffer.

6 Conclusion: Can we break the cycle?

Knowing history, must we repeat it? Humanists and other optimists insist that *H. sapiens* has unique qualities that we have arguably yet to exercise fully in addressing overshoot, among them the capacities to reason logically from the evidence and the ability to plan ahead in ways that could dramatically alter future prospects. It helps that in times of stress we are capable of cooperation, compassion and sacrifice, and that we possess a unique appreciation of our own vulnerability and mortality. The scientific evidence tells us *that some form of contraction of the human enterprise is a biophysical necessity if we are to maintain the functional integrity of the ecosphere*. Context and history therefore present us with a choice: either we accept biophysical reality, rise to our full human potential and 'engineer' an orderly way down; or we challenge the evidence and do everything we can to maintain the status quo. The former option would require the world community to plan and execute a dramatic but controlled down-sizing of the human enterprise; the latter option would ultimately force nature to impose its own contraction; humanity would suffer the ugly consequences of a chaotic implosion condemning billions to suffering and death.

6.1 Where we stand

In 2022, the only 'plans' on the official table are two variations on the second option—maintaining the status quo:

> Variation 1: **Standard 'business-as-usual-as-usual'—This plan calls for the technologically-assisted maintenance of economically extractable supplies of fossil fuels (FF), supplemented by renewable energy, to enable maintenance of the economic status quo at least for several decades, based on the assumption that we can cope with any negative 'feedback' when it occurs.** This approach (*which seems to be the default position of governments*) would continue to grow the economy, exacerbate inequity, waste resources, precipitate runaway climate change, gut the ecosphere and undermine crucial life-support functions; i.e., it has a high probability of generating socio-geo-political chaos and the collapse of global civilisation.
>
> Variation 2: **'Business-as-usual-by-alternative-means'—With the ostensible goal of avoiding the worst effects of climate change (but still not acknowledging overshoot), this plan would implement an all-out renewable energy (RE) strategy quantitatively sufficient to maintain current levels of population and material growth, i.e., the status quo.** This option, the dream of RE and Green New Deal advocates (but arguably not technically feasible in a climate-friendly time frame) (Seibert and Rees, 2021), would not really halt climate change, and would otherwise generate the same negative social and ecological impacts as Scenario 1a; i.e., socio-geo-political chaos and the collapse of global society.

Both variations suggest that humanity's techno-hubris is exceeded only by collective denial and ignorance of systems behaviour.

The as-yet-unacceptable alternative—acknowledging overshoot and recognising that a major reduction of both population and economic throughput (consumption and pollution) is the only way to eliminate it—is barely beginning to take form. Victor (2019), for example, explores realistic possibilities of living without economic growth; and the degrowth movement contemplates simpler, localised lifestyles, much reduced production and consumption, and greater social equality—but not reduced populations (see R&D, 2022).

But full realisation of the controlled contraction option requires a deeper dive beginning with a personal and cultural—indeed, 'civilisational'—transformation of the fundamental values, beliefs, assumptions and attitudes that underpin neoliberal/capitalist industrial (MTI) society. Crucially, the new cultural narrative must acknowledge that the human enterprise is a fully dependent subsystem of the non-growing ecosphere that we ourselves are destroying. This, in turn, demands a shift from the prevailing obsession with material growth (quantitative increase) and technological efficiency towards true development (qualitative betterment, such as improvements in nature reserves, public facilities, health care, education, opportunities for personal development, etc.) and greater equity, but all on a much-reduced scale. The world must also formally acknowledge that (un)sustainability is a collective problem requiring collective solutions; the present individualistic competitive race to mutual destruction must give way to unprecedented international cooperation in developing an inclusive survival plan.

In short, the continuity of civilisation requires a cooperative, planned major contraction of both the material economy and human populations. The overall goal must be to establish and maintain the necessary conditions for a smaller human family (one to two billion people) to enjoy both economic and ecological security through 'one-planet living'. Rees (2020a) provides examples of policy directions consistent with this change of course. People will learn to thrive on less and live more justly in a 'steady-state' relationship with nature (see Daly, 1991), well within the remaining regenerative and assimilative capacities of the ecosphere (see Figure 4). Can there possibly be a more riveting intellectual and practical challenge?

Of course, not all problems are solvable at a global scale. To be brutally clear-eyed, the prospect that our increasingly fractious world community will happily collaborate to achieve the one-planet goal is hardly the brightest star in the constellation of possible human futures. Failure would indeed be tragic—if the world's nations cannot come together to fully engage their common fate, humanity proclaims itself to have no more practical intelligence or conscious moral agency when it comes to its own inclusive survival than does any other species in overshoot at the brink of collapse.

Thankfully there is always some good news—having long since learned 'the way', Tikopean society, at least, might well continue to thrive for another three millennia, regardless of what happens elsewhere.

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Population decline will likely become a global trend and benefit long-term human wellbeing

Wolfgang Lutz[1,*]

Abstract

Summarising earlier publications, I draw a rather optimistic picture of the human future on this planet, if priority is given to universal education, and, in particular, to female education. The benefits of a greater focus on education range from a lower desired family size and empowerment to reach this goal, to better family health, to poverty reduction, to greater resilience, to expanded capacities to mitigate and adapt to climate change, and, ultimately, to the emergence of better institutions and social values that are less obsessed with material consumption and violent nationalism and more concerned with cooperation, care and wellbeing. I also show that extended periods of below replacement level fertility are beneficial for long-term human wellbeing, and that the human population is on the path to peaking during the second half of this century and then declining to 2–4 billion people by 2200. As this smaller population will be well-educated, they should be healthy and wealthy enough to be able to cope fairly successfully with the already unavoidable (moderate) effects of climate change.

Keywords: population; climate change; long-term; human capital; female education

1 Introduction

"Towards a world of 2–6 billion well-educated and therefore healthy and wealthy people" was the title of an editorial I published in 2009 in the Journal of the Royal Statistical Society (Lutz, 2009), and I further expanded this title in 2017 by adding the words "... that would be able to cope well with the consequences of already unavoidable climate change" (Lutz, 2017). In both papers, I am speaking about the longer-term future of the 22nd century and beyond. The challenge at

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hand, however, is how to manage the necessary transitions over the coming decades, including the transformation of our energy system, the relocation of people, and the possible conflicts arising from nationalism, vested interests of certain groups, and, at a deeper level, backward-oriented patriarchal attitudes resisting the enlightenment and empowerment of women.

In the opening plenary speech of the Pontifical Academy of Sciences meeting in the Vatican in 2017, I introduced the notion of "the rise of *homo sapiens literata*" (intentionally using the female adjective with the generic male noun *homo*) to highlight the key role of female education in accelerating not only the demographic transition, but also the urgently needed transformation of countries into societies that are less obsessed with conventional economic growth, material consumption and violent expansive nationalism, and are more concerned with cooperation, care and quality of life.

In this short commentary, I will try to argue that this focus on more education, and, in particular, female empowerment through education, can help to resolve the current apparent controversies around the issue of population. While there is a very rich body of literature showing that education has positive effects on health, poverty reduction and economic growth, and that it lowers the desired family size and enhances access to contraception (Galor, 2010; Lutz, 2014; Prettner and Strulik, 2017), strangely, these insights have not yet entered the so-called population debate. In this commentary, I will explicitly refer to the Debate contribution by Rees (2022, this volume) as well as to a recent set of comments in the "Population Debate Revisited" of the "Great Transition Initiative", and, in particular, its opening essay by Lowe (2022). Both of these contributions focus on the role of population trends in global environmental change, and state that despite its overriding importance, population is hardly discussed in the climate change literature because it is considered a taboo topic. They also call it the elephant in the room.

Here I argue that the role of demographic trends and longer-term population forecasts that draw on different possible scenarios must indeed be a prominent and explicit topic in our discussions of the future of humanity. But this discussion should also be based on the most recent state of the art in demography, particularly on the multi-dimensional approach to modelling changing population size and structures– which is the very definition of demography. I should clarify at this point that I also consider changes in the educational structure of populations by age and sex as demographic changes under a multi-dimensional definition of demography (Lutz, 2021). Strangely, of the over 25 commentators in the abovementioned "Population Debate Revisited", I could recognise not a single one as being a demographer. In the following, I would like to show how this debate can become more enlightened and less controversial once it is based on the proper state-of-the-art demography, rather than on often poorly informed and ideologically predefined views. The same applies to statements by people panicking about depopulation for mostly nationalistic reasons.

2 The role of demographic change in our "dangerous ecological overshoot"

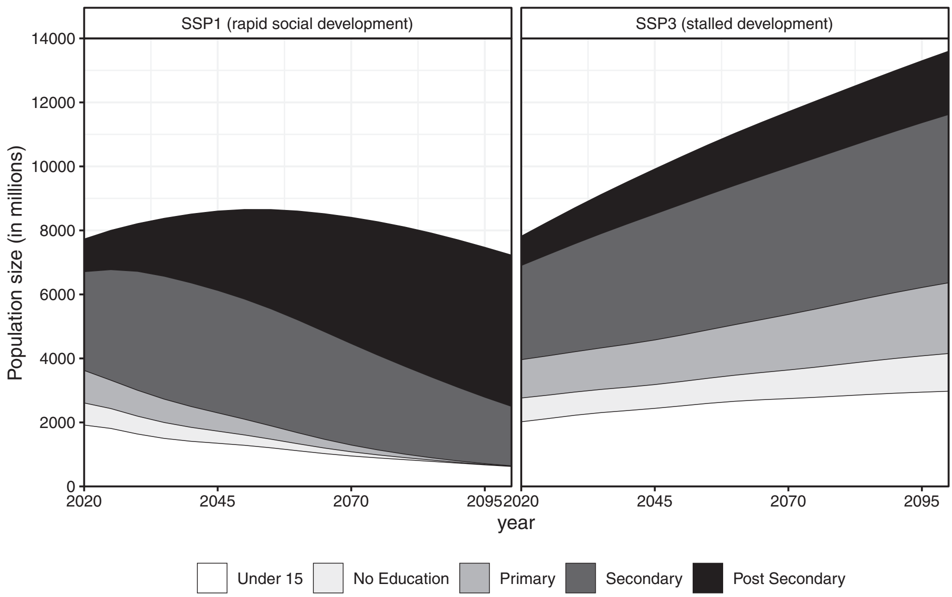
In his Debate article in this issue of the Vienna Yearbook of Population Research, William E. Rees, the father of the highly influential concept of the ecological footprint, makes a convincing case that our modern techno-industrial society is in a state of dangerous ecological overshoot. In a nutshell, his point is that too many people consume and pollute too much on a finite planet. While acknowledging the important role of prevalent material production systems and consumer lifestyles in causing this overshoot, he also stresses that continued population growth is the major contributor to this dangerous degradation of the ecosphere, and argues that resistance to family and national population planning is one of the "largest potholes on the road to sustainability" (Rees, 2022, p. 2).

In a similar vein, Lowe (2022), in his opening essay to the abovementioned "Population Debate Revisited", highlights the important role population growth plays in current and future climate change trends. He also claims–unfortunately without providing the numerical information on which this claim is based–that the synthesis of results from several climate models shows that if world population follows the UN medium population forecast, it is not feasible to limit global warming to below 2 degrees Celsius above pre-industrial levels, which the Paris Agreement has set as an overriding goal. I will call this claim into question later in this commentary. At this stage, I would simply like to point out that his entire argument focuses only on the so-called mitigation side (how factors contribute to greenhouse gas emissions), and disregards the potentially even more relevant effects of demography on the adaptation side. In particular, he fails to recognise how future demographic trends might affect the adaptive capacity of societies to cope with the level of climate change that is already unavoidable, even if the Paris goal should be reached. While it is clearly important to secure the functioning of life support systems–including climate-related factors–to protect human existence and well-being on this planet, a focus on adaptation to the ongoing and unavoidable consequences of climate change is equally essential.

The Shared Socioeconomic Pathways (SSPs, Riahi et al., 2017), which are now widely used in the climate change modelling community and are extensively cited in the recent Report of the Intergovernmental Panel on Climate Change (IPCC, 2022), are based on a multi-dimensional population model by age, sex and six levels of educational attainment, and are explicitly designed to cover both the mitigation and the adaptation effects of alternative future demographic trends. In this context, it has also been shown that education, in particular the universal education of women, is not only the most powerful driver of fertility decline, but is also a key contributor to the empowerment, abstract thinking, forward-looking planning and access to information that societies will need to enhance their adaptative capacity and reduce future climate change-related fatalities (Lutz and Muttarak, 2017; Lutz et al., 2014).

A look at the SSP scenarios also makes clear that alternative future demographic trends matter more for climate change adaptation than for mitigation, mostly because

Figure 1:
World population by level of educational attainment 2020–2100, SSP1 (rapid social development scenario) and SSP3 (stalled development scenario)



Source: Wittgenstein Centre Human Capital Data Explorer http://dataexplorer.wittgensteincentre.org/wcde-v2/.

of the timing involved. The left side of Figure 1 shows the SSP1 scenario, which is the most optimistic in terms of rapid social development and the associated expansion of mitigative and adaptive capacities. Under this low population growth scenario, the world population increases from 8.0 billion people currently to a peak of 8.7 billion in 2050, after which it starts a slow decline, reaching 7.2 billion by the end of the century. This compares to projections that the world population will increase to 9.4 billion in 2050 under the middle-of-the-road (most likely) SSP2 scenario and to 10.3 billion under the worst-case SSP3 scenario, which assumes stalled development associated with high fertility. This implies that the difference between mid-century world population projections of the SSP2 and of the almost unrealistically optimistic SSP1 is only around 0.7 billion people. Moreover, virtually all of this difference comes from the populations of Africa (0.43 billion) and Asia (0.21 billion). For the industrialised countries that have by far the highest GHG emissions, the gap between these two scenarios by 2050 is negligible (0.017 billion for Europe and 0.023 billion for North America).

This time horizon of 2050 is decisive for mitigation, because the most recent IPCC report shows that to limit global warming to 1.5 degrees, CO2 emissions must fall to zero by 2050; and that to reach the less ambitious target of limiting global warming to 2.0 degrees, emissions must fall to net zero by 2080 (IPCC, 2022, WGIII). Reaching these goals will require a massive change in our energy systems, particularly in the rich countries where population growth is projected to be minimal over the coming three decades. Meanwhile, in Africa, where alternative population trajectories do make some difference over this time horizon, per capita emissions are so low that they contribute very little to the global totals. In other words, to reach the Paris climate targets, massive changes in energy and production systems and our consumption patterns are necessary, but demographic trends over the coming decades will matter very little. If, however, the global community fails to reach these targets and the transition to green technologies is stalled, even as today's poor countries become richer over time and join the club of great polluters, continued population growth in those countries would make an already very bad situation even worse. In this case, lower near-term population growth followed by a shrinking of the world population with increasing levels of education (as assumed under SSP1) would clearly be the preferred scenario.

When the focus is on the adaptation that will be necessary to cope with the already unavoidable consequences of climate change, the vulnerability of different demographic groups starts to matter in the immediate future. The current series of droughts, floods, heat waves and other extreme weather events show that we are already having to cope with serious effects of climate change at levels of warming that are still well below the Paris climate goals. And even if global warming can be limited to 1.5 or 2.0 degrees, the likely impacts over the coming decades and far into the 22nd century will be much more serious than those we are experiencing today. In this context, demographic trends do indeed play a major role in the future vulnerability and adaptive capacity of different parts of the world. What matters is both the size of the population exposed to those risks as well as its composition by age, sex and, in particular, level of education. The empowering effect of education in reducing disaster vulnerability at both the individual and the societal level has been well established in a large number of studies, including in a special issue on the "Ecology and Society" (Muttarak and Lutz, 2014), as well as in summary articles in "Science" (Lutz et al., 2014) and "Nature Climate Change" (Lutz and Muttarak, 2017). A specific quantification with respect to the SSPs shows that the estimated death toll due to climate change varies by a factor of more than five when comparing an SSP1 (rapid development) to an SSP3 (stalled development) scenario under otherwise identical patterns of future climate change and the associated increasing disaster risks (Lutz et al., 2014). This much higher number of climate change-related deaths under SSP3 results from both a larger number of people being exposed to the risks and their greater vulnerability due to their lower education (see the SSP3 scenario on the right-hand side of Figure 1).

A final note on the population component of the SSPs is in order to correct a misunderstanding. Lowe et al. (2022) criticised the SSPs for neglecting possible initiatives directed at reducing fertility, and depending "solely on improvements in education and poverty reduction to drive fertility decline" (p. 27). While it is true that improving female education is considered in the SSPs as a powerful force for reducing high fertility in countries over the course of the demographic transition because it is linked to both lower desired family size and better access to contraceptive methods (poverty is actually not linked to fertility in the SSPs), there are still differences between the education-specific fertility rates assumed under different SSPs resulting from factors other than education. Hence, the lower fertility assumed under SSP1 also reflects other cultural, economic or policy factors that operate independently of education. Some of these other factors influencing demographic trends are discussed in more detail in a related effort to quantify the potential effects of meeting the Sustainable Development Goals (SDGs) on future world population trends (Abel et al., 2016). Several of the specific targets established under the SDGs directly affect demographic trends, including the targets not only for child and maternal mortality, but also for reproductive health and eliminating the unmet need for contraception, as well as different goals for female education. Unpacking the different effects that different demographically relevant policies may have seems to be more productive than the reference of Lowe et al. (2022) to the rather unspecific notion of "family planning", which they claim would be the only solution to the population problem. The observation that this rather unspecific notion comes with historical baggage and seems to elicit strong emotions in different directions could help to explain the perceived avoidance of open and direct discussions about the undeniable impacts of demographic trends on future human wellbeing.

3 Is population really a "taboo topic"?

Both Rees and Lowe as well as many of the other commentators in the population debate seem to agree that in discussions of global environmental change, the population topic does not get the attention it deserves. Indeed, population is often called a "taboo topic". Lowe (2022) identifies three reasons for this reluctance to directly address population growth and family planning: (1) the first has to do with past apocalyptic projections of the presumed consequences of a population explosion that have not come to pass; (2) the second is related to the "dark legacy of population control policies in the last century", which in some cases violated human rights; and (3) the third is that proponents of pro-poor development believe that a focus on population growth shifts the blame from the rich to the poor. While I agree that this a fair characterisation of the discussion around population, I do not share the view that this has made population a taboo topic or an elephant in the room. The SDGs that now dominate the international development agenda explicitly address all the key determinants of population trends under SDG 4 (such as universal high-quality primary and secondary female education) and SDG 3 (reproductive and maternal health). As was mentioned above, it has been shown that implementing these goals would lead to significantly lower world population growth (Abel et al., 2016).

In the more specific context of climate change, a widely cited Policy Forum paper in *Science* by John Bongaarts and Brian O'Neill entitled "Global warming policy: Is population left out in the cold?" identifies four so-called misconceptions about population and climate change (Bongaarts and O'Neill, 2018). One of these alleged misconceptions concerns the effectiveness of family planning programs, and, in particular, efforts to help women to avoid unintended pregnancies. Here, again, it matters what precisely is meant by "family planning". A focus on meeting the "unmet need for contraception" has been the dominant population policy paradigm following the 1994 ICDP (International Conference on Population and Development) in Cairo. The unmet need has been defined as concerning women who say (in surveys) that they do not want to become pregnant but are exposed to the risk of pregnancy and do not use contraception. This definition and the resulting policy focus are largely uncontroversial, and have been endorsed by women's rights groups, the World Health Organization as well as governments from around the world. Only some fundamentalist religious groups opposed to any kind of contraception have expressed opposition to this form of family planning. Hence, a focus on meeting the unmet need for contraception can hardly be called a "taboo topic". It is openly discussed in many policy forums, and is also explicitly included in the SDGs. Target 3.7 under SDG3 on Health specifically says: "By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programs" (United Nations, 2015). Again, I see no evidence of a taboo here.

What can be considered more problematic are efforts to directly influence women's desired family size. For people who are concerned about population growth and high fertility in general, one problem with an exclusive focus on the unmet need is that it only addresses women who already want to have smaller families. In other words, it does not aim to lower the desired family size, but rather takes the ideal family size as stated by women as a given that should not be influenced (Prettner and Strulik, 2017; Pritchett, 1994). This, at least theoretically, significantly limits the scope for policies aimed at lowering fertility, since in many African countries ideal family sizes are still very high, especially among the low-educated segments of the population. The most recent results from the DHS in Nigeria (Nigeria Population Commission and ICF International, 2019), for instance, show that the mean ideal family size of women with at least secondary education is 4.4 children, whereas it is 7.9 children among women with no education. This survey also shows that the proportion of births that were wanted at the time of conception remained constant at 90 percent over the past five years, while just 8 percent were considered mistimed and only 3 percent were unwanted. This indeed leaves very little room for fertility decline if only unwanted births are being addressed.

Another cautionary piece of information about the effectiveness of focusing only on the unmet need comes from a series of DHS surveys that ask explicitly about the obstacles that women face in meeting this unmet need. Of all the possible obstacles listed, only 3 percent (for women with higher education) and 8.5 percent (for women with no education) of all women classified as having an unmet need cited either cost or a lack of access to contraception (Lutz, 2014). The main reasons mentioned were health concerns, general opposition to family planning (including opposition from the woman's husband) and a lack of exposure (e.g., the woman is married but her husband is away for work). These data imply that better access alone could only help to meet these 3–8 percent of unmet needs. Female education, on the other hand, not only helps to overcome many of the other obstacles, it also makes a lower desired family size a voluntary choice that does not require any nudging, manipulation or even coercion from family planning programs (Lutz and Skirbekk, 2014). It can thus be assumed that female education is the key to lower fertility in high-fertility settings. Because female education empowers women to plan their families more effectively, it could even be seen as part of family planning, very broadly defined.

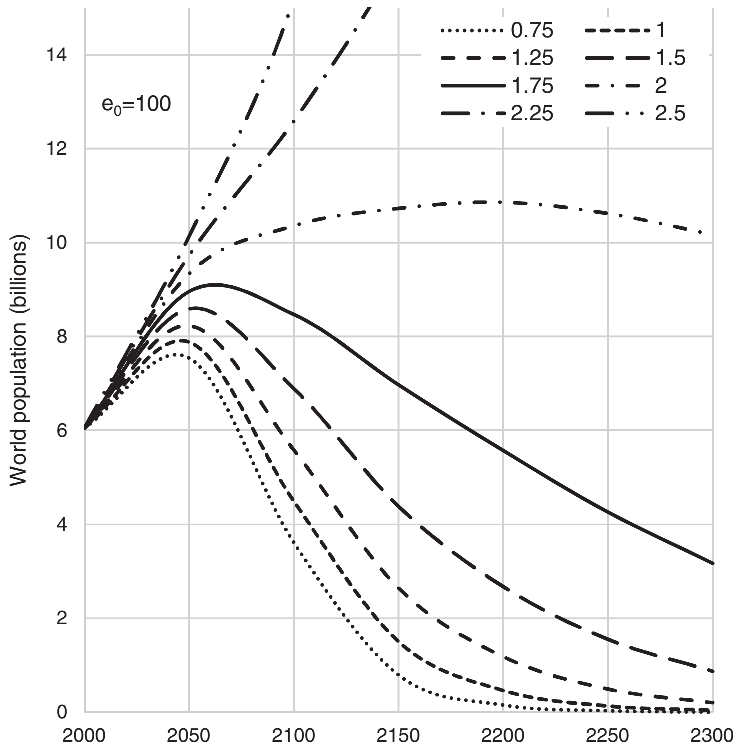
When trying to highlight evidence of the success of family planning programs in bringing down fertility rates, the case of Bangladesh is often taken as an example. Bongaarts and O'Neill (2018) pointed out the difference between trends in Bangladesh, which has a long history of family planning and currently has a low total fertility rate (TFR) of 1.95, and in Pakistan, which has similar economic indicators but little history of family planning, and currently has a TFR of 3.41 (United Nations, 2020). But a closer look at the two countries reveals that Bangladesh has also made much more progress on female education than Pakistan has. This issue motivated a recent comprehensive revisiting of the causes of fertility decline in Bangladesh that focused on the relative importance of female education and family planning by combining all available DHS data since the 1980s (Bora et al., 2023). This study found that, overall, the education of women was the driving factor behind the significant decline of fertility in Bangladesh from a TFR above 6.0 in the 1980s to the current replacement level, and that targeted government family planning programs played a significant role only in the early years of this period and in certain regions. Since higher levels of female education and improvements in reproductive health (partly due to targeted government efforts) go hand in hand and reinforce each other, it makes no sense to play one against the other. Strong efforts in both areas tend to result in the fastest fertility transition.

4 World population in the 22nd century

At the beginning of this commentary, I referred to the long-term population decline that seems to be a realistic outlook for humanity on our planet, if social development and, in particular, female education efforts continue at the same levels as those observed over the past decades. This implies that the laggards in the fertility transition in Africa and parts of South Asia will also follow the global trend over the coming decades, with their fertility reaching replacement level or even falling below that level. Such trends have been observed in virtually all populations around the world that entered the demographic transition process. This assumption of continued fertility decline to below replacement level is now shared by virtually all international population projections in their medium/most likely scenarios.

If global fertility levels remain below replacement level for extended periods and life expectancy does not continue to increase indefinitely, world population size is bound to decline in the longer run. Figure 2 shows the results of a rather

Figure 2:
World population scenarios over the coming three centuries with different stated long-term fertility levels (TFR), combined with the assumption that average life expectancy at birth will stop increasing after reaching 100 years



Source: Adapted from Basten et al. (2013) (CC BY-NC 2.0 DE).

straightforward exercise in numerical population dynamics that I published with Stuart Basten and Sergei Scherbov in 2013 (Basten et al., 2013). Based on 13 world regions, it starts with contemporary fertility and mortality levels and age structures (base year 2010), and assumes that the fertility levels will converge from the current level to the stated level of TFR by 2050 (this convergence was projected to occur in low-fertility regions as early as 2030, and a special scenario with convergence by 2070 was projected for Sub-Saharan Africa). The exercise further assumes that life expectancy will increase by two years per decade until the indicated maximum level is reached. Figure 2 only shows the case in which 100 years is assumed to be the maximum life expectancy. In the case in which 120 years is assumed to be the maximum life expectancy, all the long-term population trajectories are slightly higher.

The figure illustrates the strong sensitivity of long-term population trends to different convergence levels of fertility. As expected, all fertility assumptions slightly above replacement level will lead to continued substantial population growth, while those below replacement level will lead to a decline after the world population peaks during the second half of this century. Only an assumed TFR of 2.0 leads to a nearly stable population size of around 10 billion. But from today's perspective, a decline to the current average European level of around 1.5–which is not implausible, if current trends continue–would result in a significant population decline to below 3 billion in 2200 (about the same size as the world population in 1960; this is what I learned in school) and to below 1 billion in 2300. But even if fertility converged to the higher level of 1.75 (which is currently assumed in the medium scenarios of the UN and the Wittgenstein Centre alike), the world population would still decline to below 6 billion in 2200 and to almost 3 billion in 2300.

This projected long-term population decline to levels around 3 billion or below should be reassuring to ecologists who have estimated that the world's human carrying capacity is around this level (Dasgupta, 2004; Pimentel, 1991). But, as was highlighted in the description of the SSP3 scenario of stalled development, a continuation of current fertility trends should not to be taken for granted. A significant reversal of these trends is possible, particularly in large countries such as Nigeria, Pakistan and Afghanistan, which still have high proportions of women with low education, and which are vulnerable to religious fundamentalist movements that explicitly oppose female education. The name of the influential fundamentalist group Boko Haram in the Sahel means literally "education is sin". And since uneducated women tend to have many children who, in turn, have very few educational opportunities, there is a danger of a self-reinforcing spiral emerging; i.e., a vicious circle of low education, rapid population growth and extreme poverty (Prettner and Strulik, 2017). Such developments would not only pose serious problems for the countries concerned, they would also be sources of instability for the rest of the world.

5 From population stabilisation to balanced demographic trends

The overall goal of most population policies is "population stabilisation". This goal has been repeatedly stated in many of the United Nations policy documents produced since the 1960s, and is still cited as the overarching goal by Lowe (2022). This goal of population stabilisation was also numerically represented in the long series of UN population projections over the second half of the 20th century. The medium variant of these projections assumed that the fertility of all countries in the world would eventually converge to replacement level, and that improvements in life expectancy would come to an end once an assumed maximum level was reached. Together with the assumption of zero net migration, this resulted in a population outlook in which the populations of all countries in the world stabilise in the long run and stay at that level forever. Such a vision of stabilisation has also been politically convenient. No member government of the United Nations has had to fear that in the long run its population would either explode in an unsustainable manner or shrink significantly or even disappear. In this view, sub-replacement fertility was considered a temporary phenomenon.

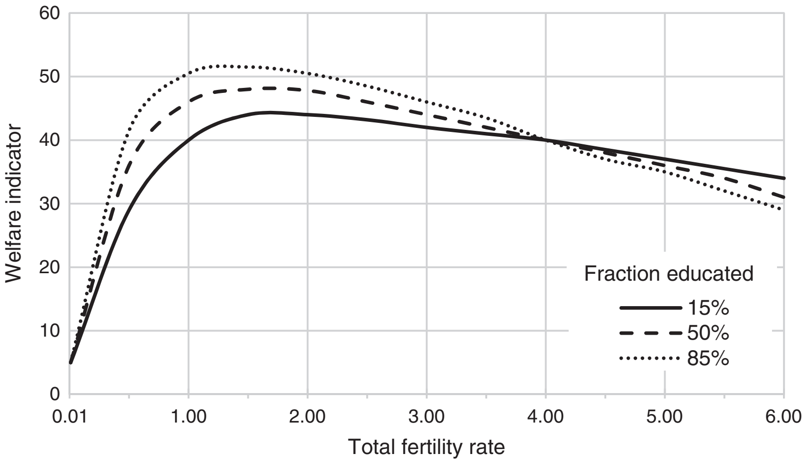
Real-world demographic trends have increasingly made this politically attractive vision of the long-term stabilisation of the populations of all countries untenable. It has become very clear that sub-replacement fertility levels are here to stay (Basten et al., 2014), and that in an increasing number of countries, fertility has fallen to levels that are even lower than those that were ever previously imagined. The TFR in South Korea is currently at 0.8, and might decline even further. Moreover, even the UN has now acknowledged that the TFR in China, which was previously assumed to have never fallen below 1.6, and to be on an increasing trajectory, has recently fallen to below 1.3, despite government efforts to increase it. In addition, the most recent data for India, which will soon to surpass China as the biggest country in the world, show that its TFR fell below replacement level much earlier than projected.

But are extended periods of below-replacement fertility a problem? Many governments, particularly in Eastern Europe, seem to think that a shrinking population is a serious issue, with some even calling it an existential problem. Aside from evident nationalistic reasons–national governments sometimes want there to be more people of their own nationality, irrespective of the wellbeing implications–are there economic reasons to assume that long-term below replacement fertility levels are a danger for future human wellbeing in individual countries or globally?

Instead of trying to provide a concise summary of this highly complex and controversial topic, I want to conclude this short commentary with a reference to a book that I co-edited almost 20 years ago entitled “The end of world population growth in the 21st century: New challenges for human capital formation and sustainable development” (Lutz et al., 2004b). After discussing the likely end of world population growth, this book also considers the possible policy implications. The concluding chapter is entitled “Conceptualizing population in sustainable development: From ‘Population Stabilization’ to ‘Population Balance’ ” (Lutz et al., 2004a). It starts with the suggestion of abandoning the concept of population stabilisation and replacing it with a more meaningful concept that addresses the wellbeing of groups of people by generations (cohorts), instead of focusing on constant population sizes. It considers not only population size but also the changing proportions of people in groups differentiated by age and education. This focus on proportions also justifies the use of the notion of “balance”, which, according to the *Oxford Concise Dictionary,* can be defined (particularly in the arts) as “the harmony of proportions”. Hence, in our context, the challenge is to find the right mix (harmony) of demographic proportions (of age cohorts, education categories, etc.) that are most conducive to welfare and intergenerational equity over the long run.

Lutz et al. (2004c) also presented a very simple quantitative model of population balance that makes human welfare dependent on survival rates (life expectancy),

Figure 3:
Simple population balance model: Welfare indicator for stable populations by fraction educated and total fertility rates, baseline parameters



Source: Adapted with permission from Lutz et al. (2004b).

consumption and environmental quality, and that distinguishes between three stages of the human life cycle (youth, working age, retirement). It further subdivides the population into two education groups (high and low), with education having a cost, and the output produced depending on education. Pollution, which is a function of output, reduces environmental quality, and thus welfare. The highly stylised simple model of Population Balance as defined in this paper yields very interesting insights that highlight the interdependencies of and the trade-offs between the demographic proportions that matter for human welfare and intergenerational equity.

The graph presented in Figure 3 shows the long-term effects of different possible levels of fertility (TFRs ranging from 0.01 to 6.00) combined with different levels of education on the welfare indicator, assuming stable conditions (=rates stay the same over time). This simple graph highlights four important aspects of Population Balance: 1. the relationship between the TFR and welfare has an inverted U-shape, i.e., very high and very low fertility results in lower welfare than intermediate TFR levels; 2. the level of maximum welfare reached is higher for the more educated populations; 3. the optimal TFR depends on the level of education, with all optimal TFRs being below replacement level, and the optimal TFR being lower the higher the level of education is (which also results from education costs); and 4: all curves exhibit rather flat peaks, implying that the level of welfare is not very sensitive to the TFR being in intermediate ranges. For the low educated population, the optimum range stretches roughly from 1.5. to 3.5. For the highly educated population, the optimum range lies more narrowly between 1.0 and 2.0, and at a significantly higher level. Note that this model also explicitly includes the environmental dimension (in admittedly very stylised form), and thus also captures the above-discussed interactions with climate change.

This 20-year-old model of Population Balance nicely summarises the main messages I wanted to offer in this comment: yes, very low and very high fertility are likely detrimental to long-term human wellbeing, but there is no reason to panic if fertility deviates somewhat from the stated optimum level. And yes, more investments in education pay off in terms of higher welfare, and even more so when combined with fertility levels that lead to long-term population decline in individual countries and, ultimately, around the world. Hence, this conclusion supports the title of the paper, which states that global population decline is not only likely, but will also benefit long-term human wellbeing.

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Depopulation or population decline? Demographic nightmares and imaginaries

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Abstract

Scientists are well aware of the major social, economic and cultural challenges brought about by population decline. However, we can often underestimate the more extreme interpretations of both the causes and the consequences of population decline in the popular discourse. In this commentary, I explore some of these toxic narratives, and speculate about how they may be linked to what appears to be a prevailing populist/ethno-nationalist view of population grounded in political tropes, rather than in scientific reality. Using Armitage's (2021) concept of "demographic imaginaries", I argue that much of this public discourse serves several vital purposes: to try to simplify a complex issue; to try to "unify"; to try to blame and scapegoat; and, ultimately, to try to negate the obligation to make tough, complex political and policy decisions. I also argue that scientists working in the field of population decline need to be more aware of these tropes, and should make more active efforts to ground the discourse of population decline in science and reality. I conclude that a bottom-up approach to responding to population decline may be the most fruitful avenue for progress in the future.

Keywords: population decline; depopulation; conspiracy; fertility; migration; Twitter; social media

1 Depopulation as a conspiracy

Frenzied talk of depopulation and/or population decline in literature and in the popular press is nothing new. However, this issue appears to be very much top of the agenda at the current point in time. In the public discourse, much of this discussion

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appears to be fuelled by one man. Prior to taking on a new HR role at a social media company, electrical engineer Elon Musk posted several tweets on the topic that garnered a tremendous amount of attention. On 8 May 2022, in response to an article on population decline in Japan, Mr Musk tweeted: "At risk of stating the obvious, unless something changes to cause the birth rate to exceed the death rate, Japan will eventually cease to exist. This would be a great loss for the world". On 26 August 2022, for example, Mr Musk wrote: "Population collapse due to low birth rates is a much bigger risk to civilization than global warming" (followed up by a second tweet saying "Mark these words" to avoid any ambiguity). This fear of global civilisational collapse has been a theme for Mr Musk. For example, at the 2021 Wall Street CEO Summit, he proclaimed: "If people don't have more children, civilization is going to crumble, mark my words" (Thomson, 2021).

The responses to these tweets were, if I may say so, rather predictable. In the popular discourse, population is always something that there is either too much of or too little – this is a common feature of how population issues are treated in literature (Shriver, 2003). The simple juxtaposition of the growth of human populations on the one hand and habitat degradation and declining animal numbers on the other makes for an appealing, simple narrative that ignores the complexities of sustainable development.

Similarly, it is often argued that if fewer babies result in fewer people, economic stagnation, geopolitical decline and, ultimately, civilisational collapse will follow. Without meaning to sound smart or condescending, most social scientists (and, indeed, most people who have, or are contemplating having, children or who have migrated) have a pretty clear understanding of the underlying reasons for population decline. As demographers, we know that population decline comes about through a combination of low fertility and out-migration. Low fertility – or, more precisely, very low fertility – tends to occur when institutional systems malfunction, making it difficult for people to achieve their reproductive aspirations. Meanwhile, if there are better opportunities elsewhere, and if people can and want to move, then they do.

However, according to many Twitter users, we have got this all wrong. As @SikhForTruth put it:

"*Everything going on today is meant to drive depopulation . . . From LGBTQ mania (they don't reproduce), food shortages, genetically engineered viruses, abortion rights, and the introduction of deadly 'vaccines' - it all points toward one thing - more death. All in the name of health*".

This tweet neatly encapsulates the views of many people on Twitter about some of the main modes through which depopulation is being foisted upon us, with some kind of vaccine conspiracy being a predominant trope. However, another explanation for why depopulation is occurring that was not mentioned by @SikhForTruth was brought up by @DaughtersOfEur, who stated: "It was never just going to be a few days . . . It's been planned for years and years. Depopulation worldwide, with the White Race first to be Gen0cide" [*sic*].

So who exactly is behind this trend? Many people believe that it is part of the globalist conspiracy. According to @VerseCannon: “Depopulation is the true agenda of the global elites, the oligarchs and world leaders, #WEFpuppets”. Indeed, Klaus Schwab and Bill Gates frequently appear in this kind of narrative. At the same time, others allocate the blame to more ethereal actors. @Short_88a reposted a video of a nun – a group not known for their contribution to the fertility rate – who “gives a grave warning regarding the depopulation agenda, and calls out the Pope as the spiritual leader of the evil globalists behind it all”. Meanwhile, in an unexpected twist, @AnandPanna1 posted a link to a Dr Lima Gaido and her exposition of “THE ELITE SATANIC DEPOPULATION AGENDA” [again, *sic*].

According to these narratives, the powers of these global elites to pursue their aims is almost limitless. In August 2022, a local news website in York announced the sad, sudden death of a man walking in a shopping street in the city. However, a tweet by “Vaccine Death Queen” of the screenshot of this headline was supplemented by two emojis: one of a vaccine, and the next of a face with a finger placed in front of the mouth whispering “sshh” . To ensure that the message of the tweet could not be misinterpreted, the words “Depopulation plan, going as planned” were added.

While some social media commenters have attributed depopulation to vaccine conspiracies, others have cited the so-called “Great Replacement” narrative: i.e., the racist notion that western elites are determined to replace whites by immigrants (Farivar, 2022). This “theory”, which links back to some of the tweets mentioned earlier, has “inspired” the perpetrators of white nationalist violence (for example, in the mass shootings in El Paso, Christchurch and Buffalo). However, it is not just in the white nationalist sphere that the issue of population decline has been raised. Concerns that differential fertility between and within countries will lead to the “depopulation” of one country or region and the growth of others are as old as the hills – and are, of course, fundamentally embedded in more universal notions of racism and eugenics. In India, for example, Hindu nationalists are currently weaponising a perception of “high Muslim fertility” (which is, in reality, not much higher than average fertility). In that country, radical priest Yati Narsinghanand urged Hindus to have more children, saying: “Otherwise they [Hindus] will be swamped by the Muslims by 2029” with a “real possibility that by 2029 India would have a Muslim prime minister and states would have Muslim chief ministers”. One of his fellow radical nationalist priests, Kalicharan Maharaj, took this view to an extreme, painting a picture of what could happen that is so stomach-churning that I simply cannot repeat it here (Scroll Staff, 2022).

No discussion of contemporary radical population policy is complete without reference to Hungary’s President Orban, who likened the low fertility and population decline crisis to a war: “In all of Europe there are fewer and fewer children, and the answer of the west to this is migration . . . They want as many migrants to enter as there are missing kids, so that the numbers will add up. We Hungarians have a different way of thinking. Instead of just numbers, we want Hungarian children. Migration for us is surrender” (Walker, 2020).

These are, of course, rather extreme examples. However, they are joined by a "lite" version of demographic determinism, which paints a bleak view of the future as a consequence not only of population decline, but also of population ageing. According to this narrative, public welfare and health systems are going to collapse; GDP growth (that pinnacle of human achievement) is threatened; the global order will be destabilised; and so on. Population decline is presented as leading to civilisational collapse, in the same way that population ageing is presented as a "silver tsunami" (Calasanti, 2020). It is, for example, argued that because Japan has failed to respond adequately to depopulation, the country has "embarked on a road to ruin" (JT 2022). Even the *Shūkan Jitsuwa*, a tabloid aimed at Japanese men, found space between its pictures of nude women to proclaim that the nation's future is *zetsuboteki* (hopeless) because of the low birth rate and rapid ageing. Indeed, in Japan, it is possible to log on to a "doomsday clock" that counts down until the very last child is alive in Japan. As the originator of this clock, Hiroshi Yoshida, an economics professor at Tohoku University, issued the following warning: "If the rate of decline continues, we will be able to celebrate the Children's Day public holiday on May 5, 3011 as there will be one child . . . But 100 seconds later there will be no children left . . . The overall trend is towards extinction, which started in 1975 when Japan's fertility rate fell below two" (Agence France-Presse, 2012). Unfortunately for Japan, since the above quote was published in 2012, the extinction day has been moved forward to 2966. Elsewhere, a 2014 study commissioned by the South Korean national legislature found that South Koreans could "face natural extinction by 2750 if the birthrate were maintained at 1.19 children per woman — assuming no reunification with North Korea or significant inflow of migrants" (Holodny, 2015). According to this study, Seoul will be fully depopulated by 2505, and Busan will have zero residents by 2413.

2 Debunking these claims

I don't believe I am part of the globalist elite. I have never been invited to Davos. In fact, the closest I have probably gotten to this super-elite who are supposedly running the world was staying at the Bilderberg Hotel in Scheveningen (no relation). But in my own experience, I have not heard any convincing evidence that the processes of population decline are, indeed, part of a Catholic/Satanic/big pharma/WEF conspiracy to rid the world of hard-done-by white people. Vaccines have been scientifically shown to save lives, not destroy them. The man who tragically died in the street in York may have just had a heart attack. On the other hand, population decline is real; it is happening now; and it brings with it a wide array of challenges. Recently, however, the public discourse on this topic has become so tightly packed together with so many other concepts that it has become almost impenetrable.

Without wishing to sound pedantic, we may want to start unpacking this issue by drawing a distinction between population decline and depopulation. The former is a simple change in numbers; just like population growth. Thus, the definition of population decline is scientific, neutral and clear. By contrast, *Thesaurus.com* returns the following synonyms for the term "depopulate": desecrate, devour, ruin, depredate, spoliate, despoil, pillage, sack, lay low, devastate, plunder, waste, lay waste. Clearly, depopulation is very different from the scientific, neutral concept of population decline, as the term evokes the language of war, devastation and destruction. Thus, in a sense, depopulation seems much more closely linked than population decline to the conspiracy theories and fears presented in much of the popular discourse.[1]

In her recent work, Armitage (2021) introduced the concept of "demographic imaginaries", which she defined as "dominant political tropes suggesting that imagination and ideology, rather than purely technical considerations around demographic data" have been "central to the creation and construction of the 'population crisis' [in Eastern Europe]". She further observed that these "imaginaries" shape the "kinds of solutions and interventions that are being implemented in response" to the perceived crisis. This concept is, in turn, built upon the idea of "social imaginaries" as developed by Anderson, and, more recently, by Taylor (2002). For Taylor, these "imaginaries" are neither ideology nor theory, but are rather "background understandings" of how people "fit together, how things go on between us, the expectations we have of each other, and the deeper normative notions and images that underlie those expectations" (Steger, 2012).

This concept allows us to look at all of these claims through a different lens. First, we have a tendency to seek simplistic answers to complex issues. As the other papers in this special issue have pointed out, population decline (and population ageing) brings with it a large and complex set of challenges, including those associated with raising productivity to ensure that macro-economic growth continues (Lee et al., 2014); maintaining the sustainability of health and welfare systems (Lee and Mason, 2012); providing public services in sparsely populated areas (OECD, 2022) even as tax receipts dwindle; maintaining cultural heritage (Signes-Pont et al., 2022); changing zoning (Yu et al., 2022), urban planning (Hollander, 2011) and land use practices (Rodríguez-Rodríguez and Larrubia Vargas, 2022); and managing the impact on ecosystem services (Bruno et al., 2021) and infrastructure services (Franklin et al., 2018), such as water (Hummel and Lux, 2007) and transport (Canzler, 2008). Tackling these challenges will require holistic, joined up responses and integrated planning – which are not, it has to be said, the strong suits of most governments. Moreover, addressing these challenges will not only be technically difficult, it will also raise thorny ethical questions (such as about whether to provide school places for a tiny number of children in rural areas) and present practical and political difficulties. Lest we forget, one of the only times when the Russian population has come out to protest the policies of Mr Putin was in response to his

1 To return to Twitter, if you search "population decline" rather than "depopulation", the messages returned are very different in character. There are no references to the vaccine/globalist/Satanic conspiracy, but rather tweets like: "Kosovo is the only Western Balkans country that will not have population decline by 2050" (@admirim) and "#China is set to register an absolute population decline. Its crisis from a dwindling and ageing workforce can be an opportunity for India to reap the next 'demographic dividend'. But rapid job creation will be key: Harish Damodaran writes" (@CPRIndia).

proposal to raise the retirement age to 63 from 55 for women and to 65 from 60 for men (BBC News, 2018).

Facing these consequences head on would also force stakeholders and policy-makers to look at the underlying dynamics of population decline in a much more systematic way. Why are fertility rates so low? Or, more precisely, why is the gap between fertility aspirations and reality so large? Answering these questions will require us to look at some of the root causes: i.e., at the deeply entrenched, seemingly intransigent challenges relating to work, gender roles, culture, family, care, the economy, state support and so on. At the same time, we must also consider the other key driver of population decline: namely, out-migration. Why do people leave? Or, to put it another way, why would people not want to stay, preferring instead to leave behind their family, their friends and their way of life? Clearly, people choose to migrate in response to the lack of opportunities in their home region, which may be due to the effects of economic shocks and transformations, or to low levels of growth in rural areas (exacerbated by poor infrastructure). Thus, people operate in systems of extreme spatial inequality in which there is (relative) freedom of movement that allows them to travel to places that appear to offer them more chances for success in life.

Therefore, we can see that both low fertility and migration are perfectly rational human responses to malfunctioning upstream institutions. Having fewer children is a mode of risk avoidance, while out-migration is a mode of maximising opportunities. Policies aimed at increasing fertility and limiting out-migration need to be holistic, comprehensive and grounded in meeting the needs, desires and aspirations of individuals with regard to reproduction and migration (or return migration) to improve their chances of success. The nation of Japan will not face extinction in 2986, and Busan will not, as “projected”, become a total ghost town in 2413 (Holodny, 2015). Yet in the world of the demographic imaginary, this technical correction simply does not matter. Such projections are tools to demonstrate the consequences of the social recession of low fertility: namely, civilisational collapse. What is the purpose of such tools? To frighten people into having (more) children – without doing anything to address the legitimate concerns that lead to lower fertility.

Thus, rather than looking at all of these tough issues in turn, we can instead use “demographic imaginaries” to package these problems together as in a gift box, while saying: “This is depopulation, and it is bad”. For good measure, the populist-nationalists can also add a nice ribbon of racism around the box and tie it with a bow of scapegoating and blame.

Since time immemorial, we have been led to believe not only that our tribe, our race, our country is better than that of everyone else, but also that we are under a constant threat from the “other”. In this simplistic worldview, population decline is linked to civilisational collapse. According to this narrative, low fertility is the fault of young people – especially women – who are selfish, individualist and feckless; reneging on their obligation to reproduce for the benefit of the civilisation, rather to spend time and money on holidays, smashed avo and Taylor Swift tickets. In this worldview, young, single women are neglecting their obligations to the country (and the race) and are therefore presented as a "national security threat" from Taiwan (Deutsche Welle, 2015) to Egypt (Galal, 2016). Older people are blamed too – or are at least stigmatised (Gietel-Basten, 2019). Ageism is legitimised (Ylänne, 2022) and mainstreamed.[2] *In extremis,* a professor of economics at Yale University proposed mass suicide or ritual self-disembowelment as a solution to the perceived grip of older persons on Japanese industry (Zitser, 2023). As Bourdieu might say, this "social imaginary" can be used to set up a "pre-reflexive framework . . . for our common-sense social repertoire" (Steger, 2012).

3 So what do we do?

The first thing I think we need to do as population scientists is awaken to the reality of how some people are talking about population decline. Yes, we can be very smart and explore it in a very calm, cool and rational way. We can be pleased with ourselves and proudly declare that it is all about rural development and infrastructure and youth employment and gender roles. We can also declare that low fertility and managed population decline may not be a bad thing (Lee et al., 2014; Marois et al., 2021; Striessnig and Lutz, 2013). However, there is a whole world of people out there who perceive these issues very differently. These people do not read *Rural Sociology*, *Land Use Policy* and *Ecosystem Services*. They may not even read *The Vienna Yearbook of Population Research*. In a dangerous echo chamber of increasingly extreme ideas, commentators, politicians (of more or less radical hues), the general public and megalomaniacs are able to propagate false ideas (and seek equally egregious responses) in a scientific vacuum. If these "demographic imaginaries" are left to prevail, they become gospel.

Of course, we cannot spend all of our time on Twitter pointing out the flaws in the arguments made by writers such as those mentioned in this article. As G. K. Chesterton once said: "If you argue with a madman, it is extremely probable that you will get the worst of it; for in many ways his mind moves all the quicker for not being delayed by the things that go with good judgement".

Nonetheless, we can be vocal, record our dissent and point out scientific flaws when politicians and key stakeholders are discussing these issues. As Datta (2020) observed: "institutional vacuum and the absence of scientific and intellectual expertise have given way to false experts and other charlatans to advance alternative conspiratorial explanations and propose populist solutions" (translated in Armitage, 2021). We can – and we must – play a role in bringing the "demographic imaginaries"

[2] This is especially apparent when looking at the manner in which older people were treated during the COVID-19 pandemic. For example, there was evidence of age discrimination in triage decisions (Barnes, 2020; Kuylen et al., 2021); grotesque statements about deaths among the elderly were made on social media (such as referring to the virus as #BoomerRemover (Meisner, 2020; Skipper and Rose, 2021)); and older people were denied agency through "compassionate ageism" or "caremongering" (Vervaecke and Meisner, 2021).

back down to earth by trying to ground narratives of population decline and population ageing in science and evidence, rather than in political tropes. Even though Twitter seems to be on the verge of collapse, we need to redouble our efforts to make the science of demographic change as publicly accessible as possible through whatever means are available, including through social media.

Indeed, we should acknowledge that this problem is at least partially attributable to how we ourselves discuss the issue. It seems that the very language we use is laden with doom and fear. Consider, for example, the use of the term "demographic winter" in various European discourses, including by the European Conservative and Reformist Group of the European Parliament (cf. Trimble, 2013). Even though the use of terms such as "demographic time bomb" appear to be on the decline (and there is a wide recognition that other expressions such as "silver tsunami" and "silver economy" are ageist (Calasanti, 2020; Lipp and Peine, 2022)), many scientists are not immune to making grand statements concerning the contribution of their own research to sensitive demographic issues, with the recent trailing of the IHME projections being an obvious case in point (Gietel-Basten and Sobotka, 2020). Moreover, we often automatically refer to "problems" of population decline and/or ageing. This is already a value judgement, and is different from referring to "challenges". We regularly use "dependency" ratios, which, apart from being misleading in terms of what is being measured and presented, imply decrepitude and a lack of agency among older people (Basten, 2013; Sanderson and Scherbov, 2015). Finally, of course, we tend to use the terms "population decline" and "depopulation" interchangeably. Perhaps we should try to use the former as a matter of course?

Finally, we also need to stop talking about a call-and-response, closed-loop way of dealing with population decline and ageing. Rather than being supported through reproductive empowerment, women (and men) are simultaneously being harangued through pronatalist propaganda, having their reproductive choices narrowed through restrictions on access to family planning services and being bribed through cash handouts to reproduce for the nation. In Belarus, President Lukashenko declared: "This is a disaster when one child grows in a family! Two are necessary. But three of them must be stimulated. Four! . . . Well, maybe someone will strike at five – we have such people, thanks to them. . . But three of them are necessary! . . . This sphere will never – at least as long as I'm the president – be deprived of attention" (Sobotka et al., 2019). In Turkey, meanwhile, President Erdogan declared: "Rejecting motherhood means giving up on humanity . . . I would recommend having at least three children" (Sobotka et al., 2019). This is because, according to Mr Erdogan, having just one child doesn't do anything "for the vitality of the country" (Idil, 2020): "One or two (children) is not enough . . . To make our nation stronger, we need a more dynamic and younger population . . . We need this to take Turkey above the level of modern civilizations" (AlArabiya, 2014). Mr Erdogan added that those opposed to this view "have been engaged in the treason of birth control for years and sought to dry up our generation" (AlArabiya, 2014).

Higher birth rates will not solve the social, political, economic and institutional challenges associated with population decline. Rather, we need to strive to change the narrative. Population decline is happening here and now. Every country on earth will experience it at some point or another in the future. We need to change our mindset and think in different ways; to think about how we are going to respond to this "grand challenge". In this vein, I want to close with three quotes:

> *"Ever since the Meiji Restoration 150 years ago, the Japanese have been harbouring the illusion that happiness can only be attained through growth . . . But that's no longer sustainable. We need to figure out ways to achieve happiness while scaling down, and Tokigawa can become an example." (1)*

> *"Depopulation is an unstoppable phenomenon happening all across the nation. It's neither good nor bad, but something we must accept." (2)*

> *"Simply increasing the population won't solve the many issues these shrinking communities face. It's more about how we can turn these issues into advantages." (3)*

These quotes, for me, encapsulate the need to adapt our mindset, and to just get on with dealing with the causes and the consequences of population decline in a clear-headed, realistic way. However, these quotes do not come from some famous demographers, rural sociologists or urban planners. They are from residents of Tokigawa, a small municipality in Japan's Saitama Prefecture, which, like so many others, is undergoing rapid population decline. Quote (1) reflects the thoughts of Norio Koyama, a nonfiction writer who founded an event space in the town in late 2020. Quote (2) is the opinion of a local realtor, while quote (3) comes from a local artist. These residents are contributing to efforts to offset some of the challenges of population decline in this rural area through various economic, cultural and social activities.

What these quotes tell us is that we, as scientists working on population decline, need to get out of our offices and away from our computers, and to stop modelling and theorising these demographic changes long enough to find out how communities are responding to them on the ground. It is only by doing so that we will be able to truly see "what works" at the grassroots level, and, in turn, be able to craft sustainable policies to address the very real challenges of population decline from the ground up.

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A governance perspective on East Central Europe's population predicament: Young exit, grey voice and lopsided loyalty

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Abstract

Much of East Central Europe today faces the double challenge of having a population that is both ageing fast and shrinking steadily. Elderly-oriented political dynamics and myopic governance are part of this predicament, and are also among the reasons why future prospects are not rosy. Having started the post-communist transition with younger populations, successive governments in this region have comprehensively squandered a decades-long window of opportunity to adapt their policies to the predicted ageing ahead (Vanhuysse and Perek-Bialas, 2021). Especially in Hungary, Poland, Czechia, the Slovak Republic, Romania and Bulgaria, this failure is reflected in low active ageing and child well-being index rankings, low levels of social investment and mediocre educational outcomes, and family policies that reinforce traditional motherhood roles or barely support parents at all. Poland, Romania, Croatia, Hungary and, especially, the Baltic states also experienced large-scale emigration ('young exit'). Slovenia and the Visegrad Four, but not the Baltics, became premature pensioners' democracies characterised by unusually high levels of pro-elderly policy bias ('lopsided loyalty'). While the salience of family policies increased around the time the demographic window closed, this shift was driven by pro-natalist, neo-familialist and gender-regressive political ideologies, rather than by a concerted effort to boost human capabilities or reward social reproduction. But by then, elderly voter power ('grey voice') in East Central Europe was among the highest in the world. Politics strongly constrains the likelihood of appropriate human capital-boosting policy responses to the region's population predicament. Alarm bells thus ring for a generational contract under pressure and for longer-term societal resilience.

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1 East Central Europe's peculiar population predicament

More than three decades after the fall of the Iron Curtain, the countries of East Central Europe (henceforth ECE[1]) are remarkably diverse as policy regimes. Yet they remain united not just by a common communist past. In many cases, they also share similarly challenging demographic predicaments – and, I shall argue, gloomy future outlooks. Around 1989–1990, ECE countries were significantly demographically younger than 'Western' EU member states. However, they have largely squandered their quarter-century-long subsequent demographic window of opportunity for policy reform. This has badly prepared ECE democracies – notably Romania, Bulgaria, Slovenia and the Visegrád Four (Hungary, Poland, Czechia and the Slovak Republic) – for the coming three decades, as these countries have now entered a period of accelerated demographic ageing, adding to the problem of steady population decline.

Here's the demographic macro-picture in a nutshell.[2] As a result of the uncertainties, changing family values and material hardships during the post-communist transition, fertility rates have fallen sharply in much of East Central Europe, and have remained low into the 21st century; though there have, of course, been significant fluctuations (Sobotka and Fürnkranz-Prskawetz, 2020). In ECE, completed cohort fertility for women born in 1980 is 1.56. While this rate is somewhat higher than that in Southern Europe and is only marginally lower than that in Germanic Europe, it is well below the rates observed in Nordic and Western Europe. Moreover, ECE populations are now ageing fast. As we noted in Vanhuysse and Perek-Bialas (2021, p. 393), as recently as in 2015, the average old-age dependency ratio in the 13 new EU member states (11 of which are East Central European) was 26.7, which was still below that in the 'Western' EU-15 states (32.7). But by 2050, the old-age dependency rate will increase by 25 points to reach 58 in the EU-15, and by nearly 30 points to reach 56.5 in the new EU-13. Thus, by mid-century, chronological population ageing in East Central Europe will have caught up with ageing trends in Western Europe.

But crucially, if we remeasure ageing prospectively á la Sanderson and Scherbov (2019) by looking at the share of the population with low remaining life expectancy, we find that East Central Europe is *already* older than Western Europe today. This development is partly a reflection of lagging progress in healthy lifestyle cultures,

[1] I thank the editors for multiple helpful comments. By ECE I shall refer here to the following 11 EU member states from East Central Europe: Estonia, Latvia, Lithuania, Poland, Hungary, Czechia, the Slovak Republic, Romania, Bulgaria, Slovenia and Croatia.

[2] Demographic data in the paragraphs below are based on the European Demographic Datasheet (Vienna Institute of Demography, 2016, 2022).

health policies and health technologies in ECE. Additionally, due to low fertility and emigration, many ECE populations have started shrinking significantly. Between 2000 and 2021, the populations of Romania and Croatia declined by one-seventh, while the populations of Lithuania, Bulgaria and Latvia fell by one-fifth. In other words, much of East Central Europe today faces the double challenge of having a population that is both ageing fast and shrinking steadily.

2 The fraying intergenerational contract

Does this matter? It does, mightily, if we care about the longer-term sustainability of the welfare state and the cohesion and resilience of these societies. To be sure, we should avoid obsessing about demographic indicators in isolation or singling them out as policy targets. Remember Goodhart's law: When a measure becomes a target, it ceases to be a good measure. After all, these indicators merely measure the behavioural outcomes of underlying societal conditions. But that is also why they matter. When used wisely and comprehensively, indicators can be weathervanes or alarm bells, indicating deeper sociological tensions or fractures. One of the deeper issues at hand here, I submit, is the fraying intergenerational cohesion of East Central European societies, which is largely a result of elderly-oriented political dynamics and myopic governance along multiple policy dimensions.

Welfare states are lifecycle redistribution machines set up to care especially for the young and the old by taxing the productive contributions of the working-age population (Vanhuysse and Gál, 2023; Vanhuysse et al., 2021). They constitute an implicit, and hence an eternally contestable and politically ever-contingent rolling intergenerational contract that helps to reproduce societies over time. Younger generations must eternally follow older generations – and they must be willing, politically, to finance the consumption of the preceding generations. The key requirement for such a continued functioning of the intergenerational contract is productivity-adjusted demographic continuity. Barring radical transformations in generational consumption and lifestyle patterns, or immigration at levels that are politically indigestible in contemporary (East Central) Europe, this means that the working-age population must not only keep paying enough taxes and social security contributions over time; they must also keep producing enough babies, then turn these babies into productive adults who'll do the same in return, rather than, say, leave the land, depend on welfare, or engage in tax strikes against the old (Gál et al., 2023).

In general terms, the intergenerational contract becomes frayed when the ratio of social rights to productive contributions of some birth cohorts is higher than that of others. The demographic challenges of ECE generally mean that in these countries in the decades ahead, all else being equal, smaller middle-aged generations will need to support through their productivity, one way or the other, much larger old and very old generations, who are, in turn, likely to become increasingly dominant electoral groups as a result of rising life expectancy.[3] Between 1990 and 2040, the share of the oldest-old (aged 80 or older) will have more than tripled in Hungary and Latvia and more than quadrupled in Romania and Poland. Over the same period, the share of the population aged 65+ will have almost doubled in Hungary (to reach 25%), more than doubled in Latvia (to reach 26%) and increased 2.5 times in Romania and Poland (to reach, respectively, 25% and 26%) (Vanhuysse and Perek-Bialas, 2021, p. 376). This trend will powerfully affect larger societal and political-electoral dynamics.

3 Young exit and low quality of governance

The risk of ruptured intergenerational contracts is aggravated, notably in the Baltic states, Romania and Bulgaria (but much less so in Czechia and Slovenia), by a particular form of population decline after EU accession: significant outmigration of adults in their twenties and thirties – the childbearing and family-formation life stages. This 'young exit' is empirically associated with low levels of governance quality. Compared to the European average, East Central European countries have tended to combine above-average net emigration levels with below-average governance levels within the EU, including higher levels of corruption and lower levels of adherence to the rule of law, government effectiveness and regulatory quality.[4]

When free movement to Western Europe became available to them through EU membership, large numbers of young adults in Central and Eastern Europe reacted by voting with their feet to seek better economic opportunities than they could expect to find at home (notably in the medical, nursing and care sectors and in certain blue-collar professions), but also to access better public goods, including better infrastructure, education and quality of governance. In so doing, they took their

3 This intergenerational strain may be modified, but is unlikely to be resolved, by the possibility that the capacity of the middle-aged generation to support more older persons could be compensated for in part by the possibility that less overall support will be needed for the smaller-sized younger generations. Of course, all else being equal, this strain will reappear in a more acute form later when these smaller-sized younger generations become middle-aged, and need to shoulder both downward and upward resource transfers to, respectively, younger and older generations of different sizes and/or varying longevity.

4 The bivariate correlation between average net immigration per 1000 persons in 2005–2010 (after EU accession) and Kaufmann and Kraay's (2020) composite Worldwide Governance Indicator (averaging six dimensions: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption) in the five preceding years is 0.51. Except for Czechia and Slovenia (which rank below average only on governance), all ECE countries are situated in the bottom-left quadrant of the EU sample, which is characterised by below-average (typically negative) net immigration combined with below-average governance (data for Bulgaria and Romania refer to 2008–2013 and 2003–2008, respectively). Thanks to Frederik Pfeiffer for data assistance. Note also that especially in recent years, countries such as Czechia, Slovenia and Poland (since about 2019) have reported a positive migration balance, in part due to instability and poor living standards further East (including, tragically, the Ukraine war), and in part as a result of Brexit.

skills and human capital with them, even though their education had been almost fully financed by the tax contributions of the preceding generation back home. This perverse form of poorer-East-to-richer-West brain drain – or cream skimming – is the other side of the valued 'freedom of movement' coin. It contains more than a whiff of both international and intergenerational unfairness/imbalances. To the extent that these young emigrants subsequently started or expanded families and stayed abroad, East Central European population losses and valuable human capital losses were compounded over multiple generations.[5]

So what are the appropriate responses? Here's the rub: the prospects for policy solutions do not appear rosy either. This is not just because the capacity of the state to compensate for low fertility through human capital investment in health and education is generally limited, especially in countries with declining populations (Siskova et al., 2022). What is more, adopting a political demography lens shows that politics is endogenous to the problem at hand (Goerres and Vanhuysse, 2021). East Central Europe's population predicament has in part been caused, rather than tempered or resolved, by states. It is precisely the productivity-adjusted demographic continuity underlying the intergenerational contract that is at risk in East Central Europe, where systemic failures of governance along multiple dimensions have contributed to eroding, rather than fortifying, the human capital foundations and the longer-term resilience of the welfare state. To better understand the roots of the current population challenges, we need to study the political pathways leading up to the present (Cerami and Vanhuysse, 2009). Below I build on Vanhuysse and Perek-Bialas (2021) to argue that there is a distinctly East Central European phenomenon of political push *before* demographic pull in the 1990s, followed by a decades-long political failure to prepare for predictable demographic change.

4 Lopsided loyalty: Manufactured grey voice and premature pro-elderly bias

Early in their transitions to market democracy, many ECE governments proactively tried to buy social peace and political quiescence by (ab)using social policies, notably public pension systems, as buffers against large-scale unemployment and social unrest (Vanhuysse, 2019). This led to historically unprecedented numbers of working-age citizens seeking to retire early or to receive a disability pension. This massively bloated pension systems at a time when levels of population ageing were very modest. In the first seven years of the transition alone, the estimated share of pensioners within the electorate increased from 32 to 40 percent in Hungary and from 27 to 34 percent in Poland (Vanhuysse, 2006, p. 120). In Slovakia, 80 percent of new pensioners

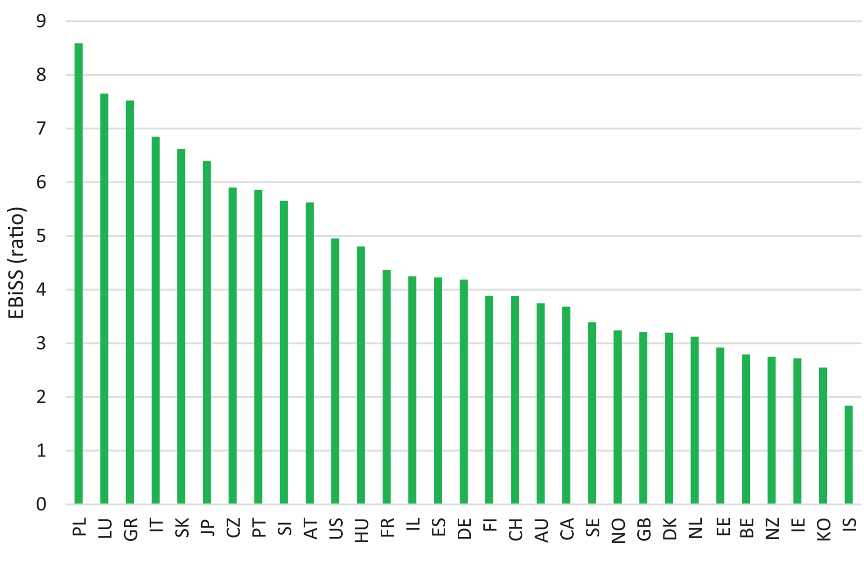
[5] These dynamics may be mirrored by the tens of thousands of young Ukrainians (especially women) who have fled the Russian invasion by going westward since February 2022, notably to Poland and the Baltic states.

retired early by 1994, compared to barely any five years earlier, while Slovenia was one of just three out of 28 European countries where narrow pensioners' parties had sustained electoral success (Vanhuysse and Perek-Bialas, 2021, p. 380).

This politically 'pushed', rather than demographically 'pulled', boom in pensioner numbers set in motion powerful new electoral dynamics and policy feedback mechanisms leading to the emergence of pensioners' democracies or gerontocracies (Vanhuysse and Perek-Bialas, 2021). The much-enlarged grey voice has made it harder to retrench or reform pension systems, to reduce pro-elderly policy bias or to tackle special pension regimes for farmers, police, military and other occupational groups. Multiplying the electoral turnout rates and group sizes of elderly and younger voters, Vanhuysse and Goerres (2021) constructed an indicator of the relative power of elderly voters for a 109-country sample in 2015. Remarkably, on this elderly power indicator, six ECE countries ranked among the top 20 within this global sample. Large parts of East Central Europe were far along the path to gerontocracy well *before* they started ageing rapidly.

Unsurprisingly, these electoral power balances were reflected in policy outcomes. The Visegrad Four and Slovenia, unlike the Baltic states, have evolved along new pathways towards prematurely high levels of pro-elderly policy bias, measured as overall per capita social spending on the elderly relative to on the non-elderly. As Figure 1 shows, around the time of the 2007–2008 global economic crisis, not just the 'usual South European suspects' of Greece, Italy and Portugal, but also these five

Figure 1:
Elderly bias of social spending ratio (EBiSS), 2007–2008



Source: Author's computations.

demographically still younger East Central European societies, had the most heavily pro-elderly biased policies in the OECD, as measured by the elderly bias in social spending ratio (*EBiSS*).[6]

The welfare state in Slovakia spent 6.6 times as much on every elderly Slovak as on every non-elderly Slovak in the late 2000s. By contrast, in demographically comparable Ireland, that ratio was just 2.7. And Poland occupied, as it were, the pole position within the entire OECD in pro-elderly policy bias, spending 8.6 times as much on every elderly Pole as on every non-elderly Pole. But in demographically comparable New Zealand, the state spent only 2.7 times as much. Similarly, while effective retirement ages have been raised from internationally low levels in the past two decades (except in Slovenia), systemic pension reforms adjusting for increasing life expectancy and rising old-age dependency ratios have been few and far between – and have been subject to reversals and political business cycles. In sum, politics came first, while policy outcomes came second. Thus, grey electoral clout led to premature pro-elderly bias well before demographic challenges really kicked in.

5 Multidimensional failures of governance in the face of predictable demographic developments

While the size and the pace of the early post-communist drops in fertility and the post-EU-accession westbound emigration flows were partially unexpected, the larger long-term demographic picture was not. Observing accelerating population ageing trends is not unlike watching elephants on the move: they are enormous, momentous, easy to spot and slow in getting started. The old-age dependency ratio has been rising steadily since at least 1990 in the Baltics, Slovenia, Romania and Bulgaria, but from comparatively low levels. Moreover, while it is rising quickly now, this ratio did not start increasing significantly until 2010–2015 in the Visegrad Four. Thus, these countries benefited from having a particularly long demographic window of opportunity to better prepare for changing demographic dynamics.

An adaptive, non-myopic policy response would have been to rebalance lopsided policy models towards the non-elderly, notably towards parents and children. There was a need for policies that placed more value on social reproduction and social investment as a means of promoting individual human flourishing

6 On the *elderly*-oriented spending side, the *EBiSS* numerator includes old-age-related benefits in cash and in kind, survivors benefits in cash and in kind, disability pensions, occupational injury and disease-related pensions, and early retirement for labour market reasons. On the *non-elderly*-spending side, the *EBiSS* denominator includes family benefits in cash and in kind, active labour market programs, income maintenance cash benefits, unemployment compensation and severance pay cash benefits, and all education spending. To control for demographic structure, the resulting elderly/non-elderly social spending ratio has been adjusted by the means of each country's old-age support ratio – i.e., the number of persons aged 20–64 over the number of persons aged 65 or older (Vanhuysse, 2013). For more on elderly bias in public policy, see Gamliel-Yehoshua and Vanhuysse (2010); Vanhuysse (2014).

and intergenerationally cohesive and gender-egalitarian societies, rather than for policies that were merely tools in the service of pro-natalist and pro-familialist political ideologies. In particular, there was a need for high-quality education programs, especially in early childhood: a social policy with high social returns that could be characterised as genuine investments in future foundations, rather than as consumption spending (Vanhuysse, 2015). In the same vein, family-work reconciliation policies and other legal and policy measures aimed at changing cultural (gender) norms and valuing caregivers more would have better rewarded parents who were rearing the next generation to productive adulthood at home (Gál et al., 2023). But over the past three decades, ECE countries have, on the whole, comprehensively failed to sufficiently reform their policy models to better prepare for the faster population ageing ahead (Vanhuysse and Perek-Bialas, 2021). There are multiple and mutually reinforcing reasons for these countries' failures, including their low levels of administrative capacity, their patronage politics and other semi-corrupt political practices, and, subsequently, their significant democratic backsliding, especially, but not solely, in Hungary and Poland (e.g., Dobbins and Labanino, 2023; Vanhuysse, 2008).

The political demography of this missed opportunity to develop policy models in preparation for expected demographic change is reflected in a host of synthetic policy or outcome indicators, reviewed in Vanhuysse and Perek-Bialas (2021). According to the EU's four-domain, 22-dimensional Active Aging Index, Poland occupied the bottom position in the 27-country sample in 2012, while Hungary ranked third lowest, Latvia ranked sixth lowest and Romania was in the eighth lowest position. According to UNICEF's five-domain, 26-dimensional indicator of child well-being for 29 countries, Romania and Latvia occupied the two bottom positions, while Hungary and Poland occupied the ninth and 10th lowest positions, respectively. Today, Slovenia and Estonia generally rank high on family-friendly policy indicators, above Finland and alongside the other Nordic countries: on UNICEF's four-domain, 41-country ranking, Slovenia was in the fourth position and Estonia was in the eighth position (Chzhen et al., 2019). Elsewhere, however, East Central European family policy regimes have generally ranked poorly, as they have generally either reinforced only mothers' roles in raising children, or have left parents with little public support altogether (Javornik, 2014).

The contrasting policy pathways taken by the Baltic states and the Visegrad Four are particularly evident when comparing approaches to investing in the future human capital basis of these now rapidly ageing welfare states. The Baltics, and especially Estonia and Latvia, have proactively implemented comprehensive social investment strategies as an integral part of larger programs of post-Soviet nation-building and of welfare state recalibration aimed at building more competitive, skill-focused political economies (Toots and Lauri, 2022). By contrast, in the Visegrad Four countries, right-wing parties have always been critical of or hostile to social investment policies (including when – or, rather, because – these policies were strongly pushed by the EU), and even left-wing and politically liberal parties have never been wholeheartedly supportive of such policies. These countries have evolved from implicitly neglecting social investment in the early post-communism period to explicitly rejecting such policies in recent decades (Szelewa and Polakowski, 2022). With the partial exceptions of Estonia and Poland (which have made great strides in PISA scores since 2010) and Czechia (which performed well in mathematics), ECE countries have performed consistently poorly on PISA tests. Even in the recent PISA waves, the ‘Eastern’ EU scored lower on average than the ‘Western’ EU on mathematics and problem-solving, with Romania, Hungary and Bulgaria being particularly poor performers (Vanhuysse, 2015).

6 Alarm bells ringing

Sustainable and balanced intergenerational resource transfer constellations are the glue that binds societies together over time (Vanhuysse et al., 2021; Vanhuysse and Gál, 2023). While any one policy indicator ought to be used with the same caution as demographic indicators, low performance on the wide array of indicators discussed here constitutes an ominous sign of deeper social problems and biased policy priorities in most of East Central Europe. Alarm bells should therefore be ringing, warning of the real and present danger of increased intergenerational imbalances, and of fraying, or mutating, social contracts.

Apparently modifying this picture somewhat, after 2010–2015, the political salience of family policy (as well as working-life extension) has been increasing in much of (non-Baltic) East Central Europe, especially in Poland and Hungary (Inglot et al., 2022). However, this shift was typically driven by the pro-natalist and neo-familialist ideologies of the strongly Christian-conservative, nationalist-populist and gender-regressive parties that are also behind the significant democratic backsliding (Cook et al., 2023; Szelewa and Polakowski, 2022). This new neo-familialist policy focus has improved mothers’ and children’s well-being relative to previous decades, even though it was not the result of a genuine desire to build resilient future foundations by better rewarding both fathers and mothers for their contributions to social reproduction and by investing more in the human capabilities of young generations. Moreover, by the early 2010s, the levels of political clout of grey voters in East Central Europe were already among the highest in the world (Vanhuysse and Goerres, 2021).

All in all, this adds up to a bleak population-political macro-picture for most of this region, with Estonia being the most notable exception. Now that the long demographic window of opportunity is closed, the prospects for policy responses that would redress past generational imbalances and boost future human capital are further constrained by young exit, grey voice, and gender-regressive, neo-familialist population politics. Political dynamics are an additional reason to worry about a generational contract under pressure in East Central Europe, both today and tomorrow.

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Low, but not too low, fertility can represent a positive development

Vegard Skirbekk[1,2,3,4,*]

Abstract

The public discourse about the ongoing fertility decline and the spread of low fertility, and the consequences thereof, is often unscientific and emotionally charged. As I argue in my book, *Decline and Prosper!* (Skirbekk, 2022), low fertility *per se* does not pose a major societal threat – and it is also accompanied by a number of benefits. In this article, I summarize my main points: namely, that i) the negative consequences of low fertility are often exaggerated and based on false assumptions; ii) low fertility is driven by many different, interacting factors, and is the byproduct or the cause of many positive societal developments; iii) low fertility is here to stay; and iv) societies urgently need to adapt to a world with fewer children. Fertility decline is self-perpetuating: once low fertility has become the norm in one generation, the fertility level is much less likely to increase in subsequent generations. At the same time, no plausible level of migration would be enough to meaningfully alter population aging in the long term. If, however, societies make the right choices, low fertility can enable humans to live more sustainably well into the future, and can stimulate further positive developments in the human condition.

Keywords: global demographic change; low fertility; ageing; population concern

1 Introduction

More and more countries around the world already have or are steadily approaching having fertility rates below the replacement level (which is currently slightly over two

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children per woman, and is falling over time due to reductions in mortality). As of 2020, around 100 countries had a total fertility rate lower than the replacement level (United Nations, 2022). There is little evidence that this downward trend in fertility is coming to an end or will be reversed in the foreseeable future (Skirbekk, 2022; United Nations, 2022; Vollset et al., 2020). In middle- and high-income countries – including in much of East Asia, Europe, North America, the Caribbean, parts of Latin America and, more recently, China and India – low fertility rates have sparked concerns about population aging and decline. Some observers have warned that fewer births will lead to economic stagnation, ballooning social security costs and imploding welfare systems due to shrinking workforces and high shares of older persons (aged 65+ years) in the population. Indeed, some have predicted that whole societies or even mankind in its entirety will be driven to extinction, or be "over run" by (sub)populations with higher fertility. In other world regions, including in parts of West Asia and Sub-Saharan Africa, low fertility is sometimes perceived as an invasive Western, secular phenomenon that threatens to erode traditional culture (Goldman, 2011). Nonetheless, fertility is gradually declining in these regions as well.

The public discourse about low fertility and its consequences is often unscientific and emotionally charged. As I argue in my book, *Decline and Prosper!* (Skirbekk, 2022), low fertility *per se* does not pose a major societal threat – and it also provides a number of benefits. In this article, I summarize my main points: namely, that i) the negative consequences of low fertility are often exaggerated and based on false assumptions; ii) low fertility is driven by many different, interacting factors, and is the byproduct or the cause of many positive societal developments; iii) low fertility is here to stay; and iv) societies urgently need to adapt to a world with fewer children.

2 Low fertility is not a harbinger of doom

Many common assumptions about the negative consequences of low fertility – and of population aging in particular – are not or are only partially supported by evidence. The countries with the lowest fertility and the chronologically oldest populations tend to be economically better off (Götmark and Andersson, 2020; Lee et al., 2014; Vandenbroucke, 2016) and to have better age-specific health than countries with higher fertility and younger populations (Chang et al., 2019; Skirbekk et al., 2022). Notably, all of the world's 10 largest economies in terms of absolute gross domestic product – including India and China – now have below-replacement fertility (Skirbekk, 2022). Some of these countries, such as Germany and Italy, have had low fertility for several decades. Thus, there is little reason to conclude that low fertility is at odds with economic strength. Moreover, cataclysmic prophesies about the impact of population aging on society tend to be guided by an inaccurate understanding of the malleability of the aging process and/or the needs and abilities of the older population. More recent cohorts of people aged 65+ have higher education, improved cognitive function and better health; and they also hear better than previous generations (Engdahl et al., 2021; GBD 2019 Ageing Collaborators, 2022; Skirbekk et al., 2013; Strand et al., 2019). The vast majority of people aged 65+ in the 27 European Union member countries – one of the oldest world regions – are able to perform all instrumental (e.g., shopping) and basic (e.g., preparing food) activities of daily living without any major difficulty (75% and 91%, respectively) (Gaertner et al., 2019). In fact, the ratio of people in good health to people in poor health is actually about the same in the chronologically younger South Asian and African populations as in the chronologically older Western European and East Asian populations (Skirbekk et al., 2022). While there is no denying that health and functional impairments and the need for care tend to increase as people get older, the relationship between chronological age and functioning is weaker than is often presumed, and depends to a great extent on people's health, which is, in turn, influenced by the health care, education, lifestyles and living conditions they experienced throughout their lives.

Negative prophesies about the consequences of low fertility also need to be counterbalanced by adequate recognition of its benefits. While low fertility brings with it new challenges, such as the increasing prevalence of unwanted childlessness and a need to restructure social security systems; it can also contribute to better maternal and child health, as mothers have more time and resources to care for themselves and their families. Having fewer children also means that young and middle-aged adults – and women in particular – can invest more time and energy in continuing education, enabling them to fulfil their potential on the labour market and contribute to the community outside of their immediate families. Moreover, having fewer children may help humanity to reduce its ecological footprint, and could ease crowding and congestion in places where population density is already high (Sherbinin et al., 2007). Slowing population growth and low fertility can reduce pressure on infrastructure, and may improve access to quality educational and work opportunities if there is less competition among young people. By contrast, fast population growth could reduce opportunities to invest in youth (Asheim et al., 2023; Bashir et al., 2018; Packer, 2008). Finally, population aging might contribute to decreases in crime, physical and sexual interpersonal violence and war (Farrington, 1986; Haas, 2017; Kanazawa, 2003).

It is also often overlooked that today's low fertility actually represents a return to historically normal levels of net fertility (i.e., the number of surviving offspring per person) (see Skirbekk, 2022, pp. 39–65). For most of human history, women have had an average of two or slightly more children who lived long enough to reproduce themselves. From the early 19th to the early 21st century, infant and child mortality declined dramatically. More children survived to reproductive age, while the total number of babies born declined only slowly. From a historical perspective, it was this period of high net fertility and enormous population growth that was the anomaly. The world's current net reproduction rate of just over one surviving daughter per woman (Keilman et al., 2014) is probably about the same as it had been for most of the pre-demographic transition era, during which the global population grew only slowly (Johansen, 2002; Maddison, 2010; UN, 1973). Current net fertility in Europe and North America is around a quarter below the net replacement level, and is slightly increasing in several countries (Eurostat, 2022) – which is a far less dramatic trend than claims about the impending collapse of the human population or the erosion of the "traditional family" due to low fertility would imply. The primary difference between nuclear families of the present and those of the more distant past is that fewer of their children are dying – which most observers would consider a good thing. One might argue that human fertility behavior has finally "caught up" to the condition of low mortality.

3 Why are people having fewer children?

In addition to lower infant and child mortality, today's low fertility has been deeply intertwined with many other positive developments in the human condition (Santelli et al., 2017): e.g., the proliferation of education; the spread of safe and effective contraception; improvements in women's rights and opportunities; decreases in child and adolescent marriages; economic progress; and more freedom to live as one desires. It is important to consider how attempts to reverse fertility decline may infringe upon societal advancements in these important spheres of life. Other drivers of today's low fertility include a reduced need to have children in order to secure one's own welfare; new conceptions of young adulthood as a time of exploration; secularization; the high financial costs of having children; (lack of) job opportunities for young adults; increases in the cognitive demands of work; changes in partnership dynamics; and biological constraints (e.g., semen quality, age at menarche and menopause). Geopolitical and economic instability, economic downturns and environmental disasters or climate change may further depress the desire for (more) offspring (Sobotka et al., 2011; Tong et al., 2011), see also Skirbekk (2022, pp. 265–284). All of these factors continuously interact with each other and evolve over time.

In the world's richer countries, most people still want to marry and have children – but later, and not at any cost (see Skirbekk, 2022, pp. 159–176). People now see their twenties as a time for studying, travelling, establishing a career, forming an identity and searching for a suitable partner. Childbearing and childrearing remain closely linked to partnerships (Bergsvik et al., 2019), see also Skirbekk (2022, pp. 217–245). Today, people spend a much lower proportion of their reproductive life in a partnership than was previously the case. New processes of dating and partnership formation allow people to "test" potential partners for extended periods of time before having children. Unrealistic expectations about finding the "perfect partner" may contribute to later family formation. As women's educational and labour market outcomes improve, continuing preferences for a "male breadwinner" and the expectation that mothers should perform the majority of household labour might likewise prevent many people from finding or keeping a partnership. Thus, large shares of people remain single, and those who marry often do so later in life. Moreover, many marriages dissolve, which contributes to lower fertility.

Fertility delay is a major driver of fertility decline. In higher-income countries, many people do not have their first child until their mid-thirties, and may end up – voluntarily or not – having just one child. In addition, many women and men forego having children altogether. Approximately one in five women in their late forties are childless in the UK, Germany, the Netherlands and the United States; and one in four women in their late forties are childless in Italy, Switzerland and Singapore (Sobotka and Beaujouan, 2018). The proportion of people who do not have children is increasing. In several industrialized countries, childlessness is now more common among men than it is among women (Kneale and Joshi, 2008). Childlessness is particularly high among men with low education and/or low financial resources.

4 Low fertility is here to stay

Fertility decline is self-perpetuating: once low fertility has become the norm in one generation, the fertility level is much less likely to increase in subsequent generations. This can be described as a “low fertility trap” (Lutz and Skirbekk, 2005; Lutz et al., 2006; Skirbekk and KC, 2012). Fewer births in one generation mean fewer potential parents in the next. Moreover, people who have internalized the idea that smaller families are “normal” tend to have smaller families themselves. Finally, aspirations tend to increase across generations, even as it becomes more difficult for people to attain what many see as the pre-conditions for having children: e.g., a stable job; a committed partner; adequate housing; and a sense of having sufficiently explored the opportunities of a child-free life. All of these mechanisms make it unlikely that fertility will rebound once it drops below 1.5 children per woman.

Globally, more and more governments are implementing policies designed to encourage higher fertility (e.g., one-time baby bonus, expansion of day care), see Skirbekk (2022, pp. 357–386) as well as United Nations (2021). From a human rights perspective, it is an admirable policy aim to help people to have the number of children they ideally want to have. From an economic perspective, it is also advantageous to prevent generations from shrinking too quickly, so that individuals and cultural systems have more time to adapt. While the policies implemented so far may have improved family life somewhat, they have, at best, had only temporary and modest effects on birth rates. This is because most policies only superficially reduce the burden of childbearing. Many of the barriers to having as many children as one would like to have would be difficult to address to via policy measures (e.g., difficulties establishing and maintaining a partnership; preferences for a lifestyle at odds with childbearing), and some interventions would be controversial in some countries (e.g., expanding access to assisted reproductive technologies). In sum, policies are unlikely to reverse fertility decline.

Migration has sometimes been proposed as a way to counteract negative population growth and/or population ageing. However, no plausible level of migration would be enough to meaningfully alter population ageing in the long term. Between 1990 and 2020 Africa’s population rose from 638 to 1,361 million – and the share who emigrated out of this world region was around 1.1% to 1.2% (Africa Centre for Strategic Studies, 2023). If the share of emigrants remains stable, emigration would increase to 20–30 million persons as Africa's population grows toward 2.5 billion by mid-century. This would not be enough to alter age structures in major receiving world regions. Moreover, education tends to be low across much of South America, Africa, the Middle East and South Asia – and thus in all regions of the world with relatively young populations (Barro and Lee, 2013; Gust et al., 2022). About nine out of 10 adolescents in South Asia and Sub-Saharan Africa and seven out of 10 adolescents in Latin America and the Middle East and North Africa (MENA) region lack basic skills: i.e., they are not able to perform at the PISA level 1 (the most basic level, which entails being able to answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined) (Gust, Hanushek et al. 2022). These conditions limit the relevance of migration for alleviating labor shortages. Migrants can also generate substantial fiscal and social costs (Brochmann and Grødem, 2013; National Research Council, 1997, ch. 7; Wadensjo, 2000), especially if working-age migrants have problems establishing themselves on the labour market.

5 Adapting to a world with fewer children

Given that neither low fertility nor population aging will be reversed in the long term, the most relevant question is how societies can best prepare for and adapt to a world with fewer children and more older people. There are clear challenges that need to be addressed. Some physical and cognitive abilities decline with age, and some work skills may become redundant over time. While population aging will likely put a strain on welfare and pension systems, there is enormous room to optimize how people's health and abilities change with age. Greater investments in education, preventive care, health service provision (physical and mental) and the promotion of healthy lifestyles across the entire life course are key to enabling longer working lives and reducing the strain on health care and welfare systems as populations get older. It is also necessary to address inaccurate beliefs about the aging process and old age, as well as outdated ideas about what constitutes age-appropriate behavior, which can influence how people behave and function across the life course (Bowen, 2011). Due to demographic changes, increasing numbers of people may lack familial support in old age, making universal social security systems important sources of assistance. It is, however, crucial to ensure that these systems are sustainable over time by balancing the generosity of benefits and the age of eligibility. Doing so would reduce the risk of insolvency and prevent some generations from supporting a system that may not provide them with adequate benefits.

To maintain economic stability, people will need to spend a greater number of years of their life as "contributors" (performing paid and unpaid work), rather than as "dependents" (recipients of financial support and/or care). This might entail delaying retirement, as well as encouraging earlier labour market entry (Loichinger and Skirbekk, 2016) and the participation of women in the labour market.[1] However, extending the "contributing" period of life will also require much deeper adjustments to how individuals and societies approach working life. The focus should be on designing working contexts that make working more attractive, and on making sure that people have the tools to perform the jobs they like doing. Investments in employees' health, skills and motivation across the entire life span will be necessary to ensure that people work sustainably. Improving options for (re)training and education; providing support for people changing jobs and careers, including later in life; creating more opportunities for quality part-time work and intermittent sabbaticals; improving rehabilitation and (re-)integration programs; and addressing the perception of retirement as a reward are just some of the measures that could encourage people to remain in the workforce longer.

Alongside investments in human capital and working conditions, investments in labor-saving technologies would help to replace human labour where it is scarce, and to free up human labour in sectors where it is unnecessary. Automation has already contributed to the displacement of the vast majority of European primary industry workers, and has lowered the number of workers in secondary industries. Some studies have suggested that automation is actually driven by low fertility and population aging (Abeliansky and Prettner, 2023; Acemoglu and Restrepo, 2022; Stähler, 2021). It has been estimated that if currently available technologies were implemented everywhere, just 2% of the world's current agricultural workforce (and around 0.5% of the world's total workforce) would be needed to produce all the food consumed in the world today (Vittis et al., 2022). By making more efficient – as well as more sustainable – use of human labour, societies will be able to sustain economic development, while also improving working conditions. It will, of course, be necessary to support people who are displaced by technology by helping them to integrate into other sectors.

Another, less discussed challenge of low fertility is the increase in childlessness, particularly among men with low education and low economic resources. Increasing proportions of men in many countries will not only lack financial and educational resources, but will also have less family support as they grow older. Societies need to pay attention to this growing risk group. Evidence suggests that much of the increase in childlessness is "coincidental;" that is, more people are ending up childless without explicitly wanting to do so (see Skirbekk, 2022, pp. 105–140). Many people who postpone having children until they are older overestimate their ability to conceive later in life, naturally or with the support of assisted reproductive technologies. To

[1] Notably, policies that improve young people's employment opportunities and help more women combine work and family life are apt to be met with more enthusiasm than policies that delay retirement. Furthermore, retirement policies that allow for more flexible work schedules at higher ages and provide older people with work opportunities more suited to their interests and skills could prove popular.

help prevent unwanted childlessness in future generations, young men and women need to be better informed about their biological chances of reproducing in later life, and more cognizant of how their life choices may impact their chances of having children. Policies that address younger peoples' housing and the labor market opportunities may also be effective.

If societies fail to seize the benefits of the demographic dividend, or "get old before getting rich," they will face greater challenges related to population aging. These challenges can be exacerbated if countries do not accumulate sufficient capital or invest in crucial areas, like preventive health care, education, infrastructure and technology. As social mobility tends to be lower at older ages, countries should seek to increase social equity at younger ages by implementing policy measures aimed at reducing economic inequality earlier in the life course.

6 Breathe in, breathe out – low fertility can enable humans to live more sustainably

Low fertility, together with population ageing and, eventually, a declining population, represent the demographic hallmarks of the 21st century for countries all over the world. More balanced, evidence-based discussions of the causes and consequences of low fertility are urgently needed. Societies, communities and individuals will have to adapt: i.e., individuals will need to spend more years contributing to society, and societies will need to invest much more in the education and health of all their members. Some of these changes will be painful, but the dividends from these investments will likely far outweigh their costs. If societies make the right choices, low fertility can enable humans to live more sustainably well into the future, and can stimulate further positive developments in the human condition.

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The key role of early education in an ageing and shrinking population: The example of Germany

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Abstract

Germany is currently among the 10 oldest countries in the world, as measured by the share of population aged 70 years and over. With the baby boomer cohorts of the 1950s and 1960s having started to reach retirement ages, a new phase of ageing is about to take place. In this debate piece, we argue that investments in human capital at any age and at any stage of the life course are indispensable for dealing with an ageing population. Investments in early education are most effective and efficient, as early skills beget later skills. We show that in an ageing society, it is most efficient to invest in children from the very beginning to develop their full human potential, and to ensure that no child is left behind. Moreover, investments in early education programmes have benefits in addition to those directly related to children, including benefits related to fertility, maternal employment and the integration of parents with a migration background. Globally, more and more countries are faced with increasing proportions of older people and decreasing proportions of working-age people in their populations. Thus, what we describe here for Germany can in many respects be transferred to other country contexts.

Keywords: population ageing; human capital; education; early education programmes

1 Demographic trends in Germany

Germany is currently among the 10 oldest countries in the world, as measured by the share of population aged 70 years and over. Life expectancy has been increasing and the total fertility rate (TFR) has been continuously below the so-called replacement level of 2.1 children per woman since the early 1970s (and even, on occasion, before

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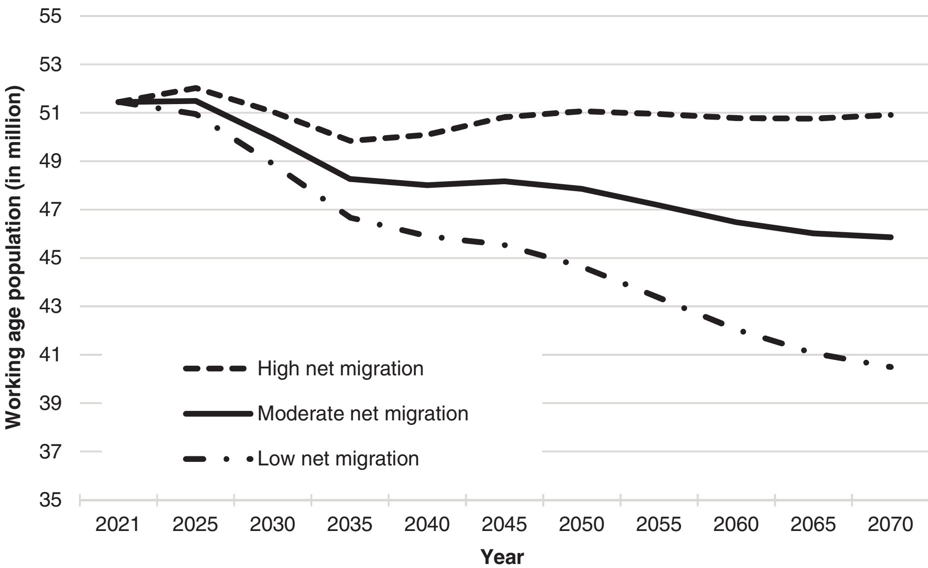
then). At present, the TFR stands at 1.6 children per woman, and it is unlikely to rise significantly in the near future, despite some moderate increases recorded in recent years. Moreover, the number of deaths has surpassed the number of births in every single year since the early 1970s, leading to negative natural population growth. This means that the population would have started shrinking about 50 years ago had it not been for the effect of immigration. As positive net migration – i.e. more immigrants than emigrants – made up for the deficit in births over deaths in most years, the population in Germany increased from 77.7 million in 1970 to 84.4 million in 2022.

Germany has been a country of immigration for decades, attracting migrants from a wide range of origin countries. Germany has the second-largest absolute number of foreign-born residents globally, after the United States (McAuliffe and Triandafyllidou, 2021). As a result, 27% of the population have a so-called migration background, which means that either the individuals themselves or at least one of their parents did not possess German citizenship at birth. Between 2005 and 2021, the increase in the share of the population with a migration background was more pronounced among children below age 10 than among other age groups, rising from just over one in four to almost one in two. Germany is actively trying to attract labour migrants from abroad, and it is reasonable to expect further refugee migration and other forms of migration to Germany. Therefore, the share of persons with a migration background in the German population is expected to increase in the future.

Given that the birth deficit is likely to grow as the baby boomers born in the 1950s and 1960s get older, and assuming that there is no extraordinary increase in the TFR, immigration will continue to be the decisive factor in whether the population of Germany increases, stagnates or decreases over the coming decades. The moderate variant (Variant 2) of the latest official projections by the Federal Statistical Office of Germany is based on the assumptions of moderate further increases in life expectancy, a TFR of 1.55 and average net migration of 290,000 persons per year. Under these assumptions, the size of Germany's population would remain barely unchanged for the next 50 years.[1] The ongoing change in the age composition would, however, continue: the share of the population aged 67 and older is projected to increase from 20% currently to 25% in 2040. Age 67 is the soon-to-be statutory retirement age. Over the same period, the share of the population aged 20 to 66 is projected to fall from 62% to 57%. While this change in the working-age population might not seem very large in relative terms, it means that the number of people of working age will decline by about four million in less than 20 years. As Figure 1 illustrates, the future size of the working-age population will depend on the volume of net migration. However, worries about the labour supply are not just concerns for the future, but are already a reality today, as it is becoming increasingly difficult to fill open positions at various skill levels and in a range of occupations, including openings for professional

[1] Under a scenario with low net migration assumptions (180,000 net migrants per year), the population is projected to decrease to 74.5 million in 2070; while under a high net migration scenario (400,000 net migrants per year), the population is projected to increase to 89.8 million (Destatis, 2022).

Figure 1:
Population of working age (20 to 66 years), by migration variant (low, moderate and high net migration assumptions)



Source: Destatis (2022), own depiction.

workers in the (health) care sector and the IT sector, qualified craftsmen and low-wage service workers (e.g., Fitzenberger, 2023).

2 Investing in education as a strategy for coping with demographic change

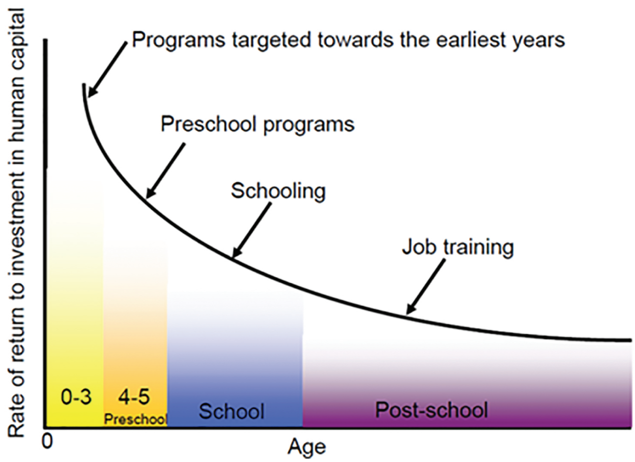
Investment in a population's human capital is increasingly recognised as one of several strategies for coping with demographic change, not least because it is one parameter used to increase labour potential and productivity in an ageing society, alongside increasing the labour force participation of women and persons who do not have German or another EU country's citizenship, increasing working hours, raising the retirement age, labour migration, and the expansion of automation and AI. In Germany, as in other high-income countries, employment rates are highest and unemployment is lowest among people with higher levels of education (e.g., Loichinger, 2015). Among the potential reasons for this advantage are positive selection into higher education, opportunity costs, the association between education and health outcomes, and differences in job quality and opportunities. This positive association between education and employment reflects the returns to education at the individual as well as at the societal level, and points to the relevance of investments in education, particularly in contexts with declining labour potential. However, it is not only the labour shortage that makes education so important in ageing societies, as there are many other outcomes that might improve through education, and that are important in light of demographic change, including life satisfaction and healthy life expectancy. Furthermore, it is not education per se that is the most effective and efficient tool to tackle demographic change. As we will argue in this debate piece, investments in early education are particularly important in an ageing population with relatively small birth cohorts, and with a significant share of children who are growing up in a non-German-speaking household.

3 Human capital investments – what does the research tell us?

The discussion of investments in education raises several questions. Important ones are: When are investments most effective and, even more importantly, when are they most efficient? Among education researchers, it is primarily education economists who deal with these questions. Most international and national studies that have addressed these issues in recent years have pointed to the high effectiveness and efficiency of investments in early education (e.g., Cunha and Heckman, 2008; Spiess, 2017). This finding is the result of the so-called multiplier effects that these investments produce, given that early skills are the basis of later skills. This means that skill gaps that develop at one point in childhood persist into higher ages, and may even widen because skills are self-reinforcing. Moreover, skills acquired earlier in life tend to increase the productivity of investments in skills later on ("skills beget skills"). Research has shown that all children, but especially those from disadvantaged families, benefit from early investments in education. Education researchers have also emphasised that the quality of the programmes matters, i.e. a certain level of programme quality is the precondition for positive education effects (e.g., Barnett, 2011). Thus, targeted spending on good quality programmes in the early years of the life course is a very effective measure for increasing the human capital of ageing societies. Moreover, the existing efficiency studies have shown that investments in these earlier years are not only very effective, but are efficient as well, at least once a long-term perspective is considered. This argument is closely linked to the work of the Nobel Prize winner James Heckman and his co-authors, who investigated such efficiencies mainly based on examples of special programmes in the United States. Heckman summarised this research in a stylised graph showing the high returns related to early investment in high-quality programmes (see Figure 2).

However, it is often noted critically in this context that at least some of the evidence on which Heckman's graph was based came from longitudinal studies that examined "only" high-quality programmes for highly selective groups of children in specific regions of the US. While it is clear that these studies found evidence of high

Figure 2:
Rate of return to investment in human capital by age



Source: Authors' extrapolation and adaption of Figure 2 in Heckman (2006, p. 1901) with permission from the American Association for the Advancement of Science.

knowledge gains, it is certainly also true that their results cannot be transferred 1:1 to the German context, or to other contexts. Research on the economics of education in recent years has generated further evidence that is much more transferable to the German context, or that is even based on German data. This is the research that has examined the impact of universal early education programmes in European countries; i.e. of those services that are basically available to all children, and are not targeted to specific groups (Spiess, 2017). For example, the results of a study based on Norwegian data demonstrated the long-term effectiveness of the expansion of publicly funded early education programmes. In the work of Havnes and Mogstad (2011, 2015), human capital has been shown to have increased contingent on an expansion of publicly funded early education and care programmes. The authors found that this expansion increased the number of students who finished school and who attended college, and reduced the number of social assistance recipients, to mention just a few effects. Other studies based on European data found evidence of medium-term effects of investments in such programmes mainly up to school age. Studies for Germany (for a summary, see Spieß, 2021) showed that investments in early education programmes increased human capital, for instance in the form of non-cognitive skills that are particularly relevant for later labour market outcomes, and resulted in a higher degree of school readiness and more students attending higher secondary school (*Gymnasium*).

In addition, early education programmes have other positive effects that should be taken into account in light of the expected shrinking of the labour force in Germany. Many empirical studies have shown that these programmes increase the maternal labour supply (e.g., Müller and Wrohlich, 2020) at both the extensive and the intensive margins, which means that they can help to increase both the labour force participation and the work volume of mothers. Thus, investments in early education programmes also allow earlier investments in the human capital of parents – in particular of mothers who would otherwise be unable to balance paid work and unpaid family work – to be used more broadly. In this respect, investments in early education can provide direct and immediate benefits, in addition to the child-related benefits that can take a number of years to feed through. Furthermore, early education programmes can have a positive impact on the realisation of fertility intentions. Studies for Germany have found that the expansion of publicly funded early education programmes in recent years has led to an increase in fertility (e.g., Bauernschuster et al., 2016), even though fertility is still well below the replacement level. It is, however, important to keep in mind that the labour market returns of fertility effects take even longer to materialise than the effects of investments in children's human capital, as it takes the length of time from birth until labour market entry in the first instance, and a few years less, from early education programme attendance to labour market entry, in the second instance. And last but not least, there is empirical research showing that early education and care programmes can increase the integration of mothers whose children attend them (Gambaro et al., 2021).

Although investments in high-quality early education programmes can help to increase the human capital of both the current and the future labour force, this does not mean that investments in the education of individuals at later stages in the life course are not effective, especially over the short term. Thus, in addition to interventions targeted at young children, investments in the current generation of students and in the current workforce should also be improved to increase the productivity of an ageing society. More efforts should be made to reduce the percentage of children who leave school without graduating or who do not receive any further education or training, as depending on the country and the context, this group can represent a sizeable labour potential. In Germany, for example, almost one in five 30-year-olds does not have any vocational training or higher education. Finally, investments that support lifelong learning later in the life course should be expanded. As empirical research has shown that participants in further education are mainly individuals with higher socio-economic status (SES), more investments are needed to support lifelong learning among groups with lower socio-economic status, especially given that the latter are at higher risk of declining employability as they grow older.

4 (Early) education policy in Germany – some facts

In light of these findings from the international and national literature on the effectiveness and efficiency of educational investments, a question that arises is whether they are reflected in German education policy. While there have been many reforms in the early education sector in recent years – most notably the expansion of early education programmes for children under age three – there are still many challenges to overcome. Empirical findings show that this expansion has primarily benefited children from families with higher levels of education and income: for example, the take-up rate of children under age three whose mothers have lower educational qualifications has increased to a disproportionately lower degree than that of other children (Schmitz et al., 2023). Children from families with lower socio-economic status or in which the parents have a migration background continue to be underrepresented in early education programmes. In 2020, the attendance rate of children under age three who had less well-educated mothers (without a university entry degree) was 28%, meaning that 28 out of 100 children below age three attended this programme; while the attendance rate of children who had a better educated mother (with a university entry degree) was 43%. The gap in attendance rates was also large between children depending on whether their family did (38%) or did not speak German (24%) at home (Schmitz et al., 2023). The latter finding is particularly noteworthy considering that children who do not speak German at home can acquire these language skills at early education programmes – an important skill for further learning in school.

Although such attendance differences are no longer observed among preschool children, the question of how the quality of education can be improved for these children arises, as it does for younger children. There is evidence that children from different socio-economic groups attend early education programmes that differ in quality, and that children from disadvantaged groups tend to use lower quality early education programmes, leading to further educational inequalities (Stahl et al., 2018). This is particularly serious because there are no national quality standards in Germany – an issue that has been debated for several years. It remains to be seen what steps the current government will take to reach its goal of introducing minimum standards aimed at ensuring that all children, regardless of their family background or the region where they live, attend early education and care centres with a certain level of quality. Thus, while further increases in public spending on early education are necessary, across-the-board increases do not seem to be the right approach. Instead, these increases should be combined with considerations of targeted support for children from disadvantaged groups as well as, for instance, for children whose mother tongue is not German. This is particularly important, given that the percentage of children being raised in a non-German-speaking household is increasing and will probably continue to rise in the future.

In addition to these inequalities in early education programmes, there are many other inequalities in the German educational system that hinder people from developing their full educational potential. Overall, public spending on education in Germany is still below the 2018 target of 10% of GDP. This target was set by the former German chancellor, who declared that Germany should become an "education republic" (*Bildungsrepublik Deutschland*). In 2021, education spending accounted for just 4.7% of GDP (Statistisches Bundesamt, 2022). Since Germany still spends relatively little on primary school children compared with other countries (OECD, 2022), investments should be increased, especially in this area. This is particularly necessary given that a recent report on the development of skills among primary school pupils showed that in the first year of the coronavirus pandemic, there were significant skills losses compared with previous years (Stanat et al., 2022). Depending on the skills area, an average of 18% to 30% of pupils failed to achieve the minimum standards. The current trend in education shows that performance has declined in almost all federal states, albeit to very different degrees. At the same time, the gap between socially disadvantaged children – with and without a migration background – and children from privileged families has widened. More investments will be required to prevent these skills gaps from widening further. In addition, more money is needed to develop the skills of children with a migration background early on, otherwise the costs will be even higher later.

5 Recommendations for Germany (and other countries)

Human capital investments at various stages of individuals' lives are needed to address the challenges of demographic change in both the short and the longer term. Although these investments will be expensive, failing to invest in early education today will prove even more costly in the future. Children from families with lower socio-economic status will particularly benefit from human capital investments. The education needs of many children with a migration background are also well-known, for example when it comes to language acquisition and skills. Having said that, it should be kept in mind that the group of those with a migration background is demographically and socio-economically quite diverse, just as the group of those without a migration background. In addition, given the capacity of investments in human capital to reduce the growing income and education gaps between population subgroups, such investments are effective tools for reducing social inequalities, and thus for increasing equality of educational opportunity. The goal of providing all children with quality education from an early age onwards is relevant not just to ageing societies – as a matter of fact, it is formulated as SDG (Sustainable Development Goal) target 4.2: "By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education".

In an ageing society, it is important to develop the full educational potential of all members; hence, no child, youth or adult should be left without good quality early education, schooling, training or continuing education. While we focused here on education at an early age, providing education and training to people throughout their working lives is another important strategy for coping with demographic change. This approach is also useful in light of technological change and other developments that make lifelong learning necessary – regardless of demographic change, but again in particular due to demographic change. Engaging in continuing education throughout the life course should not be an option mainly for workers with higher socio-economic status, but should instead become part of everyone's working life. This would have a positive impact on overall employability into old age, a factor that is key to extending working lives. The extension of working lives is a policy goal in Germany aimed at strengthening the sustainability of social security systems, especially the public pension system. Such training programmes should take place inside and outside of companies, and should increasingly provide on-the-job training as well. This latter kind of training allows employers to recruit new workers even if they lack some of the skills that are required for specific jobs, thereby enlarging the pool of potential applicants. Moreover, training programmes for the working population might also be one way to help migrants integrate further and faster into the German labour market. Reducing the number of bureaucratic hurdles migrants need to overcome before their educational qualifications are accepted in Germany might prove effective in this context.

While it is clear that there is a need to invest further in education to meet the challenges associated with demographic change in Germany, one question that remains to be answered is that of the administrative level at which such investments should be made. The answer depends on the context. Whereas decisions regarding investments in school education are made at the level of the 16 federal states in Germany, the situation is even more heterogeneous in the area of early education programmes outside of schools. The responsibility for funding early education programmes lies with local and state governments, while many on-the-job training programmes are funded either solely by employers or employees, or jointly by public and private actors. However, when considering the goal of increasing human capital, these differences should not matter, and discussions about who is responsible for spending cannot be an excuse for not investing further. What complicates this situation is that population ageing and especially population decline tend to manifest themselves differently at the subnational level. The latter poses different challenges for different regions, for example, in terms of attracting qualified education personnel. Today there is already a shortage of early education and school teachers for selected education levels and fields, and the competition for skilled personnel will likely increase further. The reasons for these challenges are related to both supply and demand: significant shares of educational personnel belong to the baby boomer cohorts and are about to retire, and the number of children below age 14 is projected to increase (Autor:innengruppe Bildungsberichterstattung, 2022).

Many of the conditions that have been described here for Germany can be transferred to other country contexts. In an increasing number of countries, the proportion of older people in the population will increase while the size of the working-age population and its share in the total population will decrease. Many countries are already seeing their populations shrink due to negative natural growth and/or emigration. According to the United Nations World Population Prospects 2022, 61 countries are projected to experience a population decline of 1% or more between now and 2050 (United Nations, 2022). While an unrealistically large number of migrants would be required to reverse the ageing process (Craveiro et al., 2019), immigration can slow this process and increase the number of working-age people in a given population. Depending on the level of immigration, the population will grow, stagnate or decline. Under all of these circumstances, investments in the human capital of all members of society – with or without a migration background – will be beneficial for individuals and for society as a whole. And investments at young ages will be especially important.

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PERSPECTIVES

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Implementing youth-oriented policies: A remedy for depopulation in rural regions?

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Abstract

The depopulation of rural areas has received increasing attention in recent years, both in scientific discourses and in policy-making. One main factor contributing to this rural shrinkage is the out-migration of the rural population. In particular, young and well-educated people have been leaving rural areas and moving to urban agglomerations. While the drivers as well as the consequences of out-migration have been well researched, less is known about measures to counteract youth out-migration as one of the main drivers of depopulation. Based on a comparative case study conducted in four rural regions affected by youth out-migration in Austria and Germany, this paper discusses policy measures that are specifically targeted at influencing young people's migration aspirations. In addition, the effects of these measures on rural youth migration are analysed. After implementing measures that take the needs of young people into consideration, all four case study regions started to experience a decrease in their negative youth migration balance. This was mainly due to an increase in in-migration, while youth out-migration rates remained stable. However, these developments follow the general trend of rural youth migration in Austria and Germany in recent years. Thus, more research is needed to evaluate the actual impact of youth-oriented measures. This paper introduces the "youth-oriented regional development" approach, and highlights perspectives for future research on policies aimed at mitigating the challenges facing rural regions that are experiencing depopulation.

Keywords: rural areas; depopulation; youth migration; regional development; rural policy; research perspectives

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1 Introduction

In recent years, the depopulation of rural regions has received increasing attention in scientific discourses and in policy-making. In general, rural depopulation is caused by a mix of decreasing fertility rates and high rates of out-migration. As it is mainly young people who are leaving rural areas to pursue education, work or entertainment opportunities, the demographic decline in these areas is closely linked to the ageing of the population. These two demographic processes can, in turn, lead to a self-reinforcing process of negative cumulative causation (Myrdal, 1957).

Today, this process of negative cumulative causation is specifically addressed by scientific discourses on urban (Bontje and Musterd, 2012; Haase et al., 2014; Wiechmann and Pallagst, 2012) and rural shrinkage (Galjaard et al., 2012; Haartsen and Venhorst, 2010; Hospers and Syssner, 2018), as well as on peripheralisation (Kühn, 2015; Kühn and Weck, 2012; Lang et al., 2022; Leibert and Golinski, 2016). Rural shrinkage is strongly linked to the out-migration of young people. While young people with lower education and qualification levels tend to move shorter distances and often stay within or close to their region of origin, young people with higher education and qualification levels generally move longer distances. This brain drain can have negative effects on a region's economic output, resulting in a decline in the quality of life, which may, in turn, lead to further out-migration (Elshof et al., 2014; Küpper et al., 2018). At the same time, depopulation and its negative effects can have severe consequences for municipal budgets that rely on demographic and economic development.

While the scientific discourse on urban and rural shrinkage mainly points to the interdependencies between demographic and economic development, the discourse on peripheralisation applies a more nuanced perspective to the (re)production of peripheries, going beyond the traditional understanding of the meanings of periphery and peripherality (Leibert and Golinski, 2016). According to the concept of peripheralisation, peripheries are social constructs – not geographic facts – that are produced through demographic, political and discursive processes (Bernt and Liebmann, 2013). As the starting point of the peripheralisation process, the out-migration of well-educated young adults is seen as evidence of the deficits of the regional education system and labour market, but also as a threat to the innovative potential of the affected regions. Hence, the future of rural regions has become a "demographic destiny" (Leibert and Golinski, 2016, p. 256).

1.1 Policy responses to population decline

To secure the sustainability of the affected regions, policy-makers in several countries have implemented strategies for adapting to or reversing the trend of population decline (Haartsen and Venhorst, 2010; Heeringa, 2020; Küpper, 2010; Meijer and Syssner, 2017; Syssner, 2016). In general, the scientific literature has identified four options for dealing with shrinkage: (1) trivialising the numbers, (2) counteracting decline, (3) adapting to decline or (4) utilising shrinkage as an opportunity (Hospers and Reverda, 2015). While (1) and (2) are usually seen as the least promising strategies from a scientific perspective, they continue to be widely used by local and regional governments (Heeringa, 2020; Küpper, 2010; Syssner and Meijer, 2020). According to Syssner and Meijer (2020), one potential explanation for this insistence on growth-oriented policies is that many governments have spent years investing in a growth rhetoric. On the one hand, giving up the goal of counteracting decline and restoring population growth may signal governance failure. On the other hand, following a policy that aims at adapting to population decline by resizing public infrastructures in line with declining population densities can lead to a loss of quality of life for those "left behind", and limit the potentialities of the affected regions. A policy that simply focuses on resizing public infrastructures can fuel feelings of despair, resulting in discontent with political leadership and revenge by the "places that don't matter" at the ballot box (Rodríguez-Pose, 2018).

Thus, in recent years, scholars have discussed positive perspectives for dealing with population decline. Such visions can be subsumed under the label of "*smart shrinking/shrinkage*" or "*smart decline*" (Haartsen and Venhorst, 2010; Hollander and Németh, 2011; Peters et al., 2018). Here, population decline is seen as providing momentum for transformation – that is, as offering an opportunity to do things differently (Haartsen and Venhorst, 2010). Following the approach of smart shrinkage, effective measures for preventing processes of peripheralisation in rural regions that are experiencing depopulation must include policies and planning for growth as well as policies and planning for adaptation. Furthermore, such measures must position planning in areas of depopulation as an enabler of, rather than as a barrier to, economic and social development (Syssner and Meijer, 2020).

The integration of young people's needs into regional depopulation policy-making can thus be seen as an opportunity for doing things differently, as it implies that the needs of young people will receive greater attention in rural policy-making, and hence that the mode of policy-making itself will start to change. Following the logic of smart shrinkage, the inclusion of young people and their needs in rural policy-making could help to transform the social and institutional characteristics of rural regions. Integrating the needs of young people into policy-making could support the emergence of a more qualitative, and thus wellbeing-focused, regional development agenda of the kind that regional science and planning scholars have been strongly advocating in recent years (Pike et al., 2007; Shucksmith, 2018).

As youth out-migration is a key factor in population decline, policy-makers at different governance levels (from local to national) and in different European countries have, in recent years, implemented strategies specifically targeted at influencing young people's migration aspirations and reversing the process of rural-to-urban migration. Both out- and return migration and their consequences have been well researched since the early 2000s (e.g. Farrugia, 2020; Haartsen and Thissen, 2014; Ní Laoire, 2007; Pedersen and Gram, 2018; Rérat, 2014; Stockdale, 2004). As was mentioned above, there is a growing body of literature on the broader policy options for regions experiencing depopulation. However, less is known about measures aimed at counteracting the out-migration of young people as a particularly important driver of depopulation.

1.2 The need for a youth-oriented approach

Against this background, the aim of the present paper is to offer a framework for the analysis of policy measures that are specifically targeted at influencing young people's migration decisions. The research questions guiding this analysis are as follows: *How can the needs of mobile young people be integrated into rural policy-making? And, how can youth-oriented policies affect rural youth migration?*

These two research questions will be answered through a comparative case study conducted in four rural regions in Austria and Germany. In its approach, the paper contributes to the scientific discourse on strategies for mitigating the challenges associated with population decline. It also examines policy options specifically targeted at addressing the needs of the population group with the highest mobility. Based on previous studies on strategies for regions experiencing depopulation, this paper seeks to shed light on youth migration as a central entry point for both policy research and design.

The remainder of this paper is structured as follows: Section 2 introduces the theoretical foundation for a regional development agenda that focuses on the needs of a young, mobile target group. Evidence on drivers of youth out- and return migration serves as the foundation for the concept of "youth-oriented regional development", which is presented in Subsection 2.2. Section 3 outlines the methodological approach followed in this study. Section 4 discusses the main findings on the integration of the needs of mobile young people into policy-making, and also addresses the potential impact of youth-oriented regional development on rural youth migration. The concluding chapter summarises these findings and highlights perspectives for future research.

2 Drivers of youth out-migration and policy options for reversing it

One of the main drivers of depopulation in rural areas is the out-migration of young people. Thus, integrating the needs of mobile young people into policy-making can be seen as an opportunity for achieving local and regional development goals in places where depopulation is occurring. While several European countries have implemented youth strategies in recent years to support the participation of young people in public life and policy-making, these strategies have often been place-blind. At the same time, policies that focus on territorial development often neglect the interests of the region's young residents. According to Faulde et al. (2020), a "real integrated approach" that combines youth policies with regional policies is rarely applied in practice.

Hence, the integration of youth policies into rural policies can be seen as a promising yet currently underexploited way to initiate a people-sensitive and a place-based approach to regional development that can serve as a foundation for the formulation of policies in rural regions affected by youth out-migration. By integrating the needs of mobile young people into measures that support regional development in rural areas, a youth-oriented regional development approach can be formulated, and a "real integrated approach" (Faulde et al., 2020) can become reality.

However, before this strategy can be implemented, an honest diagnosis of the problems in rural areas affected by youth out-migration is needed. Following Syssner and Meijer (2020, p. 165), "*to plan and innovate in rural, depopulating areas, a clear diagnosis of its challenges, limitations, strengths and assets is indispensable*". Thus, the starting point for the formulation of a youth-oriented approach to policy-making in regions experiencing depopulation must be to gain a better understanding of the characteristics and drivers of youth out-migration and return migration.

2.1 Characteristics and drivers of youth migration

Migration is an age-selective process that strongly correlates with life course transitions. As the most relevant transition is that from youth to adulthood, the propensity to migrate typically peaks at young adult ages. Research on internal migration, defined as "long-distance changes of address within national borders" (Mulder, 2018, p. 1152), indicates that two-thirds of such moves are completed by the age of 35 (Bernard, 2017). This pattern also applies to Austria and Germany: between 2010 and 2020, two out of three internal migrants in Austria and Germany were aged 35 years or younger (Statistics Austria, 2022; Statistical offices of the Länder, 2022).

In the scientific literature, the residential mobility of people between the ages of 16 and 35 years is usually defined as "youth migration" or "youth mobility" (King and Williams, 2018).[1] In the scientific discourse, the definition of "youth" is based on a relational approach to the life course: this stage is placed between the stages of "childhood" and "adulthood", with "childhood" ending when an individual reaches sexual maturity and "adulthood" starting when a person becomes economically

[1] Both terms, "migration" and "mobility", today appear in the scientific literature on young people's residential relocations (e.g., Farrugia, 2016; Mulder et al., 2020b). They are often used as synonyms. King and Williams (2018), referring to Cohen and Sirkeci (2011), highlight two advantages of using "mobility" rather than "migration": (i) that "mobility" accommodates types of movement beyond the somewhat limiting UN definition of migration; and (ii) that "mobility" is a more dynamic term "that captures the changing, fluid nature of the migratory phenomenon in the contemporary world" (King and Williams, 2018, p. 3). While I acknowledge this perspective on prioritising the term "mobility" over "migration", I will use the two terms synonymously in this paper.

independent and socially settled (Faßmann et al., 2018, p. 15). This division of the life course into life stages is, above all, socially constructed. It is based on various features of a society, such as its culture, social class, or lifestyle groups (King and Williams, 2018). Hence, there is no uniform definition of this age group. Indeed, different international organisations, such as the UN, the OECD and the EU, have different delineations of this specific life stage. For example, the youth life stage may be broadly defined as covering ages 15 to 29 years (EU) or ages 15 to 34 years (OECD). From the perspective of developmental psychology, this life stage includes the phases of early adolescence (12 to 18 years), later adolescence (18 to 24 years) and early adulthood (24 to 34 years) (see Faßmann et al., 2018). While people in the youth life stage have the highest levels of residential mobility, the propensity to migrate decreases as people enter the life stage of adulthood by starting a family. In summary, residential mobility is triggered by certain life course events, such as the completion of higher education, a job change, union formation or the birth of a child (Feijten et al., 2008) – i.e., by events that usually mark the transition from youth to adulthood.

Apart from life course events, migration is linked to lifestyle as well as to social and economic resources. Academically oriented young people in particular are often forced to leave their rural places of origin due to the structural constraints implicit in acquiring higher education (Pedersen and Gram, 2018). Studies on migration selectivity have highlighted that well-educated young adults from middle- and upper-class households have a particularly high propensity for out-migration (Elshof et al., 2014; Rye, 2011; Scheibelhofer, 2018). Moreover, young rural-to-urban migrants tend to have a stronger orientation towards urban lifestyles characterised by cosmopolitanism and individualisation (Farrugia, 2016; Pedersen and Gram, 2018). Farrugia (2016) even described a "mobility imperative", whereby rural youth must be mobile "*in order to access the resources they need to navigate biographies and construct identities*" (Farrugia, 2016, p. 837). Thus, in the perceptions of others, mobility becomes obligatory for the identity formation of a successful adult (Mærsk et al., 2023), while staying in a rural area is associated with "being not clever enough" (Pedersen and Gram, 2018).

Overall, youth migration should be viewed as a multidimensional and complex process in which life course events as well as structural and socio-economic factors must be taken into account. While research on internal migration within western countries has generally identified work and education as the main drivers of internal migration, more recent studies have also highlighted the importance of cultural amenities as well as social ties, especially those to family members (Bijker and Haartsen, 2012; Mulder, 2018). Furthermore, people's norms and values – e.g., searching for an open and tolerant living environment – are potential drivers of migration (Florida, 2004; Fratsea, 2019).

Education- and work-related internal migration is often triggered by regional disparities. Remote areas are especially likely to lack opportunities for pursuing higher education or employment in the knowledge economy. Thus, attaining higher education and following certain career paths may require spatial mobility. Leavers tend to have a stronger orientation towards individualisation and self-realisation than stayers. In contrast, stayers usually have stronger ties to their family and to other social networks in their region of origin (Dax and Machold, 2002; McLaughlin et al., 2014).

Nevertheless, leaving one's region for education- and career-related reasons is not necessarily a unidirectional decision. In different life stages, people may prefer different residential locations. While young people who are transitioning from school to university or from education to employment often move from rural to urban areas, people who have a family may prefer to live in suburban or rural areas. According to the "youthification hypothesis" (Moos, 2014; Moos et al., 2019), young people prefer to live in "*amenity-rich, often already highly gentrified, downtowns 'successful' in the knowledge economy*" (Moos et al., 2019, p. 224). Parents, by contrast, often seek out a high-quality environment for their children that offers safety and green surroundings (Kim et al., 2005). In their study on counter-urbanisation movements to peripheral areas in Denmark, Hansen and Aner (2017) found that people with children make up the largest share of all highly educated in-migrants to these areas. Furthermore, studies on rural-to-urban migration have highlighted the option of return migration, especially in the family formation phase (Haartsen and Thissen, 2014; Mulder et al., 2020a; Ní Laoire, 2007; Rérat, 2014). While family-related return migration is often linked to the image of a "country childhood idyll" (Jones, 1997; cited after Ní Laoire, 2007, p. 338), it is also driven by the desire for family support and for children to develop emotional ties to their relatives (Grimsrud, 2011; Mulder, 2018; Ní Laoire, 2007). Therefore, return migration can be seen as an opportunity for rural regions affected by depopulation. As temporal out-migration usually has a positive impact on individual development, rural regions can benefit from knowledge transfer and the inflow of human capital through return migration. Thus, the over-arching problem for rural regions experiencing depopulation is not out-migration, but the small numbers of people who return (Stockdale, 2004).

It is important to note that recent trends in youth migration were disrupted in 2020 and 2021 due to the Covid-19 pandemic. In an analysis of internal migration in Germany, Stawarz et al. (2022) found that the mobility of young adults declined in 2020, while urban-rural moves, mainly of families, remained stable. Another study on the impact of the Covid-19 pandemic on internal migration in Norway (Tønnessen, 2021) found record-high levels of out-migration from Oslo in 2020, coupled with particularly high levels of internal migration to other parts of Norway. While this wave out-migration from Oslo was mainly driven by families, the number of people in their sixties who moved out of Oslo also increased. On the other hand, out-migration from Oslo did not increase in 2020 among people under age 25. In the German study, Stawarz et al. (2022) expected rural-to-urban moves to return to previous levels after the Covid-19 pandemic ended. Similar effects are expected for other industrialised countries. Consequently, youth out-migration from rural areas will remain a challenge for the affected regions, even if the long-term consequences of the Covid-19 pandemic have yet to be fully assessed.

2.2 Policy options for steering youth migration: Towards a youth-oriented approach to regional development

In scientific debates about rural out-migration, it has been argued that young people should not be restrained from realising their desire for spatial mobility (Satsangi and Gkartzios, 2019; Shucksmith, 2010). Instead, a positive approach to migration would favour supporting return migration over preventing out-migration.

For many young people, a (potential) return is already integrated into their decision to temporarily leave their home region. In their study on return migration to the Northeast-Polder in the northern Netherlands, Haartsen and Thissen (2014) emphasised that many young migrants have mentally never left their home region. Decisions to leave could be intertwined with future plans to return to the region (Haartsen and Thissen, 2014). Furthermore, innovations in communications and transport technologies now allow individuals to maintain close ties to their place of origin. A study on migration and place attachment in rural America by Barcus and Brunn (2010) highlighted the relevance of communication technologies. The authors observed that people's ties to their place of origin can be characterised through the concept of "place elasticity", in which portability through mass communication is a central element. It is often difficult to draw clear lines between staying, leaving and returning because they intersect in the realities of young people's mobility decisions.

In most cases, voluntary migration is associated with a decision-making process that can take several years. Hence, policies should seek to actively influence this process. By emphasising the manifold opportunities in the region of origin and by investing in the creation of a regional identity, an attachment to the place of origin can be established that supports the decision to remain in or to return to the region of origin (Barcus and Brunn, 2010; Feijten et al., 2008). Studies on youth mobility have identified family and friendship ties, family roots and memories, residential familiarisation, and physical and natural qualities as relevant factors that support place attachment (Demi et al., 2009; Haartsen and Thissen, 2014; Rérat, 2014; Seyfrit et al., 2010; Stockdale et al., 2018).

Steering youth migration is a difficult task due to the complexity of the underlying motives of potential migrants. Nonetheless, it is possible to create incentives (Fidlschuster et al., 2016) for staying and returning that are tailored to the diverse needs of mobile young people. These incentives should consider the variety of needs young people have, and recognise the multidimensionality and interdependence of the operating drivers. To attract highly skilled immigrants to peripheral areas, Hansen and Aner (2017, p. 10) suggested implementing "*a broad strategy that focuses on job opportunities as well as physical, recreational, cultural, and social aspects*". Thus, policies aimed at influencing the mobility decisions of young people should include a bundle of measures that integrate hard, soft and social locational factors.

In the following, this contribution proposes "youth-oriented regional development" (Schorn, 2022) as an approach to rural policy-making in regions experiencing

Table 1:
The youth-oriented regional development approach

Dimension	Potential measures
Hard	
Jobs	Focus on jobs in the knowledge economy
	Support entrepreneurs and start-ups
	Support work-life balance
	Support job-family compatibility
	Support gender sensitivity in companies
Education	Create/ensure a diversity of opportunities for (higher) education
	Create/ensure a range of further training opportunities
Transport	Develop alternative mobility concepts
	Secure public transport to improve the accessibility of work and leisure infrastructure
	Ensure/expand the availability of public transport
Housing	Ensure the affordability of housing
	Support diverse housing options
	Provide assistance for finding appropriate housing
Soft	
Culture and leisure activities	Consider alternative lifestyles
	Create/secure leisure activities beyond clubs and associations
	Ensure the openness and accessibility of leisure activities
Social	
Emotional ties	Implement location marketing measures to support emotional ties
	Involve social networks as “intermediaries” of communicative measures
	Engage role models as authentic representatives of staying/returning
Participation	Provide information about regional participation projects
	Include diverse target groups in regional development processes
	Apply contemporary forms of participation
	Implement the results from participation processes
Culture of openness	Show an openness to new ideas
	Support social innovation
	Be tolerant of diverse lifestyles

Source: Author’s own elaboration based on the scientific literature.

depopulation (see Table 1). Based on the literature on youth migration and governance in rural regions affected by depopulation, “youth-oriented regional development” is understood as an approach that follows the principles of integrated development. It acknowledges the diverse needs of mobile young people and the fluid forms of mobility. Furthermore, it goes beyond visions of a “rural idyll” by taking structural as well as institutional dimensions of rural development into account, and it supports the sustainable development of regions experiencing depopulation. The proposed approach includes eight dimensions that are derived from scientific discourses on youth migration/mobility and its underlying drivers. It covers hard, soft and social locational factors.

Building on the classification by Hooijen et al. (2017), hard locational factors include traditional economic aspects such as jobs. In traditional migration theories, the availability of jobs is usually considered the most relevant hard locational factor. Nevertheless, recent studies on gender-selective rural-to-urban migration have also highlighted the need for gender sensitivity in rural labour markets, as well as for support infrastructures that enable parents to achieve job-family compatibility and a better work-life balance in general (Bock, 2015; Leibert, 2016; Oedl-Wieser, 2016; Wiest and Leibert, 2013). Other hard locational factors that may be relevant for young adults include access to higher and further education, public transport and high-quality housing.

As soft locational factors, Hooijen et al. (2017) have observed that cultural and recreational amenities play a central role in community satisfaction and place attachment. In rural areas, the variety and the accessibility of leisure and cultural activities are especially important. For example, leisure activities should be available for people in different life situations, and should include leisure opportunities that can be utilised without having to be a member of an association.

According to Hooijen et al. (2017), social factors constitute a third category of locational factors that are relevant for determining young people’s migration behaviour. The authors observed that social networks are especially important for the decision to migrate. While the capacity of policy measures to influence this factor is rather limited, studies on return migration have emphasised that social networks, such as family and friends, could be mobilised as “intermediaries” for the home region (Nadler, 2016; Wiest and Leibert, 2013). Furthermore, rural areas can invest in communication measures, such as location marketing that promotes positive perceptions of the area and regional identity formation among (potential) migrants, and that supports the maintenance of emotional ties. For example, successful returnees could promote the advantages of returning to their place of origin (Nadler, 2016). Moreover, participatory planning can be used to support spatial ties and the formation of a regional identity. Policies specifically targeted at the needs of young people could be implemented by encouraging their active participation in rural policy-making. Hence, mobile young people could be invited to participate in the formulation of innovative policy approaches in depopulating rural regions. However, for such a strategy to succeed, rural policy-makers and other relevant stakeholders would have to be open to integrating young people into policy-making processes, and members of the young target groups would have to demonstrate that they have the abilities and capabilities needed for participation. The involvement of young people in policy-making may be limited by a range of factors, including time constraints due to other obligations, a lack of communication skills, and a lack of interest in participating. Thus, we need to find suitable modes for participation that consider how young people in the early 21st century actually want to be included in policy-making (Kamuf and Weck, 2022; Suppers, 2022). Furthermore, rural communities must display an overall "culture of openness" towards new ideas and a tolerance of diverse lifestyles to attract a target group whose lifestyle is characterised by cosmopolitanism and individualisation. This "'culture of openness" is especially important for the institutional dimension of rural policy-making.

In summary, integrating the needs of mobile young people into rural policies can result in a youth-oriented regional development approach that applies both a people-sensitive and a place-based perspective to policy innovation in depopulating rural areas. However, given the multidimensionality of this approach, realising it is likely to be a challenge. How youth-oriented regional development can be realised in practice, and how this approach can help to steer rural youth migration, will be analysed in Section 4, following a presentation of the methodological approach of this paper.

3 Methods

We will seek to answer the two research questions through a comparative case study conducted in four rural regions in Austria and Germany that have been affected by youth out-migration since the early 2000s. These regions have implemented measures that follow the logic of youth-oriented regional development since the early 2010s, or even earlier. The case study approach helps researchers to gain a deeper understanding of a research problem (Stake, 1995), which in this paper is represented by the policy measures implemented on a regional scale to counteract youth out-migration and its negative consequences. Overall, the case study presented in this study follows an explorative and critical pragmatist approach (Forester, 2013; Wagenaar, 2011) that prioritises the principle of "learning from practice". Hence, this study sheds light on policy capacities in rural regions experiencing population decline, and opens up new research perspectives on measures aimed at mitigating the challenges associated with depopulation. In the following sections, we will present the selection criteria for the case study regions, as well as the strategies used for collecting and analysing data.

3.1 Case study selection

The analysis focuses on measures that have been implemented and actions that have been taken at the regional level. The case study regions have been consciously selected through demographic data analysis, as well as through a thematic analysis of planning documents and projects. The selection was based on the following criteria:

- a peripheral location, with the majority of the case study area displaying a low level of accessibility to urban agglomerations;
- a negative internal youth migration rate since the early 2000s;
- the existence of a regional development agency or another key player responsible for policy-making on an inter-municipal level; and
- the implementation of regional measures to mitigate the outflow of young people in the 2010s.

Based on the selection approach of "purposeful maximal sampling" (Creswell, 2013), the Hochsauerlandkreis (North Rhine-Westphalia/Germany), the district of Freyung-Grafenau (Bavaria/Germany), the district of Pinzgau (Salzburg/Austria) and the region of Obersteiermark West (Styria/Austria) were selected for the analysis (see Figure 1).

While the selected regions share a history of ongoing youth out-migration, they have different geographical locations and economic situations. The Hochsauerlandkreis is characterised by its proximity to the metropolitan region of the Ruhrgebiet to the west and by its more remote areas to the south and east. It enjoys a generally favourable economic situation due to the presence in the district of highly specialised small- and medium-sized enterprises in the field of manufacturing. The district of Freyung-Grafenau is characterised by its peripheral location bordering the Czech Republic and Austria and its transforming economy. It is dominated by the glass manufacturing, construction and service industries. The Pinzgau is an Alpine region with a strong tourism industry, while the Obersteiermark region displays a more dispersed pattern. The western part of Obersteiermark features an Alpine landscape dominated by agriculture and forestry, while the eastern part of the region is more industrialised.

In each of these regions, the composition of the various stakeholders involved in the realisation of youth-oriented regional development is different. The stakeholders come from a range of policy fields, including rural development, economic development, education and social work. Different funding schemes support the implementation of policy measures that focus on the needs of young people.

Only measures that clearly address young people were included in the analysis. In each case study region, we identified one key project that most clearly reflects the youth-oriented regional development approach (see Table 2). Based on these key projects, we traced further regional measures that address young people and their needs, and that were implemented between the late 2000s and 2019.

3.2 Data collection and analysis

We have collected qualitative as well as quantitative data for this study, interviewing a total of 37 stakeholders for the qualitative research, with eight to 10 stakeholders

Figure 1:
Location of the case study regions

per case study region (see Table A.1 in the Appendix). All interviewees possessed expert knowledge in the field of rural development or youth work. Each interviewee was involved in the design and/or implementation of youth-oriented measures in the case study region or in the funding of the implemented measures, or held a professional position in youth work. The interviews took place between March and June 2019. Additionally, 44 documents were collected, giving priority to documents that impacted the design of the regional measures in substantial and/or procedural

Table 2:
Key projects involving youth-oriented regional development in the case study regions

Case study region	Key project	Focus of key project	Founding year
Freyung-Grafenau	Mehr als du erwartest	Regional identity building	2016
Hochsauerlandkreis	Heimvorteil HSK	Supporting return migration	2015
Pinzgau	Komm-Bleib	Supporting the decision to stay or to immigrate	2012
Obersteiermark West	Regionales Jugend-management	Raising awareness of young people's needs	2012

Source: Author's own elaboration (based on expert interviews and document analysis).

terms. The regional development strategy, as the central strategic document for collaboration at the regional level, was included in all four case study regions. The quantitative data for the demographic analysis came from the statistical databases of Austria (STATcube) and Germany (Regionaldatenbank Deutschland).

Qualitative data were analysed using the method of qualitative content analysis (Zhang and Wildemuth, 2009), and applying both inductive and deductive coding. Deductive coding followed the approach of youth-oriented regional development as presented in Table 1. Through inductive coding, the theoretical approach of youth-oriented regional development can be juxtaposed with the practice of youth-oriented policy-making.

Furthermore, we described the trends and trend breaks in the internal migration rates of young people (aged 18 to 29 years) for the 2005–2020 period in order to study the potential effects of the implemented measures on youth migration. To increase the validity of the findings, we included the internal migration rates of the 30- to 49-year-olds for the same period as an indicator of family-oriented migration. The age thresholds for youth and family migration were based on the availability of data in the Regionaldatenbank Deutschland. The internal migration rates of the 18- to 29-year-olds and of the 30-to-49-year olds were later compared to the national averages for rural regions. Regions were categorised as "rural" based on the urban-rural typology provided by Eurostat (Eurostat, 2021).[2]

2 According to the urban-rural typology of Eurostat, the Hochsauerlandkreis is categorised as an "intermediate" region. However, as the district has a dispersed regional structure with low density and low connectivity, especially in its eastern part, it was included as "rural area" in the case study selection.

4 Youth-oriented policies in practice

This study is based on the hypothesis that youth-oriented policies can serve as a remedy for rural regions affected by youth out-migration. Youth-oriented regional development is an innovative approach to rural policy-making that scholars researching depopulation and youth out-migration often call for. While combining a people-sensitive perspective with a place-based perspective is an effective approach from a scientific standpoint, it is also a demanding task due to the different policy-making responsibilities involved. Thus, the question for policy-makers in rural areas that are undergoing depopulation is how the needs of mobile young people can be integrated into the practices of rural policy-making. Furthermore, it is important to consider how youth-oriented policies affect rural youth migration.

4.1 Approaches to youth-oriented regional development

All four case study regions have implemented measures to mitigate the negative effects of youth out-migration on a regional scale since the late 2000s, and especially since the early to mid-2010s. Depending on the regional context as well as on the stakeholders involved in the policy-making process, different measures have been implemented that together contribute to the realisation of a youth-oriented regional development approach. Economic actors play an important role in all four case study regions. These economic actors are often focused on strengthening regional competitiveness. On the other hand, in those regions where the stakeholders involved in the process of youth-oriented regional development have recognised the relevance of qualitative development (Hochsauerlandkreis), or where social and civil society actors are engaged in the process of rural policy-making (Obersteiermark West and Pinzgau), there is an increasing focus on wellbeing-related measures. Overall, the variety of measures implemented in the four case study regions clearly shows the place-based nature of youth-oriented regional development.

Nevertheless, the comparative case study also reveals the similarities of youth-oriented regional development strategies in practice (see Table 3). All four regions share a focus on the hard locational factor of "jobs", as well as on the social locational factor of "emotional ties". The realisation of these two dimensions is often interlinked. For example, the variety of career opportunities is highlighted through place-branding activities. A third relevant factor that all case study regions cover in their youth-oriented policy-making practices is the involvement of young people in rural policy-making processes. Hence, young people are seen as relevant stakeholders in youth-oriented development. The realisation of the different dimensions of youth-oriented development in the case study regions will now be presented in greater detail.

4.1.1 "Jobs" as the most dominant dimension

The hard locational factor of "jobs" dominates the regional approaches to youth-oriented regional development. In all four case study areas, this is the dimension

Table 3:
Realised dimensions of youth-oriented regional development in the four case study regions

Dimensions of youth-oriented regional development	Freyung-Grafenau	Pinzgau	Obersteier-mark West	Hochsauerland-kreis
Jobs	strong focus	strong focus	strong focus	strong focus
Education	partial focus	partial focus	partial focus	partial focus
Transport	partial focus	partial focus	strong focus	partial focus
Housing	partial focus	partial focus	no focus	partial focus
Culture and leisure activities	partial focus	strong focus	strong focus	strong focus
Social ties	strong focus	strong focus	strong focus	strong focus
Participation	partial focus	strong focus	strong focus	strong focus
Culture of openness	partial focus	partial focus	partial focus	strong focus
Perspective on mobility	**Staying (Returning) (Incoming)**	**Staying (Returning) Incoming**	**Staying (Returning)**	**(Staying) Returning (Incoming)**

green	strong focus
yellow	partial focus
red	no focus

Source: Author's own elaboration.

with the largest number of measures. The relevance of this hard locational factor in the realisation of youth-oriented development can be explained by the discourse about skilled worker shortages, which the economic actors that are involved in rural policy-making have identified as a major driver of regional economic development.

Through regional initiatives, some of which also cover the life stage of childhood, young people are given insight into the different career opportunities in their region of origin. Members of the target group receive information about regional jobs at job fairs and information events that are organised by regional stakeholders in cooperation with schools. The Hochsauerlandkreis, the district of Freyung-Grafenau and the district of Pinzgau have all implemented regional employment websites that address young people in particular. Furthermore, some of the implemented projects focus on job opportunities for specific highly qualified professionals working in the fields of healthcare (Hochsauerlandkreis and Freyung-Grafenau), tourism (Pinzgau and Hochsauerlandkreis) or technology (Hochsauerlandkreis, Freyung-Grafenau and Obersteiermark West). Alternatively, some projects try to encourage young people who are transitioning from school to work or college/university to participate in vocational training in one of the enterprises in the region. In these initiatives, an apprenticeship is presented as a promising career path relative to enrolling in higher education.

Since the mid-2010s, the opportunities arising through digitalisation as well as remote working have been recognised in some of the case study regions. For example, in the Freyung-Grafenau district, the regional development agency has established a partnership with a spin-off of the University of Applied Sciences Deggendorf (a neighbouring district of Freyung-Grafenau) called the TechnologieCampus Freyung, which provides a digital business incubator as well as co-working spaces. This measure, which is focused on the needs of young people in a knowledge-based society, could help the district attract and retain expertise that is relevant for innovative development. The implementation of co-working spaces in the districts Freyung-Grafenau and Pinzgau in the mid- to late-2010s further indicates a heightened awareness that specific infrastructure and support services are needed to support the new work models of the knowledge-based society.

The analysis also reveals that sensitivity to work-family compatibility has been increasing. Different actors have focused on creating an institutional and infrastructural environment that supports work-family compatibility. For instance, some actors have campaigned for awareness within municipalities and in companies, or have implemented pilot childcare projects (Obersteiermark West, Pinzgau and Hochsauerlandkreis). Thus, the measures realised in the "job" dimension incorporate both a quantitative, growth-oriented approach and a qualitative, wellbeing-oriented approach to regional development.

4.1.2 Investment in emotional ties through communication measures

Second only to the dimension of "jobs", the dimension of "emotional ties" is the most relevant dimension covered by the practices of youth-oriented regional development in the four case study regions. In the practices of the regions, the "emotional ties" dimension is strongly linked to the "jobs" dimension. The communication measures emphasise career opportunities as well as opportunities for self-realisation and individual wellbeing. The relevance of the link between these two dimensions is highlighted by the fact that three of the four key projects identified in the case study regions (Table 2) cover both dimensions (Hochsauerlandkreis, Freyung-Grafenau, Pinzgau) and use place branding as a central instrument.

All four case study regions have established place-branding strategies since the early 2010s, some of which communicate messages that present visions of a "rural idyll". These measures address (potential) stayers and returnees in particular. Regional stakeholders have set up websites to distribute their messages to the target groups. Furthermore, they have created accounts on social media platforms such as Facebook or Instagram to engage with young people. Information on job opportunities, events or services that meet the lifestyle needs of young people in the respective region are presented on these platforms. In the place-branding strategies of the Hochsauerlandkreis and the Freyung-Grafenau district, examples are presented of individuals who pursued successful career paths in the region or who undertook a successful return that resulted in a better work-life balance. Overall, the aim of the place-branding measures is to reframe the perception of the region as a place where "nothing happens" to a place that has "a lot to offer for different needs". Through the communication measures, the strengths and opportunities of the region are emphasised, and efforts are made to create a positive regional identity. Hence, through their place-branding strategies, these regions that are experiencing depopulation are attempting to counteract the image that often dominates young people's narratives about rural places: namely, that these are "dull places" (Gunko and Medvedev, 2018; Pedersen and Gram, 2018). Thus, with these strategies, the regions are addressing the discursive processes that drive peripheralisation.

However, such communication measures should not only promote the region and its locational factors, but should also help residents maintain social ties and foster feelings of social connection to the region of origin – even for those who have temporarily left it. Here, the social media platforms are of central relevance. The regional profiles on Facebook, Instagram, and XING (Hochsauerlandkreis) or websites specifically created for this purpose (Obersteiermark West) enable an exchange between young stayers and leavers, but also allow for networking with potential employers. This exchange furthers the maintenance of social or professional networks with the region of origin.

As well as through social networks, social ties can be created through physical meetings. In the Hochsauerlandkreis, regular meetings with newcomers and returnees were organised before the start of the Covid-19 pandemic. The manager of the Heimvorteil HSK regional initiative in the Hochsauerlandkreis also organised regular gatherings and events for (potential) returnees around the Christmas season, when many young people who had left temporarily return to the area to visit their families. These events are aimed at encouraging potential returnees to reconsider their location decision through creating an emotional attachment to the place of origin.

4.1.3 Youth participation as a means to support place attachment

The third relevant dimension of youth-oriented policy-making that is realised in the regional practices is "youth participation". Through participatory projects, young people were at least occasionally involved in rural policy-making processes throughout the 2010s. In the four case study regions, youth participation is considered a suitable approach for implementing cultural and leisure opportunities tailored to the needs of young people. The participatory approaches the regions have implemented range from formalised participation in the context of children's and youth parliaments or youth forums organised at the local level (Hochsauerlandkreis, Pinzgau) to informal participation through selective and topic-related collaborative planning projects (all four case study regions). Providing information about projects developed by regional stakeholders is an inclusive form of involvement that is frequently practiced in all four case study regions. Information is distributed via the websites of regional initiatives, social media platforms, regional events or regional newspapers. However, providing information about regional projects is also the approach with the lowest levels of participation. In contrast to this basic mode of participation, young people themselves have been encouraged to initiate and implement projects in the Hochsauerlandkreis, the Obersteiermark West region and the Pinzgau district. Thus, in these regions, members of the target group have been empowered to take responsibility for the design of their living environment: i.e., the measures are implemented not just for young people, but also by young people.

In summary, especially in the three case study regions of Hochsauerlandkreis, Pinzgau and Obersteiermark West, a steady inclusion of young people in regional policy-making is a tried and trusted strategy. Through such participatory projects, young people's perspectives and needs are recognised. Thus, participatory projects can create a feeling of "we do matter", especially if the outcomes of participatory projects become reality. This process can, in turn, foster attachment to place.

4.1.4 Realisation of other dimensions depends on problem awareness and political will

In addition to the three dimensions mentioned above, other dimensions of youth-oriented regional development are considered, albeit in different ways. Some of the dimensions are again covered through an integrated approach, as was already observed for the "jobs" and "emotional ties" dimensions. A link to the "jobs" dimension can also be observed in the realisation of the "education" dimension, whereby education and career counselling frequently serve to inform young people about regional career opportunities. At the same time, measures that focus on the creation of higher education and further training opportunities were identified. For example, a college for nursery education was established in the Pinzgau district in 2016 after regional stakeholders had campaigned for it on state level. This measure was intended not only to provide higher education to young people, but also to help fill a gap in the supply of childcare staff in kindergartens, and to meet the increasing demand for childcare.

Measures that focus on the creation of cultural and leisure infrastructure were found in all four case study regions, with this focus being especially strong in the Hochsauerlandkreis, Pinzgau and Obersteiermark West regions. Youth centres, culture, leisure and sports facilities were built, and the projects were often carried out based on the outcomes of participatory projects.

Measures that cover the "transport" and "housing" dimensions were realised less frequently. One example of a measure that addresses the transport dimension was found in the Obersteiermark West region. Based on a call for projects by the federal state of Styria, a strategy for micro-mobility was developed in 2018. The aim of this strategy was to support the daily mobility of young people by expanding micro public transport systems in the coming years. The dimension of housing has mainly been addressed in the Pinzgau district, where pressure on the housing market has been increasing because of the region's strong tourism sector and the limited availability of land due to its Alpine geography. In recent years, political measures have been implemented to ensure the affordability of housing, especially for young people.

Overall, it can be concluded that the realisation of the "qualitative" dimensions of youth-oriented regional development is above all a matter of problem awareness and political will. When actors identify a problem as being relevant, as has been the case for the "culture and leisure activities" dimension, or when the pressure to address a problem is particularly strong, as has been the case in the Pinzgau district for the "housing" dimension, more qualitative dimensions are covered. Another enabling factor for addressing qualitative factors is the availability of funding schemes with specific aims.

4.1.5 Perspectives on mobility

The analysis identified the different target groups that have been addressed by the youth-oriented regional development measures. Contrary to the claims made in previous scientific research, these measures do not primarily address return migrants, but instead focus on other target groups. This was found to be the case in three of the four case study regions. The main orientation of the practices followed in the Freyung-Grafenau, Pinzgau and Obersteiermark West regions has been towards preventing youth out-migration. In the Hochsauerlandkreis, by contrast, there has been a strong emphasis on enabling return migration. Although the initiatives of the Freyung-Grafenau and Pinzgau districts were originally founded with the intention of promoting return migration, this strategy was abandoned over time, largely because policy-makers discovered that these measures were not particularly efficient. In addition, the regional economies increasingly experienced a need for skilled workers, which was reflected in the discourse on the skilled worker shortage.

Overall, the discourse about the shortage of skilled workers was dominant in the regional approaches. Although qualitative aspects have received increasing attention in the implementation of job-related measures, the needs of the rural economy have remained the central focus of youth-oriented policy-making. The prioritisation of the rural economy can be explained by the dominance of the discourse on the skilled worker shortage, which has often been the driving force behind the implementation of youth-oriented policies in the four case study regions. Hence, a central reason why the regions have introduced youth-oriented measures is that all four regional economies have been affected by a shortage of skilled workers. In an approach that is primarily focused on the needs of the regional economy, convincing young people to stay in the region of origin is preferred over enabling them to return. From an economic standpoint, young people are mainly seen as human capital. Thus, the idea behind these strategies is that the need for skilled workers could (at least partially) be covered by preventing young people from leaving, largely by convincing them that their region of origin offers interesting career options and a high quality of life. Equally, the dominant focus on the hard locational factor of "jobs" can be interpreted as indicating that the actors involved in these strategies see career-oriented considerations as the main drivers of out-migration. Hence, it appears that policy-makers believe that a key solution to mitigating the challenges associated with youth out-migration is highlighting the – often underestimated – career opportunities in rural regions.

On the other hand, it must also be recognised that over the long term, a youth-oriented regional development programme can only be realised through collaboration with economic actors. Economic stakeholders have co-financed many of the realised measures. This has been especially true for regions experiencing depopulation, as they often face financial constraints. Through collaborative approaches involving several stakeholders, measures have been implemented that focus on the needs not only of economic actors, but also of young people. The demand for skilled workers has led to an awareness in the case study regions that the perspectives of young people need to be considered in rural policy-making. This understanding has been coupled with a stronger orientation towards wellbeing-oriented regional development.

4.2 Youth-oriented policies and their effects on youth migration

The policy analysis has shown that youth-oriented regional development cannot be promoted through a single measure, but must instead be realised through a diverse approach that integrates different measures. A variety of projects have been implemented in the case study regions since the mid-2000s. Taken together, these projects define youth-oriented regional development practices. Depending on the problem definition and the actor arrangements, different priorities are integrated into the regional strategy. In most of the regions, the implementation of a youth-oriented regional development agenda is a process that has spanned several years. While the first individual measures were implemented in the mid- to late 2000s, a more integrated approach that covers several dimensions of the proposed theoretical framework was not formulated until the early to mid-2010s. This becomes particularly obvious when looking at the key projects that were established in this period (Table 2). The key projects in the Hochsauerlandkreis and in the Freyung-Grafenau and Pinzgau districts were established as place-branding measures through which job opportunities and the high quality of life were promoted to young target groups transitioning from youth to adulthood. These projects also sought to encourage the formation a positive regional identity. In contrast, in the Obersteiermark West region, the policy field of youth management was integrated into the instrument of regional management. Thus, a social perspective became integrated into a territorial policy field.

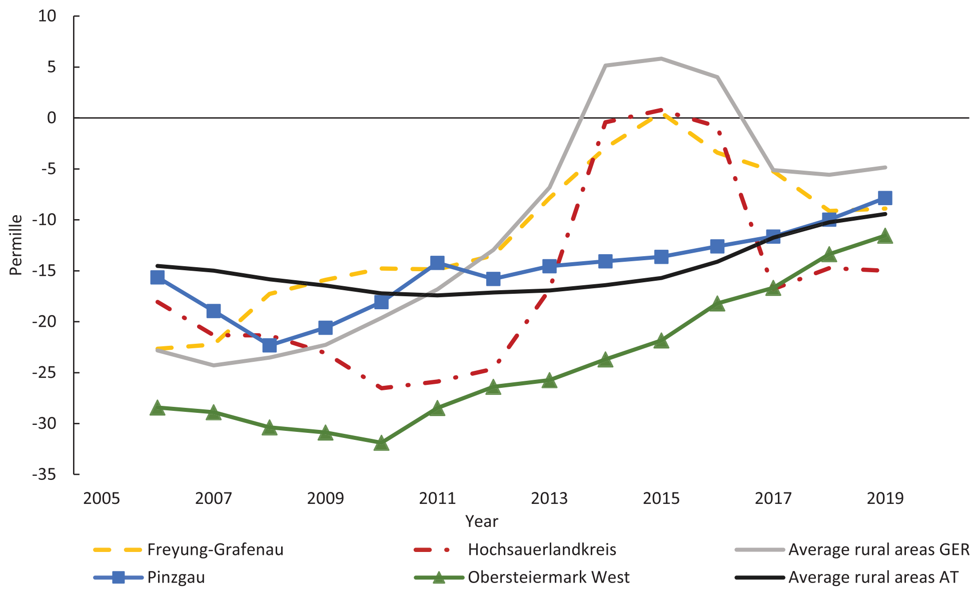
However, when examining the realisation of youth-oriented regional development measures, the question is not just what could be done or what was done in the individual regions, but also what the effects of this approach have been on the migration of rural youth. To provide an initial answer to this question, we have analysed the internal migration of 18- to 29-year-olds in the 2005–2020 period (see Figure 2). As the phase of family formation must be considered as a relevant life stage for potential return migration, we have also included the internal migration of 30- to 49-year-olds in the analysis (see Figure 3). Furthermore, we have used the moving average for illustrative purposes to smooth out short-term fluctuations (for the original data on internal migration, see Tables A.2 and A.3 in the Appendix). The data for the case study regions were compared to the national averages for rural regions in Austria and Germany.

The analysis of internal youth migration rates revealed that the negative trend has been less pronounced in all four case study regions since the mid-2010s. From that point onwards, the balance between out-migration and in-migration has stabilised. This overall positive trend is based on both increasing levels of youth in-migration and lower or stable levels of out-migration. However, the internal youth migration trends are very dissimilar across the four regions.

In the district of Freyung-Grafenau, for example, no decline in the number of out-migrants can be observed since the implementation of a more integrated approach towards youth-oriented regional development (see Table A.4 in the Appendix). In this district, the number of young out-migrants has remained relatively constant over time, with 2016 and 2017 being outliers. On the other hand, the in-migration of 18- to 29-year-olds has increased since 2014. Overall, the negative youth migration balance has stabilised since 2012 in this Bavarian district.

In the Hochsauerlandkreis, youth in-migration increased between 2012 and 2019 (see Table A.5 in the Appendix). An increase in the number of out-migrants can likewise be observed in the same period. In the rural parts of this southern Westphalian region, 2015 and 2016 represent statistical outliers in the internal migration trend. For example, there was an increase in youth in-migration in 2015 that was offset by an above-average number of young out-migrants in the following year. For both German case study regions, 2020 represents another statistical outlier, with

Figure 2:
Moving average of the internal migration rate of 18- to 29-year-olds, 2006–2019, per thousand



Source: Statistics Austria (2022) and Statistical offices of the Länder (2022).

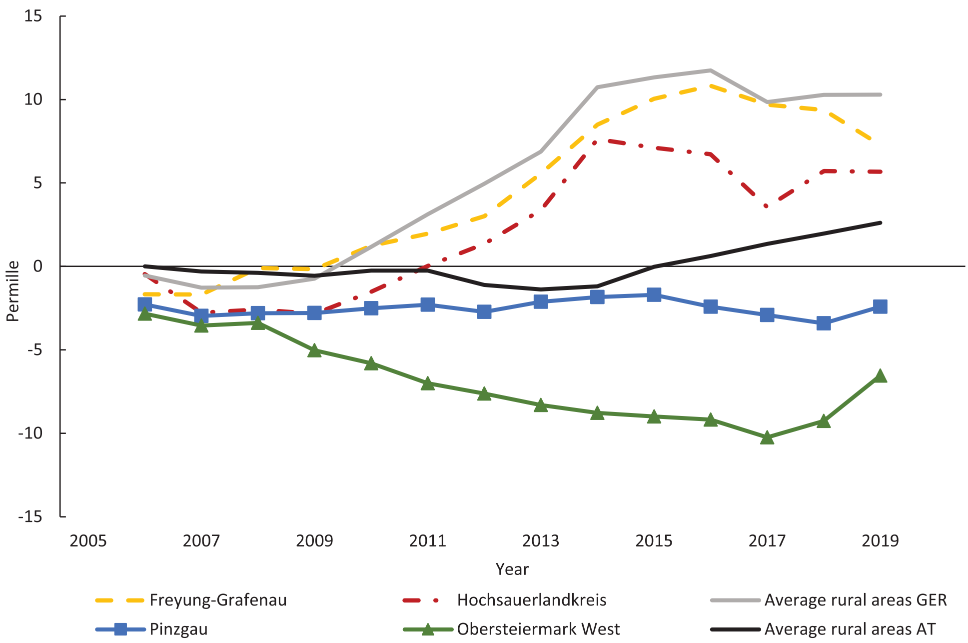
both in- and out-migration among the 18 to 29 age group remaining at lower levels. This finding can be explained by the impact of the Covid-19 pandemic on residential relocations among young people; a trend that was also observed by Stawarz et al. (2022).

In the Pinzgau district (see Table A.6 in the Appendix), no clear changes in the development of internal youth migration can be observed for the 2005–2020 period. Overall, the negative migration balance decreased, but there was still less in-migration than out-migration in this region among 18- to 29-year-olds. However, the internal youth migration balance stabilised in the second half of the 2010s due to an increase in in-migration.

The most pronounced decrease in the number of out-migrants is observable in the Obersteiermark West region after 2018. Over the same period, the number of in-migrants remained relatively stable (see Table A.7 in the Appendix). As a result, the youth migration balance markedly improved in the 2018–2020 period compared to the preceding years. The question is, however, whether this decreasing trend will continue in the future.

Based on the youth migration trends in our four case study regions, the temporal relationship between the implementation of youth-oriented measures and the

Figure 3:
Moving average of the internal migration rate of 30- to 49-year-olds, 2006–2019, per thousand



Source: Statistics Austria (2022) and Statistical offices of the Länder (2022).

migration flows of 18- to 29-year-olds appears to be relatively limited. An association between a decrease in negative youth migration rates and the implementation of measures can be observed only for the Obersteiermark West region, where the negative trend in youth migration has improved since 2018.

On the other hand, the national averages for internal youth migration in rural areas in Germany and Austria indicate that overall, the negative trend in rural youth migration has improved since the mid-2010s. Thus, external trends that influence youth migration decisions must also be considered when assessing the impact of specific policy measures in the four case study regions.

This becomes obvious when looking at the 2015–2017 period, when the number of in-migrants was above average in all four case study regions, with the trend being most evident in the two German case study regions. The fluctuation of in-migrants in this period can be linked to the refugee movements of 2015. In this year, almost one and a half million refugees entered the European Union due to an escalation of the wars in Syria and Iraq, with Germany, Austria and Sweden being the main destination countries for refugees in this period (Pries, 2020). Furthermore, these countries followed a decentralised distribution policy for the accommodation of refugees (Weidinger et al., 2017). Hence, some refugees were registered, at least temporarily, as residents of rural administrative districts. In both Germany and Austria, refugees were registered in initial reception centres before being distributed to more permanent housing. Thus, they appear in the statistics for internal – not for international – migration.

In addition, in recent years, studies have also examined the reasons why people stay in the countryside (Gruber, 2021; Mærsk et al., 2021; Stockdale et al., 2018). The increase in the immobility of young people can be explained in part by rising housing costs in urban areas (Stawarz et al., 2021), as well as by the emergence of ICT and the associated opportunities for remote working (Cooke and Shuttleworth, 2018). Moreover, some young people may have decided to stay because they were benefiting from location-specific insider advantages (Mærsk et al., 2021).

While the effects of youth-oriented measures on the migration decisions of 18- to 29-year-olds seem to be rather limited, the migration balances among 30- to 49-year-olds have been improving since the early 2010s. This is especially true for the two German case study regions of Hochsauerlandkreis and Freyung-Grafenau. When additionally considering the migration rate of people under age 18, it appears that the in-migrants who are moving to these regions are mainly families. Hence, the trend towards family-oriented counter-urbanisation in recent years that studies on rural Europe have found (Haartsen and Thissen, 2014; Hansen and Aner, 2017; Mulder et al., 2020a) can also be observed in the two German case study regions.

In the Hochsauerlandkreis and in the district of Freyung-Grafenau, both the number of family-oriented in-migrants and the number of out-migrants in the under 18 and the 30–49 age groups started to increase in the early 2010s, with 2015 (Hochsauerlandkreis) and 2016/2017 (Freyung-Grafenau) being statistical outliers (see Tables A.8 and A.9 in the Appendix). Nevertheless, the overall number of in-migrants was greater than the number of out-migrants in the most recent decade. For the Freyung-Grafenau district, it can even be concluded that family-oriented counter-urbanisation compensated for youth out-migration. The Bavarian region profited from the in-migration as well as the return migration of young families, as the number of such migrants was even higher than the number of youth out-migrants. For the two Austrian case study regions, the number of in-migrants aged 30 to 49 did not outweigh the number of out-migrants in the same age category in the 2005–2020 period. Here, the internal migration balance of 30- to 49-year-olds remained negative, even in the 2010s (see Tables A.10 and A.11 in the Appendix). In all four case study regions, the development of the internal migration rates of 30- to 49-year-olds was below the national averages for rural regions.

Based on the available data and the research methods we applied, we could not identify a causal relationship between the measures implemented to encourage youth-oriented regional development and actual migration levels. In the three case study regions of Hochsauerlandkreis, Freyung-Grafenau and Pinzgau, the out-migration rates have remained stable in this age group, even after a more systematised approach to youth-oriented regional development was applied through the implementation of key projects. We observed a decrease in youth out-migration only in the

Obersteiermark West region since 2018. However, due to the short period of time in which this development has emerged, the question of whether this trend will continue over the long term arises. On the other hand, youth in-migration has also increased in all four case study regions. Furthermore, there has been a positive development in family-oriented in-migration in the two German case study regions since the initial implementation of the youth-oriented regional development measures. Thus, further elaboration of the potential association between the realisation of a youth-oriented regional development strategy and an increase in in-migration and return migration is needed.

The migration data suggest that internal migration is also affected by external societal trends, such as the refugee movement of 2015 or an overall trend towards counter-urbanisation. The impact of a youth-oriented regional development approach overlaps with the effects of other social dynamics. Overall, more in-depth research is needed to provide a reliable assessment of the impact of youth-oriented policies.

5 Conclusion and research perspectives

While acknowledging its limitations, we conclude by reiterating that this exploratory study first and foremost established the groundwork for further discussions on policies aimed at mitigating the outflow of young people from peripheral rural areas. With the proposed approach of youth-oriented regional development, we introduced a conceptual framework to the scientific discourse that is relevant for both science and practice. On the one hand, this approach can serve as a tool for critically assessing the impact of regional measures in regions affected by depopulation. On the other hand, it can provide input for planning and innovating in regions that are experiencing depopulation.

With the proposed approach, we have entered new territory in the scientific discourse on the development of regions that are experiencing depopulation. While youth out-migration has been well researched, there are fewer studies that have examined the practical measures that have been implemented to influence the mobility aspirations of rural youth. By placing the needs of mobile young people in the centre of policy-making, this comparative case study revealed policy capacities on a regional scale, and identified trends and trend breaks in the internal migration rates of young people and young families that could give a first indication of the potential impact of the implemented measures on youth migration.

The four case study regions have adopted different approaches to youth-oriented regional development. In the three case study regions of Freyung-Grafenau, Pinzgau and Obersteiermark West, the objective was to prevent out-migration by implementing an approach that emphasised the career opportunities as well as the good quality of life in the region. In the Hochsauerlandkreis, the approach was focused instead on attracting young families and supporting return migration. All four case study regions took the hard locational factor of “jobs” into account in their applied measures. In recent years, they also began to increase their focus on the social locational factors. Here, location branding has been a relevant instrument. Social media is a popular tool for engaging with the target group and for supporting regional identity formation, which should, in turn, lead to greater attachment to place. Participatory projects that were realised in the four case study regions, but that involved a different definition of participation, should help to integrate the perspectives of the target group into rural policy-making.

However, we should recognise the limited success of youth-oriented regional development in preventing out-migration. Mobility decisions are deeply personal and individual. Furthermore, the transition from youth to adulthood is characterised by a "mobility imperative" to an even greater extent today than it was in the past. Out-migration has arguably become a normal stage in the biographies of young people. Supporting return or even in-migration must be considered a more viable option for rural policy-making. The data suggest that since the implementation of youth-oriented measures in the four case study regions, the levels of youth out-migration have remained stable, while the levels of in-migration have increased among both adolescents and young families. However, when we consider the overall trend in rural youth migration by looking at the national averages, it is unclear whether the measures had an effect. Nevertheless, a youth-oriented regional development approach could support the transformation of policy-makers' perceptions of youth out-migration from representing a threat to regional development to providing an opportunity for a critical reconsideration of rural policy-making.

While this paper has provided a first impression of the degree to which youth-oriented regional development can serve as a remedy for the depopulation of rural regions, further research is needed. The analysis uncovered various perspectives for future research that could be of relevance in population research. To conclude, we identify four research gaps to which demographic research could make major contributions through further elaborations of the proposed approach.

First, as internal migration is influenced by external social trends, long-term observation of the demographic developments in the regions that have implemented measures is needed to control for the impact of these external trends. A longitudinal evaluation would acknowledge that migration aspirations are long-term decisions, and thus that the impact of the measures will be revealed only after a longer period of time. In particular, the effects on mobility decisions of measures that focus on the phases of childhood and youth will become apparent only over the long term. Overall, the conceptual approach of youth-oriented regional development that we presented in this paper would benefit from further refinement. By theoretically mapping the chain of effects from the measures to the potential mobility decisions, and systematically including alternative causal factors at each stage of the chain, the relevance of youth-oriented policies for mitigating depopulation could be re-evaluated.

Second, a systematic, quantitative analysis of the implemented measures following the logic of youth-oriented regional development in rural regions that are undergoing depopulation could help to validate the proposed approach. Thus, the theory-driven approach could be refined through the inclusion of further findings on youth-oriented development practices. A systematic review of planning practices in rural regions suffering from depopulation could help stakeholders gain a better understanding of the conditions under which youth-oriented regional development measures should be implemented. This systematic review could include methods such as desk research, document analysis or a survey of rural policy-makers on the implemented measures. In a wider and more systematised study, creating a database of regions that are applying a youth-oriented approach could be valuable. This database could later be used for further analyses, such as a comparison with rural regions that are experiencing depopulation but have not implemented youth-oriented measures. This, in turn, leads to a *third research gap*: a comparative case study following a "most different cases" design is needed to assess the actual impact of youth-oriented policy-making on youth migration.

Finally, an assessment of the effects of a youth-oriented regional development approach should, above all, consider the attitudes of the target group towards the implemented measures themselves. An impact assessment could be performed to investigate how many young people are actually reached by the implemented measures, and whether these measures exert a relevant influence on their migration decisions. Hence, young people should be included as stakeholders in the assessment of the implemented measures. This stakeholder involvement could support the design of effective policies that mitigate depopulation driven by youth out-migration.

Overall, a deeper analysis can help stakeholders find efficient solutions to the problem of depopulation in rural regions, and can open up new research perspectives. The youth-oriented regional development approach can lead to the emergence of new and potentially fruitful debates, and provide opportunities for greater interdisciplinary cooperation between human geography, planning studies and population research in the coming years.

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Appendix

Table A.1:
List of interviewed stakeholders

1	Regional manager in Freyung-Grafenau
2	LEADER manager in Freyung-Grafenau
3	Coordinator for municipal youth work in the Freyung-Grafenau administrative district
4	Manager of the ILE Ilzer Land initiative
5	Coordinator of the Regional Contact Point Europaregion Donau-Moldau
6	Manager Konversionsmanagement Freyung und Umgebung & ILE Wolfsteiner Waldheimat
7	Coordinator for municipal youth work at the Bavarian Youth Ring (BJR)
8	Coordinator for regional management and regional initiatives in the district government of Lower Bavaria
9	Project manager of Heimvorteil HSK
10	Coordinator for the Land(auf)Schwung funding programme in the Hochsauerlandkreis administrative district
11	Manager of the Hochsauerlandkreis business development agency
12	District administrator in the Hochsauerlandkreis
13	Coordinator for regional funding schemes in the Hochsauerlandkreis administrative district
14	LEADER manager of Hochsauerland
15	Member of the youth committee in the Hochsauerlandkreis administrative district
16	Coordinator of regional development at the Südwestfalen Agentur
17	Coordinator of regional marketing at the Südwestfalen Agentur
18	Regional planner in the district government of Arnsberg
19	Manager of the Komm-Bleib regional initiative
20	Coordinator of the Austrian Federal Economic Chamber/Zell am See district
21	LEADER manager of Nationalpark Hohe Tauern
22	Regional manager of Regionalmanagement Pinzgau
23	Coordinator of Akzente Salzburg in the Pinzgau district
24	Teacher and coordinator of the education & economy working group
25	Coordinator of the Kaprun youth centre
26	Coordinator of the Forum Familie Pinzgau initiative
27	Coordinator of the regional development department in the federal state of Salzburg
28	Coordinator of the rural development department in the federal state of Salzburg
29	Youth manager of the Obersteiermark West region
30	Regional manager of the Obersteiermark West region
31	LEADER manager of innovationsRegion Murtal
32	LEADER manager of Holzwelt Murau
33	Coordinator of the Austrian Federal Economic Chamber/Murau-Murtal district
34	School director of a commercial high school
35	Coordinator for regional youth management in the federal state of Styria
36	Coordinator for regional development in the federal state of Styria
37	Representative of the Styrian platform for public youth work

Table A.2:
Internal migration rate ages 18 to 29 years, per 1000 in age group

	Freyung-Grafenau	Hochsauerland Kreis	Average rural areas GER	Pinzgau	Obersteiermark West	Average rural areas AT
2005	−17,1	−10,4	−21,0	−15,1	−24,5	−13,5
2006	−34,1	−21,8	−24,3	−15,2	−30,6	−14,8
2007	−16,7	−22,0	−23,1	−16,6	−30,2	−15,3
2008	−15,9	−20,2	−25,4	−25,1	−25,9	−14,8
2009	−19,2	−21,9	−22,0	−25,3	−35,1	−17,4
2010	−12,6	−27,1	−19,4	−11,4	−31,7	−17,1
2011	−12,6	−30,5	−17,5	−17,5	−28,9	−17,2
2012	−19,5	−20,0	−13,6	−13,8	−24,8	−17,9
2013	−8,4	−23,4	−7,7	−16,1	−25,4	−16,3
2014	4,3	−7,1	0,9	−13,7	−27,0	−16,6
2015	−4,7	29,3	22,3	−12,4	−18,7	−16,4
2016	2,0	−19,8	−5,7	−14,8	−19,9	−14,1
2017	−7,5	−12,0	−4,6	−10,7	−16,0	−11,9
2018	−10,2	−18,6	−5,0	−9,5	−14,1	−9,3
2019	−9,7	−13,6	−7,1	−9,8	−10,0	−9,5
2020	−6,8	−12,8	−2,4	−4,2	−10,6	−9,5

Source: Statistics Austria (2022) and Statistical offices of the Länder (2022).

Table A.3:
Internal migration rate ages 30 to 49 years, per 1000 in age group

	Freyung-Grafenau	Hochsauerland Kreis	Average rural areas GER	Pinzgau	Obersteiermark West	Average rural areas AT
2005	−1,5	2,9	0,0	−1,6	−2,7	0,1
2006	−3,4	−2,8	−1,1	−2,9	−3,3	−0,2
2007	−0,1	−1,4	−0,5	−2,3	−2,6	0,2
2008	−1,5	−4,1	−2,2	−3,7	−4,8	−0,8
2009	1,4	−2,2	−1,0	−2,4	−2,8	−0,5
2010	−0,3	−2,2	1,0	−2,3	−7,5	−0,4
2011	2,6	−0,1	3,5	−2,8	−7,1	0,1
2012	3,5	2,4	4,8	−1,8	−6,4	−0,4
2013	2,9	1,8	6,6	−3,6	−9,4	−2,9
2014	10,3	5,9	9,3	−1,0	−9,2	−0,8
2015	12,3	15,1	16,4	−1,0	−7,8	0,1
2016	7,5	0,3	8,3	−3,2	−10,0	0,6
2017	12,6	4,8	10,5	−3,1	−9,7	1,2
2018	8,9	5,7	10,7	−2,5	−11,0	2,3
2019	6,5	6,7	9,6	−4,6	−7,0	2,4
2020	6,4	4,6	10,5	−0,2	−1,6	3,1

Source: Statistics Austria (2022) and Statistical offices of the Länder (2022).

Table A.4:
Internal youth migration 2005–2020, Freyung-Grafenau

Year	Internal in-migration	Internal out-migration	Youth migration balance	Population aged 18–29 yrs	Internal youth migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	486	−676	−190	11098	−17,1	43,8	−60,9
2006	467	−847	−380	11135	−34,1	41,9	−76,1
2007	535	−717	−182	10870	−16,7	49,2	−66,0
2008	607	−779	−172	10830	−15,9	56,0	−71,9
2009	508	−718	−210	10920	−19,2	46,5	−65,8
2010	586	−723	−137	10894	−12,6	53,8	−66,4
2011	576	−714	−138	10986	−12,6	52,4	−65,0
2012	532	−739	−207	10640	−19,5	50,0	−69,5
2013	606	−694	−88	10454	−8,4	58,0	−66,4
2014	783	−738	45	10494	4,3	74,6	−70,3
2015	715	−765	−50	10644	−4,7	67,2	−71,9
2016	1019	−998	21	10751	2,0	94,8	−92,8
2017	1144	−1225	−81	10829	−7,5	105,6	−113,1
2018	711	−821	−110	10827	−10,2	65,7	−75,8
2019	720	−824	−104	10667	−9,7	67,5	−77,2
2020	648	−719	−71	10493	−6,8	61,8	−68,5

Source: Statistical offices of the Länder (2022).

Table A.5:
Internal youth migration 2005–2020, Hochsauerlandkreis

Year	Internal in-migration	Internal out-migration	Youth migration balance	Population aged 18–29 yrs	Internal youth migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	2911	−3286	−375	36014	−10,4	80,8	−91,2
2006	2229	−3019	−790	36235	−21,8	61,5	−83,3
2007	2336	−3132	−796	36241	−22,0	64,5	−86,4
2008	2463	−3193	−730	36180	−20,2	68,1	−88,3
2009	2521	−3317	−796	36345	−21,9	69,4	−91,3
2010	2487	−3475	−988	36414	−27,1	68,3	−95,4
2011	2623	−3727	−1104	36158	−30,5	72,5	−103,1
2012	2833	−3528	−695	34823	−20,0	81,4	−101,3
2013	3049	−3860	−811	34657	−23,4	88,0	−111,4
2014	3603	−3848	−245	34358	−7,1	104,9	−112,0
2015	5449	−4435	1014	34656	29,3	157,2	−128,0
2016	4408	−5124	−716	36168	−19,8	121,9	−141,7
2017	3723	−4150	−427	35647	−12,0	104,4	−116,4
2018	3415	−4076	−661	35469	−18,6	96,3	−114,9
2019	3349	−3820	−471	34681	−13,6	96,6	−110,1
2020	2742	−3178	−436	34109	−12,8	80,4	−93,2

Source: Statistical offices of the Länder (2022).

Table A.6:
Internal youth migration 2005–2020, Pinzgau

Year	Internal in-migration	Internal out-migration	Youth migration balance	Population aged 18–29 yrs	Internal youth migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	410	−611	−201	13286	−15,1	30,9	−46,0
2006	356	−557	−201	13220	−15,2	26,9	−42,1
2007	377	−595	−218	13157	−16,6	28,7	−45,2
2008	393	−721	−328	13086	−25,1	30,0	−55,1
2009	433	−762	−329	12995	−25,3	33,3	−58,6
2010	430	−578	−148	13000	−11,4	33,1	−44,5
2011	444	−673	−229	13055	−17,5	34,0	−51,6
2012	449	−628	−179	13007	−13,8	34,5	−48,3
2013	482	−690	−208	12905	−16,1	37,4	−53,5
2014	496	−673	−177	12873	−13,7	38,5	−52,3
2015	707	−867	−160	12943	−12,4	54,6	−67,0
2016	526	−718	−192	12968	−14,8	40,6	−55,4
2017	546	−683	−137	12856	−10,7	42,5	−53,1
2018	505	−626	−121	12788	−9,5	39,5	−49,0
2019	466	−591	−125	12723	−9,8	36,6	−46,5
2020	568	−621	−53	12491	−4,2	45,5	−49,7

Source: Statistics Austria (2022).

Table A.7:
Internal youth migration 2005–2020, Obersteiermark West region

Year	Internal in-migration	Internal out-migration	Youth migration balance	Population aged 18–29 yrs	Internal youth migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	539	−920	−381	15532	−24,5	34,7	−59,2
2006	449	−915	−466	15238	−30,6	29,5	−60,0
2007	509	−958	−449	14872	−30,2	34,2	−64,4
2008	555	−935	−380	14697	−25,9	37,8	−63,6
2009	503	−1013	−510	14542	−35,1	34,6	−69,7
2010	516	−967	−451	14226	−31,7	36,3	−68,0
2011	580	−985	−405	14024	−28,9	41,4	−70,2
2012	588	−930	−342	13783	−24,8	42,7	−67,5
2013	624	−968	−344	13517	−25,4	46,2	−71,6
2014	579	−936	−357	13242	−27,0	43,7	−70,7
2015	698	−944	−246	13160	−18,7	53,0	−71,7
2016	720	−981	−261	13139	−19,9	54,8	−74,7
2017	599	−807	−208	12974	−16,0	46,2	−62,2
2018	513	−692	−179	12699	−14,1	40,4	−54,5
2019	520	−645	−125	12501	−10,0	41,6	−51,6
2020	534	−663	−129	12215	−10,6	43,7	−54,3

Source: Statistics Austria (2022).

Table A.8:
Internal migration 2005–2020, ages 30–49 years, Freyung-Grafenau

Year	Internal in-migration	Internal out-migration	Internal migration balance	Population aged 30–49 yrs	Internal migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	595	−634	−39	25586	−1,5	23,3	−24,8
2006	555	−640	−85	25136	−3,4	22,1	−25,5
2007	508	−511	−3	24656	−0,1	20,6	−20,7
2008	570	−607	−37	24147	−1,5	23,6	−25,1
2009	550	−518	32	23572	1,4	23,3	−22,0
2010	528	−535	−7	23015	−0,3	22,9	−23,2
2011	601	−542	59	22390	2,6	26,8	−24,2
2012	636	−560	76	21443	3,5	29,7	−26,1
2013	672	−612	60	20988	2,9	32,0	−29,2
2014	796	−586	210	20408	10,3	39,0	−28,7
2015	802	−556	246	19965	12,3	40,2	−27,8
2016	963	−816	147	19599	7,5	49,1	−41,6
2017	1045	−802	243	19231	12,6	54,3	−41,7
2018	914	−745	169	18927	8,9	48,3	−39,4
2019	857	−735	122	18684	6,5	45,9	−39,3
2020	808	−691	117	18414	6,4	43,9	−37,5

Source: Statistical offices of the Länder (2022).

Table A.9:
Internal migration 2005–2020, ages 30–49 years, Hochsauerlandkreis

Year	Internal in-migration	Internal out-migration	Internal migration balance	Population aged 30–49 yrs	Internal migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	2694	−2457	237	82397	2,9	32,7	−29,8
2006	2000	−2231	−231	81503	−2,8	24,5	−27,4
2007	2199	−2312	−113	80079	−1,4	27,5	−28,9
2008	2109	−2430	−321	78604	−4,1	26,8	−30,9
2009	2070	−2242	−172	76766	−2,2	27,0	−29,2
2010	2066	−2230	−164	74962	−2,2	27,6	−29,7
2011	2278	−2287	−9	73256	−0,1	31,1	−31,2
2012	2433	−2259	174	72439	2,4	33,6	−31,2
2013	2672	−2545	127	70655	1,8	37,8	−36,0
2014	2861	−2456	405	68636	5,9	41,7	−35,8
2015	4170	−3157	1013	66879	15,1	62,4	−47,2
2016	3373	−3355	18	65810	0,3	51,3	−51,0
2017	3150	−2846	304	63980	4,8	49,2	−44,5
2018	3177	−2824	353	62477	5,7	50,9	−45,2
2019	3038	−2624	414	61457	6,7	49,4	−42,7
2020	2695	−2415	280	60552	4,6	44,5	−39,9

Source: Statistical offices of the Länder (2022).

Table A.10:
Internal migration 2005–2020, ages 30–49 years, Pinzgau

Year	Internal in-migration	Internal out-migration	Internal migration balance	Population aged 30–49 yrs	Internal migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	275	−318	−43	26552	−1,6	10,4	−12,0
2006	269	−346	−77	26511	−2,9	10,1	−13,1
2007	291	−352	−61	26185	−2,3	11,1	−13,4
2008	294	−389	−95	25953	−3,7	11,3	−15,0
2009	276	−338	−62	25569	−2,4	10,8	−13,2
2010	325	−383	−58	25251	−2,3	12,9	−15,2
2011	324	−394	−70	25010	−2,8	13,0	−15,8
2012	339	−383	−44	24707	−1,8	13,7	−15,5
2013	326	−414	−88	24544	−3,6	13,3	−16,9
2014	400	−424	−24	24217	−1,0	16,5	−17,5
2015	507	−530	−23	24071	−1,0	21,1	−22,0
2016	381	−457	−76	24099	−3,2	15,8	−19,0
2017	390	−465	−75	23898	−3,1	16,3	−19,5
2018	406	−464	−58	23636	−2,5	17,2	−19,6
2019	391	−499	−108	23361	−4,6	16,7	−21,4
2020	444	−448	−4	23047	−0,2	19,3	−19,4

Source: Statistics Austria (2022).

Table A.11:
Internal migration 2005–2020, ages 30–49 years, Obersteiermark West region

Year	Internal in-migration	Internal out-migration	Internal migration balance	Population aged 30–49 yrs	Internal migration rate	In-migration per 1000 in age group	Out-migration per 1000 in age group
2005	391	−477	−86	32406	−2,7	12,1	−14,7
2006	397	−502	−105	32145	−3,3	12,4	−15,6
2007	381	−462	−81	31648	−2,6	12,0	−14,6
2008	364	−513	−149	31011	−4,8	11,7	−16,5
2009	403	−487	−84	30326	−2,8	13,3	−16,1
2010	381	−604	−223	29706	−7,5	12,8	−20,3
2011	442	−650	−208	29103	−7,1	15,2	−22,3
2012	420	−601	−181	28453	−6,4	14,8	−21,1
2013	446	−707	−261	27909	−9,4	16,0	−25,3
2014	444	−695	−251	27314	−9,2	16,3	−25,4
2015	518	−726	−208	26653	−7,8	19,4	−27,2
2016	496	−759	−263	26324	−10,0	18,8	−28,8
2017	433	−684	−251	25748	−9,7	16,8	−26,6
2018	414	−691	−277	25179	−11,0	16,4	−27,4
2019	428	−600	−172	24463	−7,0	17,5	−24,5
2020	440	−478	−38	23966	−1,6	18,4	−19,9

Source: Statistics Austria (2022).

REVIEW ARTICLES

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Revisiting the impact of urban shrinkage on residential segregation in European cities

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Abstract

A nascent body of scholarship suggests that the depopulation of urban areas may catalyse residential segregation between different population groups and spatial concentrations of vulnerable groups. Based on a systematic literature review, this article summarises peer-reviewed articles and case studies on the role of urban shrinkage in shaping residential segregation in the context of European cities, and highlights methodological shortcomings and empirical knowledge gaps, thereby contributing to our understanding of the mechanisms through which population dynamics influence urban inequalities and their relevance for planning and policy. In sum, studies verifying the frequently assumed positive relationship between urban population loss and widening segregation remain few and far between. Moreover, mismatches between spatial and temporal scales, in addition to the indicators and metrics used in past studies, have hampered not only comparisons of how these dynamics play out in different contexts, but also the integration of spatial justice perspectives into urban planning.

Keywords: demographic change; depopulation; residential segregation; socio-spatial inequalities; spatial justice; urban shrinkage

1 Introduction

Just as the dynamics that underlie the rise and fall of urban settlements have shifted throughout history, the mechanisms that determine the socio-spatial organisation of urban space have changed over time. While the history of socio-spatial divides in cities appears to be as old as cities themselves, it was not until the late 19th century that the term 'segregation' became widely used as a catch-all concept to

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describe uneven distributions of different social groups across a city. However, to the extent that the impetus for socio-spatial divisions within urban civilisations over space and time can be seen as generalisable, it is only in the remarkable variability of experiences. Over the millennia, the forces of segregation have included, among many others, the writ of monarchs, colonisation, the preferences of landowning elites, land-use regulations, zoning ordinances, racism and redlining, restrictive immigration policies, urban renewal projects and gated housing developments, as well as other significant constructions, such as city walls, checkpoints, railways, highways and even human-made water bodies (Nightingale, 2012).

Since the turn of the millennium, numerous large, growing cities – like Berlin, London and Paris, to name a few examples in Europe – have become synonymous with housing affordability crises and worsening socio-spatial inequalities as an ongoing influx of affluent households and a lack of affordable housing push out existing residents and preclude disadvantaged newcomers from entering the housing market. These developments have intensified debates surrounding housing policy and potential responses, including rent control and land-use reforms (Seymour et al., 2020). Meanwhile, various cities affected by urban depopulation – from Leipzig to Liverpool to Lódz – have been identified as hotspots of relatively accessible and low-cost housing at one time or another, based on the theory that as a city's population declines, the demand for housing also falls. However, while it is true that property values and rents occasionally stagnate or even decrease during or in the wake of urban population losses, the reality is that due to fixed costs, asking prices for market-active housing and rental properties rarely fall below the threshold needed to qualify as affordable housing. Accordingly, policymakers in shrinking cities are often preoccupied with strategies focused on balancing the local housing market through tactics such as demolition or renovation (Martinez-Fernandez et al., 2016). Additionally, the selective out-migration and population ageing typical of shrinking cities tend to result in an increase in the share of socio-economically vulnerable households, for whom even low-cost housing can remain out of reach (Großmann et al., 2015). Thus, while shrinking cities may have an above-average share of below-market rate housing, the overall share of rent-burdened households in such cities may nevertheless grow due to declining incomes.

Following the understanding that context-sensitive knowledge is key to the development of evidence-based policies and the shift towards a more resilient and sustainable urban future, a small but growing body of literature has sought to investigate the nexus between processes of urban shrinkage and residential segregation of affluence and poverty. The bulk of this research has taken the form of case studies set in the context of European cities, especially larger cities characterised by unprecedented rates of depopulation and growing socio-spatial disparities. This may be because even though European cities have traditionally been characterised by less pronounced socio-economic residential segregation compared to, for instance, American or Japanese cities, there are many recent signs that socio-spatial disparities are increasing across Europe (Musterd et al., 2017), particularly among the so-called post-socialist countries of Central and Eastern Europe (CEE), a region that has also become the global epicentre of urban shrinkage (Wolff and Wiechmann, 2018). These developments have prompted calls for empirical research on urban depopulation in this region (Haase et al., 2016).

This article presents a review of this literature, and considers the dynamics and patterns of socio-spatial residential segregation, as well as the prospects for socially-equitable planning under conditions of urban population shrinkage in the context of European cities. In addition to giving an overview of the key concepts, theories, authors and findings, the strengths and weaknesses of this literature are summarised. Next, key methodological, conceptual and epistemological gaps are identified. Lastly, several avenues for future research that promise to provide new insights into the nexus between urban shrinkage and residential segregation are suggested. The aim is to synthesise the existing research, uncover shortcomings and gaps in the field, and propose novel lines of inquiry for further studies.

2 Conceptual background

Before diving into previous research on the link between urban shrinkage and residential segregation, it is important to first consider how these phenomena have been independently defined as objects of analysis in the broader literature.

2.1 Defining urban shrinkage

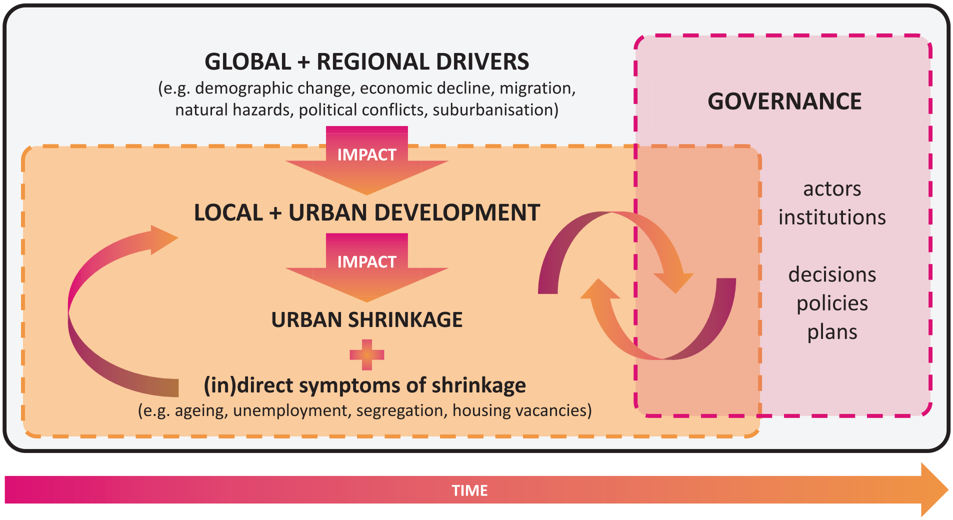
Beyond advancing a shared understanding of the concept, reviewing the defining features of urban shrinkage is valuable insofar as it serves to demonstrate what differentiates so-called ‘shrinking cities’ from other cities. Notwithstanding some key commonalities among existing efforts to define the phenomenon, there are several ways of understanding what constitutes urban shrinkage. While population decline is widely regarded as the central element, symptoms of shrinkage are as numerous as they are diverse. More precisely, urban shrinkage refers to a range of interconnected quantitative and qualitative changes occurring within a delimited urban area and over a specified period of time. Nonetheless, depopulation is widely regarded as the key quantitative indicator of shrinkage. Strictly speaking, a population shrinks either when the number of deaths exceeds births and this deficit cannot be offset by immigration, or, conversely, when net migration losses cannot be offset by natural population growth. However, the degree of depopulation that qualifies as urban shrinkage can vary. Under broad definitions, a shrinking city is any city where the peak population was recorded prior to the latest available figure, while under more stringent definitions, only those cities that meet a minimum threshold of population decline over a limited time period are classified as shrinking (Haase et al., 2014; Hartt, 2019; Wolff and Wiechmann, 2018).

Declining fertility is a frequent cause of excess natural population losses and quantitative decreases in population. Concurrent with increasing life expectancy, shrinking cities tend to exhibit faster rates of population ageing and higher concentrations of elderly residents than growing cities. In addition, shrinking cities typically experience increased rates of selective out-migration among higher-income and upwardly mobile households alongside increasing concentrations of socio-economically disadvantaged population groups (Galster, 2019; Martinez-Fernandez et al., 2016). The loss of jobs, particularly in the industrial or manufacturing sectors, is another common issue in shrinking cities (Wiechmann, 2008). Consequently, the average household income in these cities tends to decline over time (Hartt, 2019). Furthermore, especially in the context of western Europe, urban shrinkage often results in increases in vacant housing, industrial brownfields and otherwise un(der)utilised spaces. These demographic, economic and spatial changes can be caused or catalysed by critical events such as the introduction of disruptive political or economic reforms, environmental catastrophes, health crises or wars; but also by more gradual shifts in demographic dynamics, such as falling birth rates. Thus, natural population development can be both a cause and an effect of urban shrinkage (Martinez-Fernandez et al., 2016).

Beyond regional and global drivers, local governance arrangements as well as associated policy and planning strategies may influence the dynamics of urban shrinkage. However, in a neoliberal political climate that prioritises economic growth over social or environmental progress, shrinkage, along with its inherent fiscal pitfalls, may not be easily accepted by local decision-makers, let alone acknowledged (Bernt et al., 2014; Haase et al., 2014; Hospers, 2014). Shrinking cities that focus their efforts on bolstering economic development by means of conventional growth-oriented strategies, such as encouraging external investments or enacting tax breaks for the private sector, could ultimately exacerbate out-migration and socio-spatial inequalities, and thereby compromise their broader goals, like promoting social cohesion and life satisfaction (Fol, 2012; Maes et al., 2012). Alternatively, the conditions of shrinkage may present unique opportunities for cities to break free from contemporary trends of austerity urbanism and privatisation that tend to concentrate investments in prime areas at the expense of others. While emphasising the risks associated with top-down, centralised planning and triage measures for shrinking cities, many authors have argued that community self-determination and bottom-up planning are key to moving towards more holistic, sustainable and socially-equitable planning cultures (Berglund, 2020; Hollander and Németh, 2011; Pallagst et al., 2021).

Recognising the need to conceptualise urban shrinkage and to integrate it into broader theoretical debates in the fields of human geography, urban studies, urban and regional planning, and the social sciences at large, Haase et al. (2014) developed a heuristic model of urban shrinkage that incorporates the variety and interplay of the context-dependent mechanisms that underlie the phenomenon (Figure 1). While the model does not explain every case of urban shrinkage, it establishes a framework for facilitating more conceptually rigorous and context-sensitive empirical research on shrinkage, including on its causes, its consequences and the responses as well as the feedback loops and interrelations between these mechanisms.

Figure 1:
Heuristic model of urban shrinkage (adapted from Haase et al., 2014)



By developing a conceptualisation of shrinkage independent of local or national characteristics, while also highlighting the reality of a diverse world of shrinkage, the heuristic can be used to conduct further (comparative) studies of shrinkage across various scales and geographies, thereby decoupling the phenomenon from its earlier, more straightforward definition as an invariant process unshaped by (supra)local contexts. The heuristic also illustrates how the interrelated processes of shrinkage may be sufficient to trigger a vicious cycle in which depopulation leads to both urban decline – in the form of increasing vacancies, loss of amenities and loss of attractiveness – and residential segregation, which may, in turn, fuel further depopulation.

Where the heuristic falls short is in illustrating that urban shrinkage does not necessarily involve the entire area or population of a city, but may instead affect certain areas and groups in particular. Due to persistent disinvestment and urban decline, parts of a city that continuously depopulate year after year, or even decade after decade, are likely to be worse off than areas that are only briefly affected by depopulation. Out-migration driven by deindustrialisation and other forms of economic change, for instance, mainly occurs among young adults and other relatively mobile segments of the population, including recent graduates and new families. By contrast, population losses in cities that shrink due to political turmoil or violent conflicts tend to be driven by the out-migration of young men. In cities where shrinkage is triggered by environmental catastrophes or health crises, it is the most socio-economically vulnerable population groups who are most likely to experience disproportionate declines.

2.2 Defining residential segregation

Residential segregation refers to the differential distribution of social groups across (intra-urban) space. The literature has identified three quasi-universal types of residential segregation in contemporary cities:

- demographic segregation: spatial concentrations of similar age groups or household types;
- ethnic segregation: spatial concentrations of ethnic or racial (minority) groups; and
- socio-economic segregation: spatial concentrations of certain educational, occupational or income groups.

Broadly speaking, residential segregation results from at least two preconditions: heterogeneous population structures and differentiated housing market segments (Massey and Denton, 1988). Kovács (2020) described three additional factors that contribute significantly to residential segregation in cities: (1) income and wealth inequality, (2) the housing market and (3) ethno-religious differences. The influence of income inequality depends on the residents' purchasing power, which basically determines who gets to reside in certain neighbourhoods. The tendency of the wealthiest members of society to spatially distance themselves from the lower classes by seeking out 'higher-quality' (read: larger, detached) housing in 'nicer' environments is evident in capitalist societies around the world. Poorly functioning housing markets and imbalances in the housing stock can also shape segregation. Cities that permit or encourage newly-built homes in suburban areas are effectively opening a window of opportunity for the better-off strata to self-segregate. Ethnic or religious differences may also have an influence on segregation patterns insofar as there is a general tendency among people with similar backgrounds to live near one another (Tammaru et al., 2020). Clark (1991) noted that the logic behind the formation of tightly-knit ethno-religious communities can be pragmatic, as wider social networks have been shown to provide individuals with a stronger sense of safety, as well as improved access to shared services and facilities. Lastly, the socio-cultural context of cities – or, more specifically, how the most mobile population groups seek to separate themselves from others – plays a decisive role in shaping past and contemporary socio-spatial differences. While many authors have observed that affluent people tend to congregate in the most attractive neighbourhoods in cities around the world, the dynamics and levels of segregation can differ greatly across various socio-cultural contexts (Kovács, 2020).

It therefore appears that residential segregation is a complex process, the dynamics and intensity of which hinge on a myriad of factors, ranging from geographical and institutional to socio-economic and spatial characteristics. In addition to migration flows, the attitudes, behaviours, culture and economic and political institutions of urban settlements seem to affect patterns of residential segregation. While such factors may adequately explain differing intensities of segregation among cities and countries, to understand the dynamics and patterns of intra-urban residential segregation – such as at the level of districts, neighbourhoods, blocks or even individual multi-household buildings – a more nuanced account of the role of context-specific causal mechanisms is needed. Accordingly, a context-sensitive perspective that thoroughly reflects on the history and the geography of cities, as well as on the relationships between formal and informal actors, is essential not only for understanding residential segregation, but also for developing context-specific measures to combat socio-spatial divides.

When examining shrinking cities, due consideration should be given to the effects of intermittent or continuous net migration losses and reduced housing demand. Moreover, it is important to recognise that conditions of shrinkage usually contribute to underinvestment in building and infrastructure maintenance, the proliferation of urban decay and relatively high levels of housing vacancy. Consequently, in shrinking cities, policies that aim to manage a surplus of low-cost housing are often prioritised over policies that seek to improve access to affordable housing in more sought-after neighbourhoods. As such conditions tend to cause property values and rents to stagnate or even fall, average incomes may decline as well. This is because more affluent and mobile households tend to comprise the bulk of out-migrants from shrinking cities, leaving behind larger shares of lower-income and minority households. Given that such population groups are generally less mobile, these dynamics can lead to growing concentrations of socio-economically vulnerable and otherwise marginalised households in the least attractive corners of a city (Großmann et al., 2013, 2015).

3 Methodology

To provide an in-depth overview of existing research on the role of urban shrinkage in residential segregation in the context of European cities, this study takes the form of a systematic literature review supplemented by narrative methods. In doing so, a contrast to non-European contexts is offered that may stimulate future comparative research, as well as theory-building. Systematic reviews follow a transparent and replicable process that aims to minimise bias by respecting clearly defined procedures and completing a reasonably comprehensive if not exhaustive search of the literature (Tranfield et al., 2003). In order to go beyond a quantitative description of the literature, a more nuanced narrative analysis of the most frequently cited works is performed. In this step, the resulting articles are broadly grouped into two different research foci: studies that investigate how shrinkage influences the dynamics and the processes of segregation in cities more generally, and studies that examine how shrinkage relates to and shapes intra-urban patterns of segregation. In addition to offering readers a comprehensive summary of the literature, this review seeks to provide a critical assessment of the strengths and weaknesses of previously used research designs and methods, which may, in turn, serve as a basis for the development of sharper and more insightful research questions or hypotheses (Yin, 2018).

The literature search was limited to peer-reviewed articles in English-language scientific journals that have an explicit focus on urban shrinkage as a factor contributing to residential segregation. Given that several essentially synonymous terms have been used to refer to the same concepts, different combinations of the following terms were searched for using Google Scholar, Scopus and Web of Science to obtain a sample of relevant articles: 'depopulation', 'population decline', 'urban decline', 'urban shrinkage', '(residential) segregation', 'differentiation', 'fragmentation' and 'polarisation'. As this review focuses on the results of leading and ground-breaking research, the search was limited to works published since 1990. Through the application of these methods in January 2022, nearly 100 articles were found across all search services. All of these articles were checked for any duplicated or misleading results, including texts with no relation to the topics, and these articles were manually removed. Subsequently, the abstracts were screened in order to determine which of these articles empirically investigated one or more cases of residential segregation in the context of urban depopulation in Europe. This procedure resulted in a final selection of 10 articles, which are explored in greater detail below.

4 Review of previous studies

Although previous research has shown that urban shrinkage is not inextricably linked to economic decline or to quality of life (Hartt, 2019; Hollander, 2011), the broader shrinking cities literature also regularly asserts that conditions of urban shrinkage may trigger or compound socio-spatial inequalities, including residential segregation. While empirical evidence for such claims remains scarce, it is noteworthy that two recurring observations made in many shrinking cities – namely, socially-selective (out)migration and the rise of un(der)utilised spaces – directly concern the two basic preconditions of residential segregation: that is, the socio-demographic fabric and the physical make-up of cities (Großmann et al., 2013). First, since urban shrinkage is typically of a selective nature, it contributes to changes in the socio-demographic composition of the population. This is in part because depopulation tends to magnify population ageing trends. While population ageing can occur in growing cities as well, shrinking cities appear to face an increased risk of population ageing, given that out-migration from shrinking cities is typically socially selective, with the youngest and most affluent population groups making up the bulk of out-migrants. Under conditions of economic decline or change, it is often a city's most educated and experienced residents, as well as those in search of better employment or educational opportunities, who tend to leave for more prosperous areas. As a consequence, there is an added risk of socio-economically vulnerable groups becoming overrepresented in shrinking cities. Second, urban shrinkage alters physical spaces and structures by creating vacancies, abandoned buildings or brownfields. If such perforated spaces proliferate in certain areas, they may contribute to accelerated urban decay, declining property values, stigmatisation and, ultimately, further out-migration. While all shrinking cities have their own specific characteristics, in many cases intra-urban patterns of depopulation and concentrations of lower-income households appear to go hand-in-hand. This dynamic is caused by both the generally lower levels of mobility among worse-off population groups in shrinking cities and the tendency for the least desirable areas of cities to serve as niches for the poor (Fol, 2012; Glock and Häussermann, 2004; Großmann et al., 2013, 2015; Petsimeris, 1998).

Bernt (2016) argued that residential segregation should not be regarded as a phenomenon inherent to shrinking cities, but that urban shrinkage should instead be understood as one of a number of contextual factors that influence the dynamics, levels and patterns of socio-spatial change and inequality. In other words, when examining the underlying relationships between conditions of urban shrinkage and residential segregation, factors such as depopulation or housing vacancies should be observed or analysed not in a vacuum, but alongside existing explanatory variables. Großmann et al. (2013) advised researchers to draw from secondary analysis of local statistical data (to describe 'large' processes and patterns), as well as from micro-scale quantitative research (to uncover social fragmentation patterns) and qualitative research (to understand the logics of residential mobility in the housing markets of shrinking cities). As well as acknowledging the importance of local housing markets and housing supply, the authors underscored the need for context-sensitive research by suggesting that researchers consider the role of local infrastructures and amenities, including how access to public transport, green space and essential businesses shape residential mobility and segregation patterns. Moreover, at the macro level, the authors noted that national regulatory and welfare systems merit attention.

Towards the realisation of these aims, at least two strands of empirically-driven case study research examining residential segregation in cities characterised by urban shrinkage have emerged since the turn of the millennium: one focusing on how conditions of and responses to shrinkage influence the general dynamics of segregation at the level of cities or regions, and one with a greater emphasis on how shrinkage shapes intra-urban levels and patterns of segregation (Table 1). While the two strands overlap somewhat, and both generally consider temporal aspects of the causal link between shrinkage and segregation, the latter more explicitly weighs spatial changes and inequalities within cities.

4.1 Dynamics of residential segregation in shrinking cities

The former strand – that is, those studies that aim to unearth and describe the causal mechanisms behind changing socio-spatial distributions and divisions across one or more selected lower level administrative units, such as municipalities or communes characterised by urban population decline – centres on the observation that cities facing (systemic) urban shrinkage appear to be at an additional disadvantage in fostering social integration and cohesion compared to growing cities (Cortese et al., 2014). This is because some of the key drivers of shrinkage, including deindustrialisation, neoliberalisation and growing exposure to forces of

Table 1:
Chronological list of case studies on the role of urban shrinkage in residential segregation in European cities, 1998–2020

Year	Author(s)	Title	Publication	Case(s)	Temporal scope	Type(s) of segregation	Methods	Empirical focus
1998	Petsimeris, P.	Urban decline and the new social and ethnic divisions in the core cities of the Italian industrial triangle	*Urban Studies*	Milan, Turin, Genoa (Italy)	1981–1991	Ethnic; Socio-economic	Multiple case study; Quantitative-leaning	Patterns of segregation
2004	Glock, B., Häussermann, H.	New trends in urban development and public policy in eastern Germany: Dealing with the vacant housing problem at the local level	*International Journal of Urban and Regional Research*	Leipzig (Germany)	1989–2000	Socio-economic	Single case study (post-hoc); Qualitative-leaning	Dynamics of segregation
2012	Fol, S.	Urban shrinkage and socio-spatial disparities: Are the remedies worse than the disease?	*Built Environment*	Roubaix, Saint-Denis, Saint-Étienne, Vierzon (France)	1960s–2000s	Socio-economic	Multiple case study (post-hoc); Quantitative-leaning	Dynamics of segregation
2012	Maes, M., Loopmans, M., Kesteloot, C.	Urban shrinkage and everyday life in post-socialist cities: Living with diversity in Hrušov, Ostrava, Czech Republic	*Built Environment*	Ostrava (Czechia)	1990s–2000s	Ethnic; Socio-economic	Single case study; Qualitative-leaning	Dynamics of segregation
2012	Haase, A., Grossmann, K., Steinführer, A.	Transitory urbanites: New actors of residential change in Polish and Czech inner cities	*Cities*	Lódź, Gdańsk (Poland); Brno, Ostrava (Czechia)	1980s–2000s	Demographic; Socio-economic	Multiple case study; Qualitative-leaning	Dynamics of segregation
2013	Grossmann, K., Haase, A., Arndt, T., Cortese, C., Rumpel, P., Rink, D., Slach, O., Tichá, I., Violante, A.	How urban shrinkage impacts on patterns of socio-spatial segregation: The cases of Leipzig, Ostrava, and Genoa	*Urban Ills: Twenty First Century Complexities of Urban Living in Global Contexts*	Genoa (Italy); Leipzig (Germany); Ostrava (Czechia)	1990s-2000s	Demographic; Ethnic; Socio-economic	Multiple case study (post-hoc); Quantitative-leaning	Patterns (and dynamics) of segregation

Continued

Table 1: Continued

Year	Author(s)	Title	Publication	Case(s)	Temporal scope	Type(s) of segregation	Methods	Empirical focus
2014	Cortese, C., Haase, A., Grossmann, K., Ticha, I.	Governing social cohesion in shrinking cities: The cases of Ostrava, Genoa and Leipzig	*European Planning Studies*	Genoa (Italy); Leipzig (Germany); Ostrava (Czechia)	1990s–2000s	Demographic; Ethnic; Socio-economic	Multiple case study (post-hoc); Quantitative-leaning	Dynamics of segregation
2015	Großmann, K., Arndt, T., Haase, A., Rink, D., Steinführer, A.	The influence of housing oversupply on residential segregation: Exploring the post-socialist city of Leipzig	*Urban Geography*	Leipzig (Germany)	1992–2011	Demographic; Ethnic; Socio-economic	Single case study; Quantitative-leaning	Patterns of segregation
2019	Slach, O., Bosák, V., Krtička, L., Nováček, A., Rumpel, P.	Urban shrinkage and sustainability: Assessing the nexus between population density, urban structures and urban sustainability	*Sustainability*	Ostrava (Czechia)	1991–2011	Demographic; Socio-economic	Single case study; Quantitative-leaning	Patterns of segregation
2020	Hoekstra, M.S., Hochstenbach, C., Bontje, M.A., Musterd, S.	Shrinkage and housing inequality: Policy responses to population decline and class change	*Journal of Urban Affairs*	Parkstad Limburg (Netherlands)	2004–2015	Socio-economic	Single case study; Quantitative-leaning	Patterns of segregation

globalisation, are often accompanied by increasing levels of unemployment, selective out-migration, accelerated ageing, housing vacancies and the erosion of public infrastructure and urban amenities. At the same time, shrinking cities tend to struggle with a general lack of capacity and resources to respond to such pressures, let alone to worsening socio-spatial inequalities. In sum, this strand posits that urban shrinkage, particularly of the long-term variety, effectively alters the socio-demographic make-up and spatial fabric of cities, and thereby threatens to act as a catalyst of residential segregation (Großmann et al., 2013).

The influential work of Glock and Häussermann (2004) reviewed the social consequences of shrinkage and, referring to prior empirical research on the case of Leipzig, described how neighbourhoods affected by depopulation face an increased risk of becoming trapped in a vicious cycle of physical and social downgrading. The authors explained that despite the apparent advantages of shrinkage for existing tenants, such as stagnating or decreasing rents and increased housing market options, high vacancy rates may have negative consequences for social cohesion over time, as reduced demand for housing and services can fuel a self-perpetuating process of rising costs and decreasing efficiency. In the late 2000s, *Shrink Smart: The Governance of Shrinkage within a European Context,* a research project funded by the European Commission under the Seventh Framework Programme (FP7) of the European Union, further fleshed out the groundwork for several important initial findings regarding shrinkage and socio-spatial inequalities, especially concerning changing distributions of socio-economically vulnerable or otherwise marginalised groups with restricted access to housing, such as low-income households, minorities and the elderly. These findings were synthesised in separate works by Großmann et al. (2013) and Cortese et al. (2014), both of which reviewed several post-hoc hypotheses regarding the impact of urban shrinkage on socio-spatial inequalities in light of the experiences of the cities of Genoa, Leipzig and Ostrava, a group of large, post-socialist cities challenged by deindustrialisation, labour market mismatch, employment migration, declining fertility rates and suburbanisation. Großmann et al. (2013) observed that although the national contexts and the trajectories of shrinkage of these three cities differed, depopulation was an additional explanatory factor in the emergence of urban decay and increased levels of socio-spatial segregation in all of them, largely because depopulation tended to be socially selective, and thus reinforced the marginalisation of neighbourhoods and concentrations of disadvantaged groups. Cortese et al. (2014) additionally analysed and compared policy efforts to promote social cohesion, and found that although policymakers in all three cities had some awareness of the increased risk of worsening socio-spatial inequalities under conditions of shrinkage, the public policies they introduced to promote social cohesion were neither comprehensive nor prioritised. Indeed, the authors observed that socially-oriented policies largely remained in the shadow of other, seemingly more important concerns, including economic revitalisation, housing market stabilisation and urban redesign and renewal. However, the authors also acknowledged that all three cities arguably lacked the capacities to effectively respond in the first place. Thus, it appears that social cohesion represents a specific challenge for shrinking cities.

In a similar vein, Fol (2012) reviewed past studies on socio-spatial change in several shrinking cities of France, and found that shrinkage, regardless of its cause(s), led to increasing socio-spatial disparities and the social exclusion of vulnerable social groups. In most of these shrinking cities, the cumulative effect of an exodus of better-off households, a depreciated real estate market and an increase in housing vacancies was to attract the most socio-economically vulnerable households to depopulating areas, especially those with increased availability of public housing or older, unrenovated apartments. For example, in medium-sized cities, such as in Roubaix and Saint-Denis, where shrinkage triggered by deindustrialisation had marked socio-spatial repercussions, the persistent out-migration of better-off households in search of an improved living environment resulted in increased concentrations of low-income and non-native groups in dilapidated buildings and large social housing estates in the city centre. Likewise, in smaller cities, such as Vierzon, which had in recent decades increasingly lagged behind its larger peers in terms of population growth, economic opportunities and information flows, low-income households were observed to concentrate in run-down parts of the old centre, as well as in peripherally-located social housing with an abundance of vacant apartments. Ultimately, it was the most vulnerable population groups who were most affected by shrinkage-related processes, such as rising unemployment and deteriorating living standards. Fol (2012) also noted that although municipalities and local actors may be best equipped to ensure socially-equitable outcomes for policy responses to the challenges of shrinkage, tensions between the pressure to respond to the needs of existing residents and the desire to attract new residents or businesses may fuel a worsening socio-spatial divide. Urban development policies promoted under the guise of social mixing may serve as a justification for planning strategies with an implicit aim of gentrifying certain areas of the city and attracting new middle-class residents that ultimately lead to the development of pockets of relative wealth, and thus exacerbate socio-spatial fragmentation. In the case of Saint-Étienne, the local discourse surrounding social mixing served as a justification for the implementation of 'soft gentrification' tactics in the city centre, which included new housing developments, public space redesign projects and a variety of cultural offerings. By drawing better-off residents to the area, these tactics initially worked to curb concentrations of socio-economically vulnerable groups in the city centre. However, the ensuing rise in property values sowed the seeds of new challenges for existing lower-income residents, ranging from rent gouging to involuntary displacement. Meanwhile, in Saint-Denis, increased concentrations of unemployed persons and accompanying social problems were observed in areas of the city that were excluded from a large-scale urban revitalisation project that aimed to both demolish the city's most degraded housing stock and upgrade its most valued buildings. Hence, Fol (2012) suggested that policy interventions aimed at improving the living conditions of marginalised areas and increasing housing choices for low-income households may be more effective at combating increasing socio-spatial disparities such as segregation than social mixing strategies based on rightsizing or economic development. The author concluded by stating that while increasing socio-spatial disparities seem to be a common outcome of the processes of and the responses to shrinkage, further research distinguishing the spatial scales at which socio-spatial fragmentation occurs is necessary.

Towards that aim, Maes et al. (2012) considered the socio-spatial effects of shrinkage in the depopulating working-class neighbourhood of Hrušov in Ostrava, Czech Republic, arguing that in order to understand the effects of shrinkage on everyday life, it is essential to seriously consider the agency of individuals and households. Based on interviews with existing residents, the authors concluded that while shrinkage undoubtedly had negative effects on everyday life in certain neighbourhoods, these effects were especially severe in declining areas of post-socialist cities like Ostrava, where the transition to capitalism (and the widespread privatisation of housing) was an added obstacle to the development of socially-mixed neighbourhoods, and where instances of 'planned shrinkage' markedly altered the ways in which inhabitants lived. In Hrušov, the combined effect of institutional change and shrinkage led to concentrations of socio-economically vulnerable minorities, particularly the Roma. Here, the post-socialist transition led not only to a reduction in affordable housing, but also to the near complete withdrawal of social infrastructure and leisure facilities. The authors concluded that conditions of shrinkage and accompanying resource constraints represent considerable obstacles to socially-equitable urban development and the pursuit of social justice. Maes et al. (2012) observed that social mixing and social cohesion are especially challenging goals under conditions of urban shrinkage, given the financial and structural deficits it generally entails; in other words, that shrinking cities tend to lack the resources and capacities necessary to combat socio-spatial inequalities.

In another key work considering context-specific paths of socio-spatial change, Haase et al. (2012) coined the term 'transitory urbanites' to describe a new type of highly-mobile resident in formerly depopulating inner-city neighbourhoods of second-tier cities in Czechia and Poland. Specifically, the authors found that an increasing share of younger households – many of whom emotionally and pragmatically valued inner-city living in their current phase of life, but would consider relocating to peripherally-located neighbourhoods or even suburbia in the short to medium term – relocated to these areas beginning in the second decade of the region's post-socialist transition. The authors noted that this socio-spatial shift would not have been possible without the highly-fragmented inner-city housing market structures specific to many post-socialist cities that emerged due to urban shrinkage and the dilapidation of older built-up neighbourhoods. Essentially, many young newcomers managed to take advantage of the particular housing market conditions by renting a newly-privatised apartment, be it from the legal tenant, a private housing company or a relative. Although their tenures were often temporary, the behaviours and residential preferences of these transitory urbanites nevertheless paved the way for future influxes newcomers of similar ages and social status to inner cities. Thus, these temporary residents may have contributed to processes of studentification or gentrification (Haase et al., 2012).

4.2 Patterns of residential segregation in shrinking cities

The latter strand of case study research focused on patterns of residential segregation in shrinking cities includes studies that apply descriptive statistical techniques to measure concentrations of marginalised population groups at the level of districts or neighbourhoods, and thereby help to identify which intra-urban areas are the least and the most exposed to socio-spatial inequalities. While the first of these studies employed more traditional descriptive measurements such as averages, shares, frequency tables or standard deviations, recent studies have used more complex datasets, more advanced statistical techniques, more granular qualitative analyses and more intuitive methods of data visualisation. The ground-breaking work of Petsimeris (1998) used the indices of segregation and dissimilarity as well as location quotients to examine the changing spatial arrangement of social and ethnic population groups in the metropolitan areas of Milan, Turin and Genoa: i.e., three cities that form the so-called 'industrial triangle' of Italy. Four types of residential areas shared by all three cities were distinguished: the historic centre, a peri-central belt, upper-class quarters and the outer city. Using census data on occupational status from 1981 and 1991, which represents a period at the tail end of a wave of widespread deindustrialisation and deurbanisation in Italy, a positive effect was observed between inner-city population decline and increasing levels of residential segregation, above all with regard to concentrations of working-class groups in peripherally-located neighbourhoods near industrial zones, but also to concentrations of professionals and business owners in historic city centres. The author attributed this effect to shifts in the absolute and relative shares of lower and higher socio-economic groups, as well as to generally higher levels of out-migration and intra-urban residential mobility among affluent households in all three cities.

Subsequently, Großmann et al. (2013) observed that conditions of urban shrinkage contributed to the formation of niches of lower-income households in areas of low-cost housing characterised by abandonment, vacancies and decay. The outflow of residents reduced public and private investment, which, in turn, exacerbated these problems. However, the affected social groups and patterns of socio-spatial differentiation differed across the cities in question: in Ostrava, the Roma population were increasingly excluded from the more desirable parts of the city; in Genoa, concentrations of low-income households increased in the shrunken areas of the historic city centre; and in Leipzig, the shares of unemployed persons and ethnic minorities living in older working-class neighbourhoods increased. These findings demonstrated that the impact of shrinkage on residential segregation was context- and path-dependent. Additionally, in Ostrava, small-scale instances of demographic and ethnic residential segregation were observed, with older, long-time residents and younger newcomers increasingly residing on different streets and in different buildings. In Genoa, a sort of vertical residential segregation was observed in the shrinking inner-city quarters that was characterised by higher-than-average concentrations of better-off households living on the upper floors of otherwise vacant buildings. Similar observations were made in the district of

Leipzig-Grünau, a large housing estate where depopulation alongside selective demolition and upgrading measures contributed to growing income disparities between neighbouring apartment buildings. However, these spatial divisions were so fine-grained that they remained undetected when calculating segregation indices at the level of districts or even neighbourhoods. Großmann et al. (2013) concluded that although the link between shrinkage and segregation appears to largely depend on the local context and the drivers and the scope of shrinkage, as well as on the scale at which the phenomena are analysed, there is strong evidence that urban shrinkage has a catalysing effect on the (rapid) emergence of pockets of poverty and affluence within specific types of residential areas.

Großmann et al. (2015) further investigated the influence of housing oversupply on socio-spatial change and differentiation in Leipzig; a case that provided the researchers with the rare chance to investigate the impact of a city-wide housing surplus on the dynamics and the patterns of residential segregation, as opposed to a glut of vacancies confined to a specific area. The authors found that as the city's population declined during the 1990s, levels of residential mobility peaked and certain districts experienced a thorough reshuffling of residents. Using several different index-based measurements of segregation covering the five dimensions of residential segregation described by Massey and Denton (1988): evenness, exposure, concentration, centralisation and clustering, the authors found that Leipzig's city-wide housing oversupply and falling property values opened up niches for socio-economically vulnerable and minority population groups, above all in substandard housing in less attractive neighbourhoods. The authors also utilised GIS to illustrate how unemployed and non-native residents became increasingly concentrated in unmodernised, large, peripherally-located housing estates and in select inner-city neighbourhoods characterised by decay, respectively. An analysis of the average ages of the residents showed that there was an influx of young people into inner-city districts, while outer core and suburban areas grew older. Given that spatial distributions of depopulation and vacancies strongly correlated with concentrations of vulnerable groups, it appears that urban shrinkage contributed to Leipzig's socio-spatial restructuring, and to the partial re-emergence of the city's pre-war patterns of residential segregation.

Slach et al. (2019) examined how urban shrinkage impacted social sustainability in Ostrava, a sprawling city that experienced a decline in population between 1991 and 2018 due to post-socialist economic reforms, deindustrialisation, out-migration, suburbanisation, environmental degradation, declining fertility rates and a reliance on pro-growth policy strategies focused on securing financial investments or fostering economic growth. The authors concluded that shrinkage deepened existing patterns of residential segregation, which were characterised by concentrations of higher- and lower-status households in more and less desirable inner-city locations, respectively. The areas with the most pronounced levels of social exclusion were mainly concentrated in inner-city neighbourhoods characterised by higher levels of abandonment or in more peripherally-located areas near brownfields. Interestingly, while cities in Central and Eastern Europe (CEE) like Ostrava have been particularly prone to shrinkage since the turn of the millennium due to the region's post-socialist political and economic transition, unlike many shrinking cities in western Europe and America, most have not faced any major challenges related to housing vacancies, given the region's longstanding and widespread housing shortages dating from the era of state socialism. Accordingly, shrinking cities in CEE have generally not experienced the housing market imbalances or the demolition efforts that have occurred in the shrinking cities in the West. Nonetheless, the role of governmental and market actors in shaping socio-spatial change through public policies, urban planning and investment in Ostrava, as well as in many other shrinking cities, should not be ignored. It appears that at least during the initial years of Ostrava's post-socialist transition, governments saw unregulated markets as a mechanism of resource allocation that would facilitate prosperous, economically-efficient and socially-just societies. Since shrinkage was widely considered a temporary phenomenon stemming from the post-socialist transformation, the prevailing policy strategy remained focused on attracting external investment, with decision-makers assuming that economic growth would eventually translate into population growth.

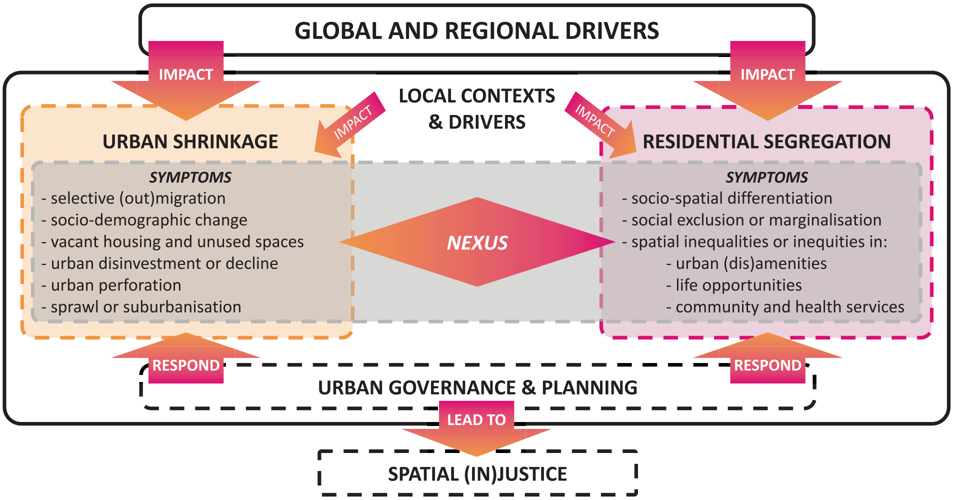
Hoekstra et al. (2020) assessed the socio-spatial consequences of housing policies introduced to respond to depopulation in Parkstad Limburg, a region with approximately 250,000 inhabitants, including approximately 90,000 in the municipality of Heerlen. The analysis focused on changing patterns of socio-economic segregation and housing accessibility among lower-income households between 2004 and 2015. The authors drew on secondary statistics to track changes in the region's socio-economic composition, as well as to map its geography of population decline and growth. Additionally, they analysed levels and patterns of residential segregation across the region, employing both the index of dissimilarity and the Theil index. The latter offers two noteworthy advantages over the former: first, the Theil index allows for the measurement of spatial evenness both between and within intra-urban units; and, second, it utilises continuous data (in this case on income), and thus does not have to rely on categorical variables such as occupational status. Even though shrinkage is less common and less severe in the Netherlands than elsewhere in Europe and the United States, the authors posited that the case of Limburg nevertheless offers a unique opportunity to investigate the effectiveness of policies specifically designed to mitigate population decline and to balance a (highly-regulated) housing market. In order to analyse the effects of housing policy interventions on population distributions, Hoekstra et al. (2020) mapped the geography of housing construction and demolition over time, and examined how these efforts served different income groups, and thereby altered levels and patterns of segregation. The authors found that even though a decree was issued stating that new construction had to be compensated for by the demolition of existing properties, and efforts were made to distribute demolitions and new developments evenly across the region, the construction of new housing in promising locations tended to go hand-in-hand with the demolition of low-quality housing in less desirable areas. Combined with growing economic polarisation and the gradual ageing of the region's population, these policies appear to have contributed to a further deepening of existing socio-spatial divides. These occurred as low-income households became substantially overrepresented in high-density areas, while the already large shares of better-off households in more sprawling areas became even larger relative to the shares of low-income households. Simply put, a widening spatial gap between poor households in inner-city neighbourhoods and relatively affluent households in suburban and rural areas was observed in the wake of shrinkage. Policy responses to depopulation had mixed effects on these dynamics; however, a tendency to focus efforts on the selective demolition of relatively inexpensive housing in high-density areas, while new housing construction mainly catered to middle-class households and was more evenly distributed across the region, disproportionately impacted low-income residents.

4.3 Summarising the state of the art

In order to illustrate the role of urban shrinkage in dynamics and patterns of residential segregation as described in the literature, Figure 2 presents a high-level overview of how various facets of these phenomena interlink with each other. For urban shrinkage, typical symptoms that have been identified as drivers of segregation are highlighted. Similarly, for residential segregation, a selection of symptoms that are particularly relevant from the perspective of shrinkage are listed, including city-wide socio-spatial unevenness, intra-urban spatial concentrations or clustering of certain population groups, as well as other patterns of intra-urban socio-spatial differentiation or inequalities. The diagram shows symptoms of shrinkage that have been identified as potential causal mechanisms of segregation. In addition, it indicates how local governance structures or urban planning responses to these symptoms may result in spatially-just or unjust outcomes (Berglund, 2020; Fol, 2012; Hoekstra et al., 2020).

Essentially, the socially-selective population losses and the altered housing market conditions typical of shrinking cities tend to lead to urban disinvestment and decline and to increasing perforation of the urban fabric, which may, in turn, trigger shifts in the city-wide extent or intra-urban patterns of residential segregation. Such shifts are especially likely to occur when there is a sudden, shock-like driver of shrinkage, such as a major political or economic change, the collapse of an industry, or even a natural catastrophe. Such events have been observed to result in both rapid and unexpected socio-spatial change (Großmann et al., 2015; Petsimeris, 1998). Thus, the dynamics of spatial inequalities and segregation under conditions of shrinkage differ from those typically observed under conditions of growth and ongoing housing shortages. Evidently, shrinkage can result in growing concentrations of disadvantaged households in the least attractive neighbourhoods with an oversupply of relatively cheap housing stock, in addition to a lack of public infrastructure or urban amenities. Continuing selective out- and in-migration alongside efforts to reuse or modernise certain properties or spaces may result in small-scale instances of segregation, such as at the level of neighbourhood blocks or even individual buildings.

Figure 2:
The nexus between urban shrinkage and residential segregation



However, the longevity of such developments – and whether these places eventually change due to, for example, reurbanisation or gentrification – depends largely on the local context, including on its housing market characteristics, future population trajectories, and urban policy and planning priorities. While context-sensitive policy and planning responses to shrinkage and segregation can facilitate equitable and just outcomes, the experiences of numerous cities indicate that non-strategic responses could make matters worse (Berglund, 2020; Fol, 2012; Pallagst et al., 2021).

4.4 Methodological shortcomings and knowledge gaps

Previous studies have improved our understanding of the general dynamics as well as the context-specific paths of residential segregation in a variety of shrinking cities around the world. At the same time, these studies raise a number of as yet unanswered questions about the causal nexus and the mechanisms at work between urban shrinkage and residential segregation. While their findings largely align with the theory that urban shrinkage, however defined, may act as a catalyst for residential segregation by age, ethnicity or socio-economic status, the scope of empirical evidence remains rather limited, and is predominantly based on the experiences of a handful of large capitals and metropolises. Indeed, with few exceptions (e.g., Fol, 2012; Hoekstra et al., 2020), the evidence for causal relationships between shrinkage and segregation in small- to medium-sized cities is largely anecdotal. Furthermore, the bulk of empirical studies, and thus the extent of our knowledge, is based on the European context, where cities have traditionally been characterised by lower levels of ethnic and socio-economic residential segregation than is the case in, for example, the United States (Cassiers and Kesteloot, 2012). Thus, while urban shrinkage has become an increasingly widespread global phenomenon from a geographical perspective, empirical studies verifying that residential segregation worsened during or in the wake of shrinkage are few and, spatially speaking, far between. Consequently, there are significant blind spots in our knowledge of many regions around the world, and it therefore seems hazardous to make broad generalisations about the influence of urban shrinkage on dynamics or patterns of segregation.

There is also a need for more granular spatial analyses of patterns of residential segregation under conditions of shrinkage. Whereas regional and urban scale studies may help to identify local causes, trajectories or effects of shrinkage, intra-urban scale analyses allow for the identification and comparison of individual neighbourhoods, and are thus important for the development of a more granular understanding of the interplay between shrinkage and segregation. Additionally, as most past studies examined levels or patterns of segregation at a single point in time, longer-term perspectives on how shrinkage impacts segregation – and findings related to potential time-lag effects – are missing. While there may be little reason to doubt that urban shrinkage implies some degree of socio-spatial change, it is difficult to determine precisely to what degree or even whether the relationship is linear, exponential or neither based on the existing literature, which has, to be clear, centred on a few exemplary cases of shrinkage. To fill these gaps, researchers have increasingly called for more systematic comparative research of the socio-spatial effects of processes of and responses to shrinkage.

Although they are evolving, the statistical techniques employed by existing studies also leave some room for improvement. An important shortcoming of these studies is that they used different methods and indicators. While the studies reviewed above made much of the spatial context, because of data limitations, most focused on patterns of spatial evenness, and essentially brushed other dimensions of residential segregation – namely, exposure, concentration, centralisation and clustering – under the rug. In addition to using different statistical techniques to measure levels or patterns of spatial evenness, the few studies that explicitly analysed intra-urban patterns of segregation employed different spatial unit types and sizes. While some analyses were performed at the level of neighbourhoods or districts, others were conducted at a larger scale, such as boroughs or census tracts. Moreover, although the studies were predominantly concerned with spatial divisions along socio-economic lines, their definitions of disadvantaged and affluent groups differed. Aside from analysing education, income and employment status, these studies failed to consider other factors of potential interest, including levels of social and human capital.

There seems to be a lack of engagement with more critical approaches, such as the political economy perspective, and of studies that explicitly consider and compare context-specific pathways, dynamics and outcomes. In addition to a need for research on similarities and differences in levels and patterns of segregation among various types of shrinking cities around the world, little attention has been given to the question of how governance frameworks and actor constellations shape the agency of decision-makers to respond to the socio-spatial challenges presented by shrinkage, especially with regard to housing vacancies. Lastly, the socio-spatial effects of place-based policy responses to shrinkage – including frequently endorsed 'smart shrinkage' strategies, such as rightsizing, greening and vacant property reuse – remain opaque. Future research could, for instance, investigate whether urban development scenarios such as uncontrolled (sub)urban sprawl or top-down demolition programs have resulted in new challenges for marginalised neighbourhoods that impede their sustainable development and hinder potential improvements in the quality of life for existing residents. Such research might have global relevance by providing lessons in the unintended consequences of implementing 'quick fixes' in response to fundamental change. In sum, the methods and the empirical results of past studies on socio-spatial change and residential segregation in shrinking cities do not lend themselves to future post-hoc, cross-sectional or comparative research. While these studies together represent a solid first cut at investigating the question of how urban population decline affects segregation, several promising angles of inquiry remain to be pursued.

5 Discussion

There is growing interest in the human geography and urban planning literature about the role of contextual factors in explaining socio-spatial change in (sub)urban environments. Recent observations from cities around the world have challenged the dominance of past notions of polarised or divided cities, and inspired a new body of research that acknowledges the limitations of broad generalisations or typologies by shedding new light on the complexity of contemporary socio-spatial processes, including residential segregation through systematic, context-sensitive analyses (Cassiers and Kesteloot, 2012; Fujita and Maloutas, 2012). The literature reviewed above shows that since out-migration from shrinking cities is almost always selective with respect to demographic, ethnic or socio-economic characteristics, urban shrinkage regularly coincides with socio-spatial change. Despite the apparent link between residential segregation and urban shrinkage, these two phenomena are typically investigated in silos and at different spatial and temporal scales. While increasing socio-spatial differentiation may be detected on the city scale using statistical techniques such as segregation indices, it appears that these shifts are most palpable for households residing in those parts of the city that are most affected by shrinkage (Großmann et al., 2013; Maes et al., 2012). Under these conditions, shrinking cities are confronted with a range of challenges related to urban development and social cohesion. At the local scale, these challenges are mainly related to processes of population ageing and so-called 'brain drain' – whereby 'left behind' residents of shrinking cities are disproportionately members of the most marginalised population groups, including the elderly, unemployed persons and social assistance recipients (Fol, 2012) – and the resulting housing supply and labour market mismatches. Meanwhile, at the intra-urban scale, shrinking cities face specific dynamics concerning levels and patterns of residential segregation, especially with respect to the risk of socio-economically vulnerable households becoming increasingly concentrated in those corners of the city most affected by shrinkage.

Despite the common perception that shrinking cities contain abundant low-cost housing, property values and rents tend to remain inelastic in response to demographic decline due to fixed property costs and associated fees incurred by property owners and landlords. Moreover, landlords in shrinking cities may contribute to housing affordability and accessibility concerns by seeking rents above the levels necessary for adequate rates of return due to, for example, cautionary risk avoidance or exploitative business practices (Berglund, 2020; Desmond and Wilmers, 2019). Under these circumstances, the financial situations and the levels of residential mobility among socio-economically vulnerable segments of the population are likely to further deteriorate. Additionally, while the underlying relationship between conditions of urban shrinkage and localised patterns of residential segregation has attracted increasing attention in the literature, the breadth and the depth of the existing studies on this topic still pale in comparison to those of the studies on segregation in growing cities characterised by processes such as gentrification or studentification. Nonetheless, if recent publications and special issues on shrinking cities are any indication, the literature appears poised to further improve our knowledge of the socio-spatial effects of urban shrinkage (Berglund, 2020; Silverman, 2020).

This review has uncovered several promising avenues for advancing the emerging body of literature on socio-spatial change and residential segregation in shrinking contexts. While previous studies have focused on larger shrinking capitals and metropolitan areas in select regions, urban shrinkage is a worldwide phenomenon that affects cities of all different shapes and sizes (Martinez-Fernandez et al., 2016). As past studies are characterised by the inconsistent use of spatial scales and methods of analysis, it is difficult to compare results. From a temporal perspective, few studies have taken an explicitly long-term perspective on socio-spatial change. Fortunately, increasing access to time-series datasets on population dynamics and characteristics promises to aid future research of this nature. Moreover, there appear to be gaps in our understanding of legacy effects, such as inherited urban morphologies and patterns of segregation. Perhaps most importantly, we lack insight into the qualitative impacts of residential segregation during and in the wake of a period of urban shrinkage on different 'left behind' population groups, including into how such an environment affects life opportunities and quality of life. In this regard, comparative case studies examining the cumulative effects of shrinkage and segregation on underprivileged groups are especially welcome. For instance, in shrinking American cities, where leading drivers of urban depopulation include deindustrialisation, decentralisation of employment, suburbanisation and sprawl, ethnic and socio-economic residential segregation have often been conflated with the post-war hollowing out of inner cities driven by car-centric urban planning, 'white flight' and, more recently, recurring waves of systematic mortgage foreclosures and home evictions that have gutted whole streets and neighbourhoods in many cities. Building on the work of Watson et al. (2006), which showed that longstanding underutilised structures in shrinking or stagnant cities may act as barriers to residential integration, the findings of Silverman et al. (2013) and Bellman et al. (2018) suggest that due to historic patterns of residential segregation by class and race in many American cities, a typical outcome of urban shrinkage is that lower-income residents are disproportionately walled off from the few remaining desirable parts of the city, and increasingly concentrated in marginalised niches or at the periphery. Similar spatially-inequitable outcomes were uncovered by Seymour et al. (2020), whose cross-correlation study of the housing affordability challenges facing shrinking cities in the US showed that, between 1980 and 2017, in places where housing costs stagnated or even declined during a period of urban shrinkage, housing remained unaffordable for many residents due to falling incomes. The authors also found that while the proportion of rent-burdened households increased in shrinking and growing American cities alike since the 1980s, these trends generally intensified at much greater rates in the former, in part due to their relatively high shares of socio-economically vulnerable residents. These recent works illustrate the great potential for future studies to leverage new indicators and metrics in order to paint a more holistic picture of the causal link between urban shrinkage and residential segregation across and between various contexts.

In sum, several critical questions regarding the nexus of urban shrinkage and residential segregation remain open, including that of how spatially-uneven distributions of selective out-migration, populating ageing, housing oversupply and other symptoms of shrinkage influence intra-urban patterns of segregation in the long run; how the type and the scope of shrinkage impact housing access among certain (underprivileged) population groups; and, perhaps most daunting, how the geography and morphology of a city – among other static and dynamic characteristics – jointly constrain or facilitate socio-spatial change and segregation during and in the wake of shrinkage. In order to answer these questions, it would be fruitful to reconsider the applicability of theories of residential segregation and neighbourhood change informed by observations from growing cities across a variety of shrinking cities and typologies of urban shrinkage. Researchers are, however, advised to exercise caution to avoid the fallacies of circular reasoning and causal oversimplification, as they otherwise risk inaccurately associating urban shrinkage with deepening residential segregation, whereas the relationship may work the other way around, or other variables may have greater explanatory force (Großmann et al., 2013). While not favouring any particular approach, it is important that researchers clarify their methodological choices and acknowledge any known limitations of their research design. Regardless of the approach used, taking a reflective stance on the decisions underlying the research is more relevant than ever in light of contemporary epistemological debates in the fields of human geography and spatial planning.

6 Conclusion

While it may be true that urban shrinkage cuts both ways, simultaneously imposing challenges as well as opening windows of opportunity for sustainable urban development and social cohesion, one caveat to this observation is that responses to shrinkage not grounded in principles of fairness and equity will likely result in socially-unjust outcomes (Berglund, 2020). Unfortunately, urban shrinkage has long presented a challenge to social justice. To paraphrase Hollander and Németh (2011), whereas at times of population growth and economic prosperity, it is often society's most vulnerable who are left without a seat at the table, and have little to no choice but to scramble for crumbs that fall to the floor; during periods of depopulation and economic struggle, there may be no crumbs left over, let alone a table to set. These constraints explain why governance of shrinkage is arguably more complicated than governance of growth, and why moving towards more holistic planning approaches that explicitly consider the complex interdependencies of population change, residential mobility and urban inequalities may be even more vital to the pursuit of social cohesion for shrinking cities than for their growing counterparts (Cortese et al., 2014; Rink et al., 2014).

The preceding literature review has uncovered several challenges facing empirical research on the effects of urban shrinkage on the dynamics and patterns of residential segregation. There is a conspicuous association between the spatiality of urban depopulation and segregation in many European cities, leading many observers to assume there is a causal link between these phenomena. Though few studies have comprehensively analysed this association, interest in the socio-spatial implications of urban shrinkage has surged in recent years. To date, however, existing studies on the interplay of urban shrinkage and residential segregation are limited to a few relatively well-known metropolises characterised by rather exemplary conditions of shrinkage. In other words, we lack empirical verification of a causal effect between shrinkage and segregation across a wide range of – for lack of a better term – 'ordinary cities'; that is, small to medium-sized cities that are less well-connected to the global economy. Our ability to conceptualise and achieve a deeper understanding of the causal relationship between urban shrinkage and residential segregation is further hampered by our incomplete knowledge of how context-dependent factors – be they environmental, historical, political or social in nature – figure into the equation at various spatial scales. In addition to having to grapple with the confusion surrounding the supposed functional link between shrinkage and segregation, we are largely in the dark about how these phenomena relate temporally.

Our capacity to develop socially-equitable planning approaches to urban shrinkage and residential segregation is inhibited by these unknowns and other unknown unknowns. Consequently, shrinking cities risk pursuing responses to shrinkage that overlook its socio-spatial effects and the potential for context-insensitive planning to exacerbate residential segregation and social exclusion, especially in the most marginalised corners of a city (Cortese et al., 2014; Maes et al., 2012). While shedding light on these knowledge gaps would undoubtedly go a long way towards improving our understanding of urban shrinkage, in reality, they represent only a few missing pieces of the puzzle of socio-spatial change. Nevertheless, recent research on poverty, evictions and the persistent housing accessibility and affordability challenges faced by socio-economically vulnerable residents highlight the importance of understanding these dynamics in order to mitigate urban inequalities, and to move towards the development of more spatially-just cities (Desmond and Gershenson, 2017).

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RESEARCH ARTICLES

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Immigration and the prospects for long-run population decreases in European countries

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Abstract

Between 2009 and 2018, the total fertility rate fell in most European countries. In 2018, fertility was below the replacement level throughout Europe. Net migration was positive for two-thirds of European countries. This paper illustrates the implications for long-run population growth of observed net migration-fertility-mortality combinations in 20 European countries over the 2009–18 period by comparing the observed net migration to a zero population growth-related 'replacement level' for net migration. The results show that in several northern and north-western European countries, the net migration level has been consistently above this replacement level: if the net migration level and fertility and mortality rates remain constant, the population would increase. However, the findings also indicate that in all of the eastern European countries covered, the net migration level has been consistently below the net migration replacement level. The results further show that in Finland, Norway and Switzerland, the long-run implications of having constant fertility-mortality-net migration levels change from leading to population growth to leading to population decline. The opposite pattern is observed in Germany. The feasibility of preventing long-run population decreases through changes in net migration levels is discussed in light of the results.

Keywords: migration; population decrease; population growth; fertility; population model; Europe

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1 Introduction

In 2018, the total fertility rate (TFR) was below the (approximately 2.1) replacement level in every country in Europe.[1] In the absence of immigration, constant fertility would result in long-run population declines throughout the region (Espenshade et al., 2004; Gietel-Basten and Scherbov, 2020; Matysiak et al., 2021; Rindfuss et al., 2016; Sobotka, 2017). In most European countries, fertility has been below this replacement level for several decades (UNDP, 2019a). The prospect of a decrease in population is a concern in many European countries (Lutz and Gailey, 2020). In 2019, 43% of the European countries that responded to a United Nations inquiry cited 'countering long run population decline' as a major underlying reason for their current immigration policy (UNDP, 2019b). Moreover, some news stories and some politicians have portrayed the prospect of population decreases in 'gloom and doom' terms (Van Dalen and Henkens, 2011).

Despite their low fertility, population growth remained positive over the 2015-20 period in a majority of European countries (Eurostat, 2021; UNDP, 2019a). In roughly two-thirds of European countries, net migration levels have been positive (De Hass et al., 2019; UNDP, 2019a). Even though these countries have below the replacement level fertility, it is a theoretically possible that a decrease in their national population will never happen if their net migration remains sufficiently high (Coleman, 2002; Parr, 2021).

Should the recent population growth in most European countries be viewed as a temporary artefact of the population age structure, which has been formed by each country's national history of birth rates, death rates, immigration and emigration (so-called 'population momentum')? Or should the growth in some countries be seen in the context of a combination of net immigration, fertility and mortality, which, if sustained, will lead to population increases over the long run? For each country, what is the critical level of 'replacement net migration' that would produce zero long-run population growth in combination with constant fertility and mortality at current levels (Espenshade et al., 1982)? And, in light of recent trends, does sustained net migration at this 'replacement level' appear feasible in each country? This paper aims to answer these questions, and, in doing so, to provide new perspectives on recent population growth and net migration trends in European countries.

[1] Parr (2021) proposed a 'migration-adjusted replacement level' for fertility that is applicable to populations in which the level of net migration has positive values. Here, the term 'the replacement level' is used to refer to the replacement level proposed by Dublin and Lokta (1925). In other words, it is used to refer to the fertility level that will result in a population that also has constant mortality rates and zero migration eventually reaching a stationary state. It is not a reference to the measure proposed by Parr (2021).

2 Fertility, mortality, migration and population growth trends in Europe 2009–2018

There are substantial differences between European regions in population growth rates and their components (Wilson et al., 2013; Table 1). The TFR is generally higher in northern and western Europe and lower in southern and eastern Europe (Rindfuss et al., 2016). Between 2009 and 2018, the TFR decreased in roughly two-thirds and increased in the remaining one-third of European countries (Eurostat, 2021; Table 1). The mean age at childbirth increased in every European country. Fertility changes were uneven both between different regions of Europe and between different countries within the same region. The largest reductions in the TFR were in northern European countries, especially in Iceland, Finland and Norway. The TFR also fell in north-western Europe, particularly in Ireland, the United Kingdom (UK), Belgium and the Netherlands. The trends in southern European countries were mixed: in Italy, the TFR fell to a very low level, while in Spain and in Portugal, the TFR changed only slightly. Over the same period, the TFR increased in most eastern European countries, with the largest increases occurring in Hungary, Czechia, Slovakia, Latvia and Lithuania. Among the central European countries, the TFR increased substantially in Germany and, to a lesser degree, in Austria. However, there was little change in the TFR in Switzerland (Eurostat, 2021).

Between 2009 and 2018, life expectancy at birth increased in all European countries, with the larger increases generally occurring in eastern European countries, and the smallest increases occurring in Germany and the UK (Eurostat, 2021; Parr et al., 2016; Table 1). Despite these trends, life expectancies at birth remained below the European average in the eastern European countries.

In 2009, natural increase (i.e., the number of births minus the number of deaths) was positive in 62% of European countries (Eurostat, 2021). The countries where it was negative were mostly in eastern Europe, and also included Austria, Germany, Italy and Portugal. By 2018, the percentage of European countries in which natural increase was positive had fallen to 55%, with Spain, Greece, Finland, Poland and Slovenia joining the list of countries with a negative natural increase, and Austria leaving it.

Net migration to Europe as a whole was positive over the 2009–18 period. The rates of net inflow in the northern and western European countries tended to be higher than in the southern European countries (Eurostat, 2021; UNDP, 2019a). There was substantial migration out of eastern European countries and into northern and western European countries following the 2004 and 2007 expansions of the European Union (EU) (Kahanec and Zimmermann, 2016). Poland and Romania were the eastern European countries with the highest absolute numbers of emigrants (Eurostat, 2021). The outflows from Poland rose between 2009 and 2013 and then diminished somewhat between 2013 and 2018, while the outflows from Romania fell from 2009 to 2013 and then increased between 2013 and 2018 (Eurostat, 2021). Emigration from the Baltic states declined, while emigration from Bulgaria and

Croatia increased. Emigration from Spain, Greece, Portugal and Ireland rose from 2009 to 2013 following the Great Recession, and then fell between 2013 and 2018.

Over the 2009–18 period, Germany and the UK generally received the largest numbers of immigrants (Eurostat, 2021). In 2015, the number of immigrants to Germany was unusually large. This was mainly due a sharp increase in the number asylum seekers, most notably from Syria, and, to a lesser extent, from Iraq and Afghanistan. There were also unusually large asylum seeker inflows to Austria, Belgium and Denmark in 2015, and to Sweden in 2016 (Hagelund, 2020; OECD, 2017; Pew Research Centre, 2016). Immigration to Spain fell steeply during the 2009–2013 period, which was characterised by unfavourable economic conditions and very high unemployment. However, it largely recovered in the years that followed. Indeed, in 2018, Spain replaced the UK as Europe's second most popular destination for immigrants (OECD, 2019). Immigration to Greece, Portugal and Ireland also recovered from post-Great Recession lows. However, immigration to Italy, Norway and Switzerland fell during these years.

Over the 2009–2018 period, the net migration rates were generally highest in the central European countries (Switzerland, Austria and Germany), the Nordic countries (Norway and Sweden) and Luxembourg (Table 1). Belgium, Denmark, the Netherlands, France, the UK and Italy had more moderate rates of net inflow. Most eastern European countries experienced net outflows, with Czechia, Hungary, Russia and Belarus being notable exceptions. In Spain and Ireland, net outflows in the earlier part of this period were followed by net inflows in the latter part (Eurostat, 2021).

In 2009, population growth was positive in all northern, western, central and southern European countries, except Germany and Iceland (Eurostat, 2021; Table 1). In contrast, population growth was negative in a majority of eastern European countries.[2] Between 2009 and 2018, the population growth rate decreased in roughly two-thirds of European countries. In 2018, the list of European countries experiencing population decreases included Greece, Italy, Portugal and a large number of eastern European countries.[3] However, while the populations of Germany and Estonia had previously been declining, the populations of these countries grew in 2018 (Table 1).

3 Review of the literature on replacement migration

It has been demonstrated mathematically that a population that has a constant net immigration level, an amount with a fixed age composition, constant below replacement fertility rates and constant mortality rates will converge over time

2 The exceptions are Russia, Poland, Czechia, Slovakia, Albania, Kosovo, Montenegro, North Macedonia and Slovenia.

3 In Poland, Kosovo and Montenegro, population growth was negative in 2018.

Table 1:
Population growth rate, rate of natural increase, rate of net migration, total fertility rate (TFR) and life expectancy at birth for males and females: Selected European countries 2009 and 2018

Country	Population growth (%)		Natural increase (%)		Net migration (%)		TFR		Life expectancy at birth: Male		Life expectancy at birth: Female	
Year	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**
Northern Europe												
Denmark	0.4	0.4	0.1	0.1	0.3	0.3	1.83	1.73	76.9	79.1	81.1	82.9
Finland	0.5	0.1	0.2	−0.1	0.3	0.2	1.86	1.41	76.6	79.1	83.5	84.5
Iceland	−0.6	2.4	1.0	0.6	−1.5	1.9	2.33	1.71	79.8	81.3	83.8	84.5
Norway	1.2	0.6	0.4	0.3	0.8	0.3	1.98	1.57	78.4	81.1	83.2	84.5
Sweden	0.9	1.1	0.2	0.2	0.7	0.9	1.93	1.76	79.4	80.9	83.5	84.3
Benelux countries												
Belgium	0.8	0.5	0.2	0.1	0.6	0.4	1.84	1.62	77.4	79.4	82.8	83.9
Luxembourg	1.7	2.0	0.4	0.3	1.3	1.6	1.59	1.39	78.1	80.1	83.3	84.6
Netherlands	0.5	0.6	0.3	0.1	0.2	0.5	1.76	1.59	78.4	80.3	82.5	83.4
Central Europe												
Germany	−0.2	0.3	−0.2	−0.2	0.0	0.5	1.35	1.57	77.8	78.6	82.8	83.3
Switzerland	1.1	0.7	0.2	0.2	0.9	0.5	1.49	1.52	79.9	81.9	84.6	85.7
Southern Europe												
Italy	0.3	−0.2	−0.0	−0.3	0.4	0.1	1.45	1.29	79.1	81.2	84.2	85.6
Baltic states												
Estonia	−0.2	0.4	−0.0	−0.1	−0.2	0.5	1.71	1.68	70.0	74.0	80.3	82.7
Latvia	−2.0	−0.8	−0.4	−0.5	−1.6	−0.3	1.47	1.61	67.5	70.1	77.7	79.7
Lithuania	−1.3	−0.5	−0.3	−0.4	−1.0	−0.1	1.50	1.64	67.1	70.3	78.7	80.7
Central-Eastern Europe												
Czechia	0.4	0.4	0.1	0.0	0.2	0.4	1.52	1.71	74.1	76.2	80.5	82.0
Hungary	−0.2	−0.1	−0.3	−0.4	0.2	0.3	1.33	1.54	70.0	72.7	78.3	79.6
Poland	0.8	−0.0	0.1	−0.1	0.0	0.1	1.41	1.46	71.5	73.7	80.1	81.7
Slovakia	0.2	0.1	0.2	0.1	−0.0	0.1	1.45	1.55	71.4	73.9	79.1	80.8
Balkan countries												
Bulgaria	−0.6	−0.7	−0.4	−0.7	−0.3	−0.1	1.65	1.55	70.2	71.5	77.4	78.6
Croatia	−0.2	−0.7	−0.2	−0.4	−0.0	−0.3	1.59	1.47	72.8	74.9	79.7	81.5

Source: Eurostat (2021).

towards a stationary state with a constant size and age distribution (Espenshade et al., 1982; Pollard, 1973). Espenshade et al. (1982) calculated that, in combination with fertility rates and mortality rates for 1977, an annual net immigration of 840,000 people would be needed to generate a stationary population equal to the 1980 population size for the USA. However, in the almost 40 years that have passed since the publication of Espenshade et al. (1982), surprisingly few studies have estimated 'replacement migration' levels using this method, and it appears that none has applied it to an extensive range of populations. A rare example of the use of this method is Gesano (1994), who calculated that a constant net migration of 389,000 people would be needed to generate a stationary population equal to Italy's 1991 population. While Gesano (1994) dismissed this level as 'probably unmanageable', over the 2003–04 and 2007–08 periods, recorded net migration in Italy exceeded this level (Eurostat, 2021).

To date, the most widely known study of the 'replacement migration' levels that will prevent long-run population decline under specified scenarios for future fertility rates and mortality rates is undoubtedly the UNDP (2000). The method used in by the UNDP (2000), first, calculates for each of a range of populations the maximum population size and the time point at which it is reached by a population projection that combines the fertility and mortality assumptions used in the United Nations' 1998 medium variant projection with an assumption of zero international migration. Second, the method calculates for each population the net international migration, which, in combination with the same fertility and mortality assumptions, would maintain the aforementioned maximum population size from the time it was reached to the end of the 2000–2050 time period. The results show that in Europe, the European Union (EU), France, Germany, Italy, Japan, the Republic of Korea, the Russian Federation and the UK (but not in the USA), the 'replacement net migration' levels were considerably above the levels for the corresponding countries or region used in the United Nations' 1998 medium variant projection. However, in the EU, France and the UK, the levels fell within the range of (what was then) recent experience. The method used by the UNDP (2000) to estimate 'replacement migration' differed from that of Espenshade et al. (1982). Indeed, as Espenshade (2001) noted, the rationale for the UNDP (2000) method for calculating 'replacement migration' is unclear. Whereas Espenshade et al. (1982) calculated the replacement migration level for a recently observed population size, the UNDP (2000) calculation is for a hypothetical future (and likely never-to-be-observed) population scenario. The UNDP (2000) method considered an implausible scenario in which net migration changed abruptly to a zero level, which did not reflect the (at that time) recent experiences of the populations it considered. The UNDP (2000) 'replacement migration' is not a synthetic measure, because its value is influenced by the 'momentum' inherent in the initial age structure of the projected population. Moreover, the UNDP's (2000) estimates of the 'replacement migration' levels for the UK, Germany, France and Italy were exceeded by the subsequent average net migration levels in these countries over the 1995–2015 period (Craveiro et al., 2019).

For the 2002–2052 period, Bijak et al. (2013) presented cumulative (and constrained to be non-negative) 'replacement migration' levels that would maintain a constant population size for the European Union and its (then) constituent countries. Their results reflect the heterogeneity of the population prospects of the countries considered, showing that large volumes of 'replacement migration' will be needed to prevent population decreases in eastern and southern European countries (e.g., Romania and Bulgaria) with low fertility and negative momentum, whilst the populations of 10 mostly northern and western European countries are projected to grow throughout the period considered, even with zero migration.

Craveiro et al. (2019) estimated the annual net migration needed to maintain a constant (2015) population size in Germany, the UK, France, Italy and Spain over the 2015–60 period, assuming fertility and mortality rates change in line with the Eurostat (2014) projections. For all five countries, the 'replacement' level for net migration is initially negative and generally increases over the projection period. The authors attributed these changes to reductions in initially positive projected natural increases due to projected population ageing. The trajectories for 'replacement' net migration levels, which start from negative values and vary considerably from year to year, appear implausible in light of recent migration patterns, and unsuitable for incorporation into a coherent and civilised discussion of migration policy options (McDonald and Kippen, 1998).

The aforementioned studies addressed the stability in the total population size (and, in some studies, also the stability of the working-age population and the proportionate age structure). Other studies have focused on the question of whether immigration can maintain either annual birth numbers or the sizes of the cohorts reaching prime reproductive ages (Billari and Dalla-Zuanna, 2011; Wilson et al., 2013). Wilson et al. (2013) found that while there have been either intergenerational increases or at least intergenerational stability in the sizes of cohorts reaching prime reproductive ages in a range of western and northern European countries, there have also been intergenerational decreases in the sizes of these age groups in most of the ex-communist eastern European countries they considered. Total population growth has also been affected by increases in the sizes of successive cohorts reaching older ages. Similarly, Billari and Dalla-Zuanna (2011) demonstrated that the 1980–84 birth cohort had at least replaced the 1950–54 cohort (i.e. its 'mothers' cohort') in Spain, the UK and the USA; and, according to United Nations projections, was on course to replace it in Italy. However, this study also found that neither Germany nor Japan has achieved cohort replacement through net migration. Moreover, neither country will do so in the future, according to the UN projections.

In the description of fertility levels it is routine to compare the fertility level to a synthetically measured (invariant to population age structure) 'replacement level', which has a zero population growth implication under specified conditions (Dublin and Lokta, 1925; Parr, 2021). This paper adopts a parallel approach to describing net migration data. The 'net migration replacement level' against which the recent net migration level is compared is that proposed in a classic paper by Espenshade et al. (1982). It is the first to apply this method to an extensive range of populations. It should be noted this paper's method is quite different from the methods used in other studies that have adopted the term 'replacement migration', including those of the UNDP (2000), Billari and Dalla-Zuanna (2011), Bijak et al. (2013), Wilson et al., 2013 and Craveiro et al. (2019). The following section describes the method of calculation. The final section provides a discussion of the advantages of this method, as well as a summary and a discussion of the results.

4 Method

A population that has a constant volume of net immigration with a fixed age-sex composition, a constant fertility rate that is below the exact replacement level which corresponds to zero migration, and constant age-sex mortality rates will converge towards a stationary state (i.e., zero growth and constant numbers by age and sex) (Espenshade et al., 1982; Pollard, 1973). The stationary population size (denoted P_A) which corresponds to a constant net migration-fertility-mortality combination at the levels for a specified population and time period (denoted by A) can be expressed as the sum of components (Espenshade et al., 1982; Schmertmann, 1992). A person's migrant generation index is based on the most recent foreign-born individual from the set comprising the person plus his/her all female line of ancestry to migrate into a specified population. Thus, a person born in another country belongs to the first generation, a native-born child whose mother was born in another country belongs to the second generation, a native-born child whose mother was native born and whose mother's mother was born in another country belongs to the third generation, and so on. Following Espenshade et al. (1982), the components are labelled in terms of the 'migrant generation' index:[4]

$$P_A = \sum_{i=1}^{\infty} P_{i,A} \tag{1}$$

Where P_A denotes the total size of the stationary population, i is the 'migrant generation' index and $P_{i,A}$ denotes the size of the ith 'migrant generation'.

In the current paper, the calculation of the various migrant generation sizes, and hence of the stationary population size, uses discrete approximations of formulae in Schmertmann (1992), which are readily calculated from widely available national and international statistical agency data. The 'first generation' element in Equation (1) ($P_{1,A}$) is calculated by:

$$P_{1,A} = M_A \sum_{j=1}^{2} \sum_{x=0}^{\omega} m_{x,j,A} e_{x,j,A} \tag{2}$$

Where M_A denotes the constant annual total net migration level for A, $m_{x,j,A}$ denotes the proportion of total net migration contributed by persons of age x (last birthday)

[4] Since the calculations involve net migration (and not immigration), literal correspondence between the components and the immigrant generation groups does not apply. Hence, the names of components are in inverted commas.

and sex j ($j = 1$ denotes female and $j = 2$ male) for A, $e_{x,j,A}$ is the (remaining) life expectancy for age x and sex j for A and ω denotes the maximum age for that population.

The 'second generation' element in Equation (1) ($P_{2,A}$) is calculated by:

$$P_{2,A} = M_A \sum_{j=1}^{2} s_{j,A} e_{0,j,A} \sum_{x=0}^{k} m_{x,1,A} \sum_{t=0}^{k-x} f_{x+t,A}\, {}_t p_{x,1,A} \tag{3}$$

Where $f_{x+t,A}$ represents the age-specific fertility rate (per woman) for age $x + t$, ${}_t p_{x,1,A}$ denotes the probability of a female surviving from x to $x + t$, k denotes the upper limit of the female reproductive age range, $s_{j,A}$ denotes the proportion of births of sex j and $e_{0,j,A}$ denotes life expectancy at birth for sex j.

For all $i \geq 2$

$$P_{i+1,A} = NRR_A P_{i,A} \tag{4}$$

where NRR_A denotes the conventional net reproduction rate for A.[5] The sum of the sizes of the generation-indexed components for generations with indices 2 and above is the sum of a geometric series with initial term $P_{2,A}$ and common ratio NRR_A. Hence, substituting from Equation (4), Equation (1) can be re-expressed as:

$$P_A = P_{1,A} + \frac{P_{2,A}}{(1 - NRR_A)} \tag{5}$$

Since M_A is a scalar value used in the calculation of all the generation-indexed components ($P_{i,A}$) of stationary population size P_A in Equation (1), the *net migration replacement level* ($M_{R,A}$), which, in combination with the specified values for $m_{x,j,A}$, $e_{x,j,A}$, $s_{j,A}$, $f_{x+t,A}$ and ${}_t p_{x,A}$ would generate a stationary population size (P_A) equal to the actual population size for A (POP_A), is:

$$M_{R,A} = \frac{M_A POP_A}{P_A} \tag{6}$$

In a population projection with constant fertility and mortality at the levels for A and net migration at the 'replacement level' for A ($M_{R,A}$), the size of the population may initially depart from its initial (current) value due to 'population momentum' created by the difference between its initial and ultimate age structure. However, over the long run (i.e. if fertility, mortality and replacement level net migration remain constant indefinitely), the population size will return to its initial value (POP_A). In a hypothetical scenario in which fertility, mortality and net migration all remain stable at the levels observed for A, the population size will ultimately converge to a stationary population size (P_A) that exceeds its initial value (POP_A) if and only if the total net migration (M_A) exceeds the *net migration replacement level* ($M_{R,A}$),

5 $NRR_{\mathrm{A}} = \sum_{x=0}^{k} f_{x,A}\, s_{1,A}\, {}_x p_{0,1,A}$.

and will converge to a value of (P_A) below its initial size if and only if net migration remains below the *net migration replacement level migration* ($M_{R,A}$).

This paper compares the recorded values of net migration[6] for 20 European countries for individual years between 2009 to 2018 to the corresponding *net migration replacement level* ($M_{R,A}$) for the country and year (as per Equation (6)). The data were sourced from the Eurostat website (Eurostat, 2021). The countries and the years chosen were limited to those for which all the requisite data inputs for calculating the *net migration replacement level* ($M_{R,A}$) were available from the Eurostat website,[7] and for which fertility was below the replacement level (i.e., NRR less than one).[8,9]

5 Results

Figures 1–7 visually compare the observed net migration to its replacement level for the individual years over the 2009–2018 period for which the requisite data are available and fertility was below the replacement level. It should be noted that the scales differ widely between countries. Table 2 presents the ratio of observed net migration to the net migration replacement level for 2018 only. Equation (6) indicates that this is also the ratio of the stationary population size to the current population size. In addition, Table 2 expresses the 2018 net migration replacement level as a percentage of the 2018 population size.

5.1 Northern Europe

In all of the northern European countries, the net migration replacement level generally increased over time due to reductions in fertility (Figure 1). Net migration in Sweden remained above its replacement level throughout the 2009–18 period, despite the increases in the latter due to a reduction in the TFR. Thus, Sweden's current population growth should not be seen as merely a temporary artefact of the population age structure (Table 1): if fertility, mortality and net migration remain constant at the values for any of the years covered, there would be further population growth over the long run. The ratio of net migration to its replacement level (shown

6 There are differences in the definitions of immigration and population and in data quality between countries (Gendronneau et al., 2019).

7 For Belgium, Bulgaria, Croatia, Czechia, Lithuania, Luxembourg and Slovakia, data on immigration and emigration by age and sex are unavailable from the Eurostat website for some years.

8 Iceland was not covered for 2009 and 2010 because fertility was above the replacement level which corresponds to zero migration. Calculation of the net migration replacement level is not feasible for such fertility levels.

9 An Excel spreadsheet used for calculating the net migration replacement level is freely and publicly available from the author's ResearchGate webpage.

Table 2:
Ratio of net migration to replacement level and net migration replacement level as per cent of the 2018 population: selected European countries 2018

Country	Net migration	Net migration replacement level	Ratio of net migration to replacement level	Net migration replacement level as % of 2018 population
Northern Europe				
Denmark	4,288	44,920	0.10	0.78
Finland	11,965	33,174	0.36	0.60
Iceland	7,458	1,784	4.18	0.54
Norway	20,706	22,565	0.92	0.43
Sweden	85,621	28,390	3.02	0.28
Benelux countries				
Belgium	48,925	38,225	1.28	0.34
Luxembourg	10,659	3,493	3.05	0.58
Netherlands	86,371	67,532	1.28	0.39
Central Europe				
Germany	353,471	326,099	1.08	0.39
Switzerland	14,632	18,687	0.78	0.22
Southern Europe				
Italy	175,364	505,638	0.35	0.84
Baltic states				
Estonia	7,071	9,289	0.76	0.70
Latvia	−4,905	8,078	−0.61	0.42
Lithuania	−3,292	3,433	−0.96	0.12
Central-Eastern Europe				
Czechia	39,168	53,951	0.73	0.51
Hungary	34,759	73,653	0.47	0.75
Poland	24,289	115,495	0.21	0.30
Slovakia	3,955	23,232	0.17	0.43
Balkan countries				
Bulgaria	−3,666	36,585	−0.10	0.52
Croatia	−13,486	19,420	−0.69	0.47

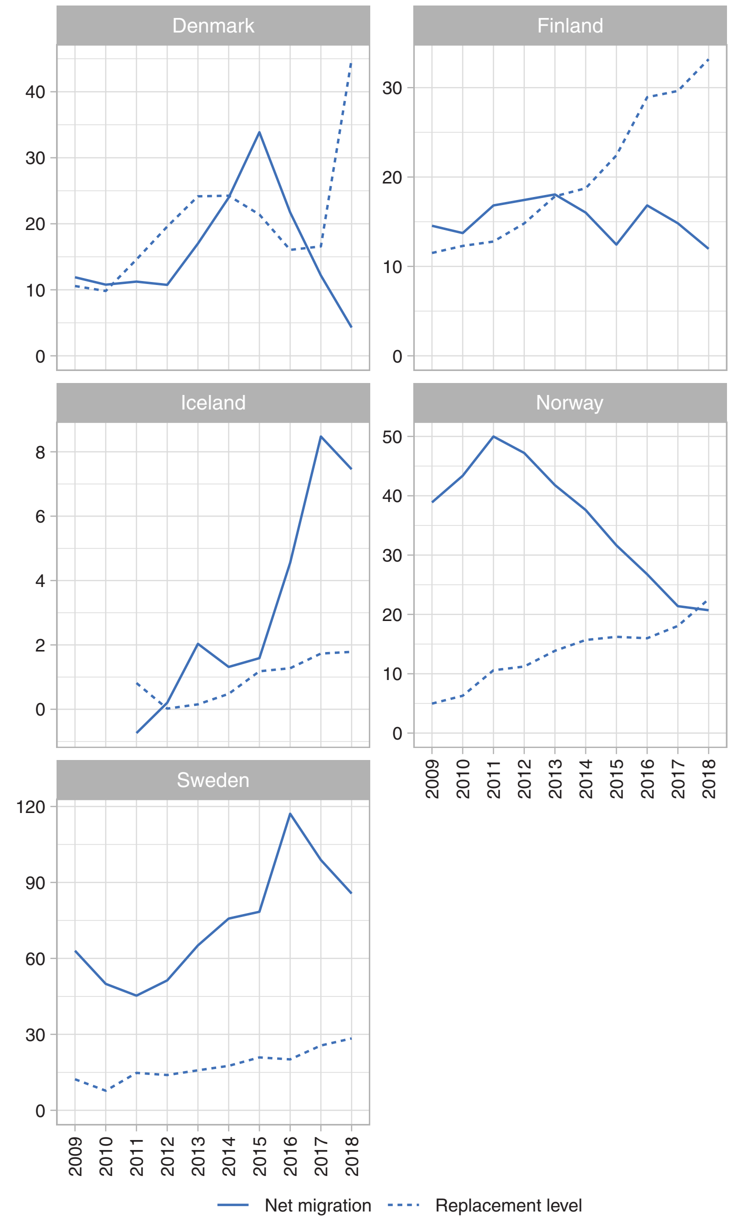
Source: Author's calculations based on Eurostat (2021).

in Column 3 of Table 2) for Sweden for 2018 indicates that if fertility, mortality and net migration remain constant, the population of Sweden would grow (over future centuries and millennia) to over three times its 2018 size.

In Norway in 2009, net migration was nearly eight times its replacement level. The low net migration replacement level for this year was the product of near replacement level fertility.[10] After 2011, the gap between net migration and its replacement level

10 The TFR for Norway in 2009 was 1.98.

Figure 1:
Net migration and net migration replacement level (000s) for Sweden 2009–18, Norway 2009–18, Iceland 2011–18 and Finland 2009–18



Source: Author's calculations based on Eurostat (2021).

narrowed progressively in Norway due to the combined effects of reductions in net migration and decreases in the TFR, which increased the net migration replacement level. In 2018, following the country's adoption of more restrictive immigration policies and border controls and a downturn in the number of asylum seekers, Norway's net migration was actually slightly below its replacement level (Hagelund, 2020; OECD, 2019). While Norway's population was still growing in 2018, albeit more slowly than in 2009, the implication of this below replacement net migration is that under conditions of constant fertility, mortality and migration, it would ultimately fall slightly below (to 92% of) its 2018 size (Table 2).

In Iceland, net migration exceeded its replacement level throughout the 2012–2018 period, but was negative and below the replacement level in 2011.[11] After 2012, Iceland experienced the most rapid fertility decrease of any European country. As the TFR fell, Iceland's net migration replacement level increased. Nonetheless, the gap between actual and replacement net migration widened. In 2018, the ratio of net migration to its replacement level was higher in Iceland than in all of the other countries included in this study (Table 2). If Iceland's fertility, mortality and migration remain constant at 2018 levels, its population would increase to more than four times its 2018 size over the long run (Table 2).

In Finland, net migration was relatively stable between 2009 and 2018. However, the relationship of net migration to its replacement level in Finland was transformed by a reduction in the country's TFR, which was the second largest in Europe over this period (Table 1; Hellstrand et al., 2020).[12] Related to this fertility decline, Finland's net migration replacement level nearly tripled. After 2014, the country's net migration was below replacement level. In contrast to the population of Norway, which will ultimately decrease, under conditions of constant fertility, mortality and net migration at 2018 levels, the population of Finland will ultimately decline to 36% of its 2018 size (Table 2).

In 2009, the TFR in Denmark was only slightly below the rates in Sweden and Norway, but the country's net migration only slightly exceeded its replacement level. The smaller gap between net migration and its replacement level in Denmark can be linked to the country's more restrictive immigration policies (Hagelund, 2020). Over the 2009–2018 period, the relationship between net migration and its replacement level fluctuated in Denmark. Between 2010 and 2013, a decrease in the country's TFR propelled the net migration replacement level above the actual net migration level. In 2015, the net migration numbers in Denmark were swelled by a large inflow of asylum seekers, which led to a migration level that was above the net migration replacement level (Pew Research Centre, 2016; OECD, 2017). In 2017 and 2018, following the country's adoption of more restrictive immigration policies and a

[11] The very low net migration replacement level in Iceland in 2012 is due to the TFR (2.04) being only marginally below the replacement level which corresponds to zero migration.

[12] Between 2009 and 2018, only Iceland experienced a larger decrease in the TFR than Finland.

decrease in the number of asylum seekers, net migration in Denmark was below its replacement level (Hagelund, 2020; OECD, 2019).[13]

5.2 Benelux countries

Between 2009 and 2018, the TFR fell in Belgium, the Netherlands and Luxembourg (Figure 2). The decreases in fertility in these countries contributed to increases in their net migration replacement levels. Nonetheless, in Luxembourg and Belgium, net migration exceeded its replacement level in all of the years considered in this study. The ratio of net migration to the replacement level was consistently higher in Luxembourg than in Belgium. In both Belgium and the Netherlands, net migration decreased significantly over the 2012-14 period. However, while net migration remained above its replacement level in Belgium, net migration fell below its replacement level in the Netherlands over this period. Subsequently, over the 2015–18 period, a combination of increases in the number of movers from newer EU member states in eastern Europe and increases in the number of asylum seekers from Syria again propelled net migration in the Netherlands to above its replacement level (OECD, 2017, 2019).

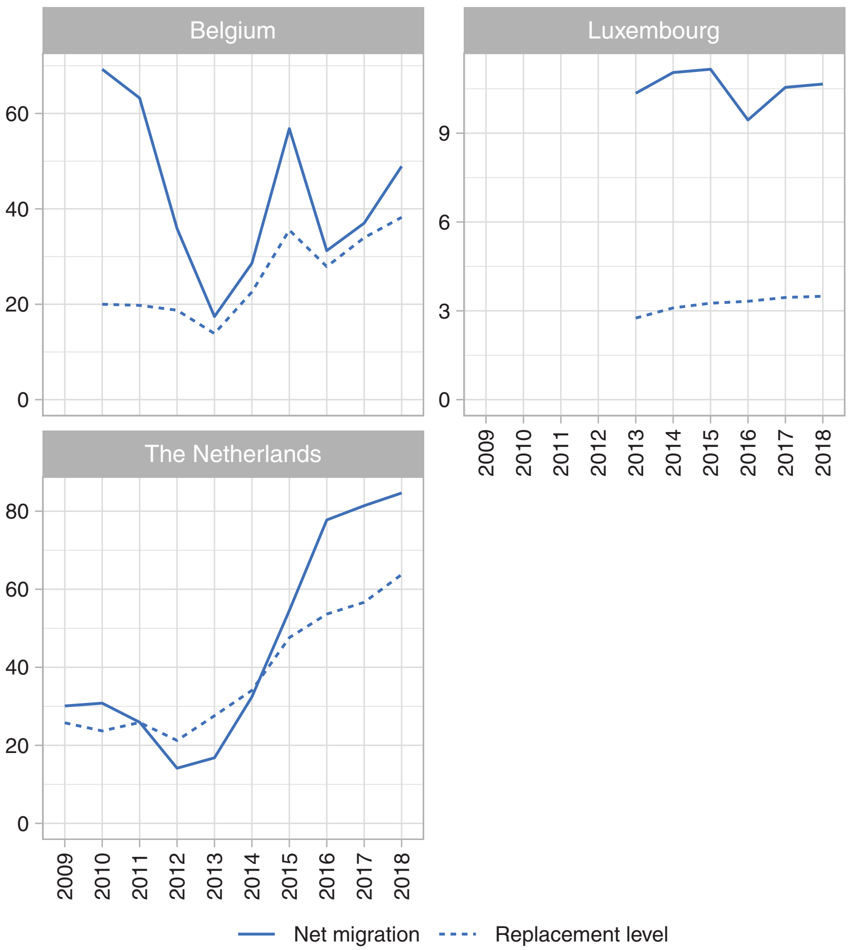
5.3 Central Europe

In 2009, the TFR in Germany was very low, at just 1.35 births per woman (Table 1). The country's economy was weak and its unemployment rate was high (Green, 2013). Like fertility, net migration in Germany was low, and was far below (just 18% of) its replacement level (Figure 3). After 2009, as the country's economy recovered, its net migration increased. After 2011, increases in the TFR and older ages at birth[14]

13 The much higher net migration replacement level for 2018 is linked to the unusual age-sex distribution of the very small net migration total in this year. Specifically, the proportion of net migration formed by females of reproductive age was much lower. Unlike males and older females, females of reproductive age affect the calculations of births. With such an age-sex distribution, a higher total net migration level is needed to equate the stationary population size with the real population size.

14 Substitution of the ratios of ASFR to TFR for 2011 in place of the observed values of these ratios for 2018 increases the net migration replacement level for 2018 to 332,593, i.e. by 2.0%. The increase to the net migration replacement level is due to the numbers of 'first-generation migrants' in the older reproductive age groups generally being larger than the numbers in the younger reproductive age groups. Thus, for any specified TFR, the size of stationary population (P_A) will be greater when the ages at birth are older than when they are younger, because of the greater weight of influence of the older reproductive ages on the calculation of the 'second generation' population size (P_2) and the flow-on effects of the increased size of the 'second generation' on the 'third and higher generation' sizes (Equations (1)–(5)). Thus, when the ages at birth are older, the net migration replacement level will be lower (Equation (6)).

Figure 2:
Net migration and net migration replacement level (000s) for Denmark 2009–18, Luxembourg 2013–18, Belgium 2010–18 and the Netherlands 2009–18

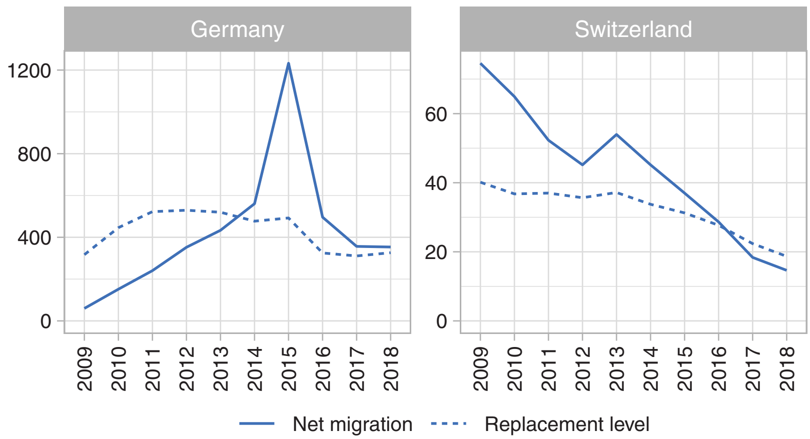


Source: Author's calculations based on Eurostat (2021).

contributed to increases in Germany's net migration replacement level.[15] In 2015, a huge spike in immigration linked to the large inflow of asylum seekers caused

[15] The decrease in the net migration replacement level between 2009 and 2011 is due to females forming an increased proportion of the (increased) net migration. Unlike males, females affect the calculations of births. Accordingly, when a higher proportion of net migration is formed by females, a smaller total net migration equates the stationary population size with the real population size.

Figure 3:
Net migration and net migration replacement level (000s) for Germany 2009–18 and Switzerland 2009–18



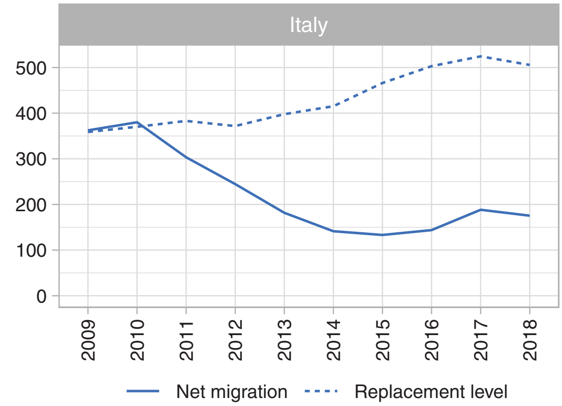
Source: Author's calculations based on Eurostat (2021).

net migration in Germany to jump to 2.5 times its replacement level (OECD, 2017; Pew Research Centre, 2016). Although net migration declined following this peak, it remained marginally above its replacement level. Not only have increases in the TFR, net migration and life expectancies between 2009 and 2018 shifted Germany's actual population growth from negative to positive, but also assuming the 2018 patterns continue, the size of the country's population would increase further over the long run (albeit only slightly).

In Switzerland, the TFR remained low at approximately 1.5 births per woman throughout the 2009–18 period (Eurostat, 2021). Nonetheless, in 2009, the country's rate of net migration, which was then one of the highest in Europe, was considerably above (1.76 times) its replacement level (Figure 3). Between 2009 and 2018, net migration in Switzerland fell rapidly, with substantial reductions occurring both before and after 2014, when a referendum proposing limits to immigration from the European Union was narrowly passed (Randall, 2016). In 2018, net migration in Switzerland was just 20% of its 2009 level, and was considerably below the net migration replacement level.[16]

[16] The reduction in net migration between 2009 and 2018 was greater for males than for females. When the proportion of females is higher, less migration is needed to replace the population. Later ages at birth and increases in life expectancies also contributed to the reduction in the net migration replacement level.

Figure 4:
Net migration and net migration replacement level (000s) for Italy 2009–18



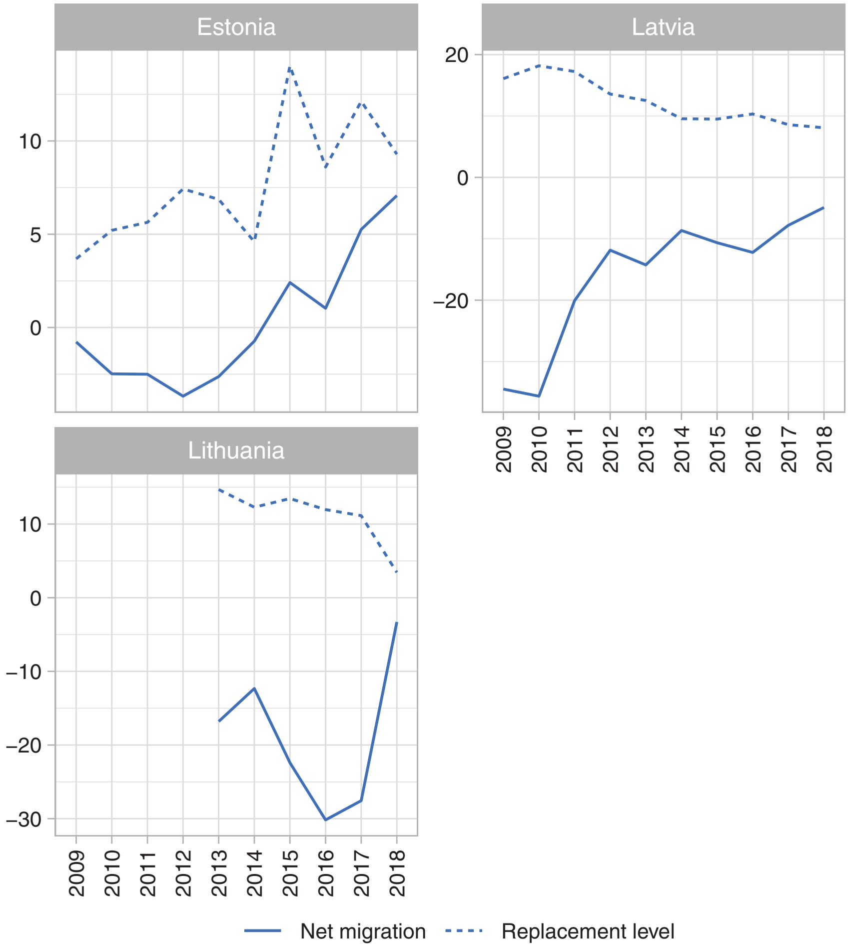
Source: Author's calculations based on Eurostat (2021).

5.4 Southern Europe: Italy

Expressed as a rate per 1000 population, the net migration replacement level in Italy in 2018 was higher than it was in the northern and western European countries previously considered, mainly because the TFR was much lower in Italy than in these countries (Table 1). Nonetheless, in 2009 and 2010, the country's net migration, swollen by large numbers of immigrants arriving by boat, roughly equalled its replacement level (Figure 4; Billari and Dalla-Zuanna, 2011; Hermanin, 2017). However, due to a significant decrease in the TFR in Italy (from 1.45 in 2009 to 1.25 in 2018), the country's net migration replacement level increased considerably, while its net migration fell sharply. Indeed, in 2018, Italy's net migration was just 35% of its replacement level. The net migration replacement level in this year exceeded any of the levels previously recorded in Italy (Eurostat, 2021).[17] Of the countries covered in Table 2, Italy had the highest values in 2018 for both the size of the net migration replacement level (Column 2) and the net migration replacement level as a percentage of the population (Column 4). The net migration replacement level in 2018 in Italy also far exceeded the value of net migration, which would have produced zero population growth in 2018 (i.e. minus the value of natural increase) (Tables 1 and 2).

17 The highest level of net migration ever recorded for Italy was 476,010 for 2007 (Eurostat, 2021).

Figure 5:
Net migration and net migration replacement level (000s) for Estonia 2009–2018, Latvia 2009–18 and Lithuania 2013–18



Source: Author's calculations based on Eurostat (2021).

5.5 Baltic states

In Estonia, net migration was negative over the 2009–14 period and was positive over the 2015–2018 period. However, even over the latter period, it remained below its replacement level (Figure 5). Thus, in the absence of substantial further increases in fertility, life expectancies and/or net migration, the positive population growth over the 2015–18 period in Estonia will give way to a decrease in the population over the long run.[18] In Latvia and Lithuania, net migration remained negative and was below its replacement level in all of the years considered. In both countries, increases in the TFR and life expectancies contributed to decreases in the net migration replacement level over the years considered (Table 1). In Lithuania, the net migration replacement level in 2018 exceeded the level of net migration, which would have resulted in zero population growth in 2018 (the value of net migration minus natural increase, i.e., 0.41% of the population). In Latvia, the net migration replacement level exceeded the (0.49% of the population) net migration level that would have resulted in zero population growth in 2018 (Tables 1 and 2).

5.6 Central-Eastern Europe

In Hungary, Czechia and Slovakia, net migration was positive but was considerably below its replacement level for all the years considered (Figure 6). Thus, a continuation of fertility, mortality and migration at the levels for any of the years considered would result in significant population declines over the long run. In Czechia and Slovakia, the prospect of long-run population decreases contrasts with recent slow population growth, while in Hungary, it represents a continuation of recent population declines (Table 1). In all three countries, recorded net immigration increased over the 2013–18 period, albeit only slightly in Slovakia.[19] In Hungary, this trend was due to a combination of an increase in returning Hungarian citizens and their foreign-born children and an increase in immigration by foreign citizens (Godri, 2020). Over the same period, the net migration replacement level generally increased in Hungary and Czechia, but it generally decreased in Slovakia.[20] In Poland, net migration was negative over the 2009–2017 period (Figure 6).[21] In 2018, due to an increase in immigration, especially from Ukraine, and a decrease in emigration, recorded net migration in Poland was positive (Eurostat, 2021; OECD, 2019). Even so, it was still far below the net migration replacement level.

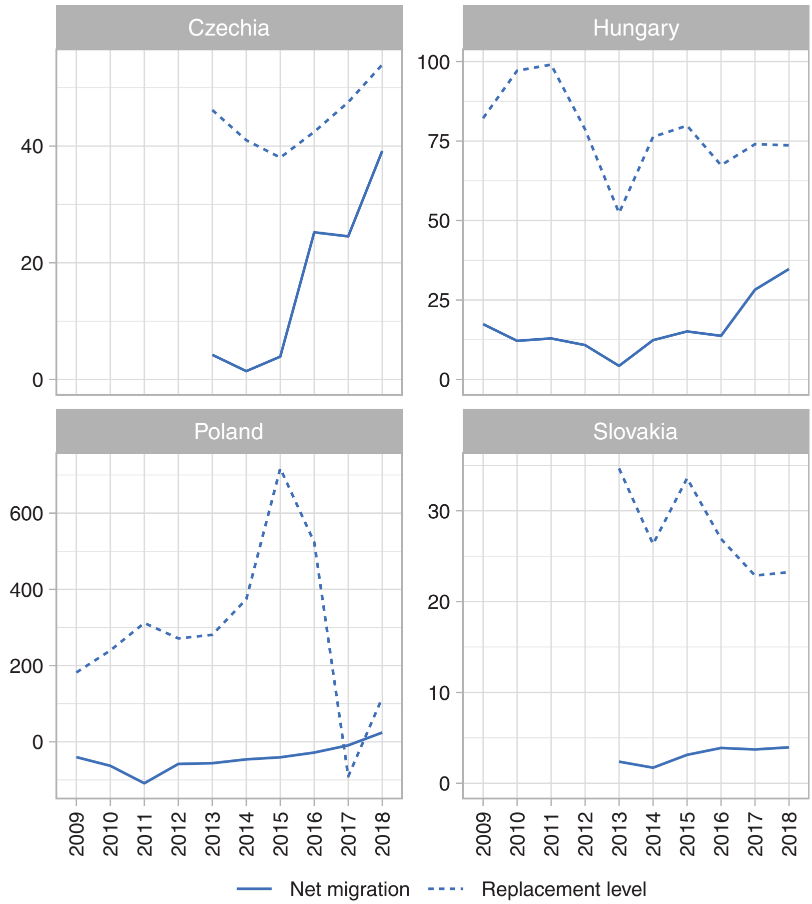
[18] If fertility, mortality and net migration remains constant at 2018 levels, the population of Estonia will ultimately decrease to 76% of its 2018 size (Table 2).

[19] In Hungary, recorded net migration may considerably overstate the underlying level due to the underreporting of emigration (Godri, 2020).

[20] The increases occurred despite increases in the TFR and life expectancies, which, other things being equal, would have decreased the net migration replacement level.

[21] In 2017, the overall negative net migration in Poland was the product of positive net migration in the young child and old age groups and negative net migration among young and middle-aged adults. The values of both P_1 and P_2 are positive because the positive net migration in the child age groups is multiplied by higher values of life expectancy and post-migration births than the negative migration in the adult age groups. Hence, scaling overall negative net migration equates the TSP with the actual population. The proportionate distribution of net migration for 2017 is, however, very different from that for other years.

Figure 6:
Net migration and net migration replacement level (000s) for Czechia 2013–18, Slovakia 2013–18, Hungary 2009–18 and Poland 2009–18

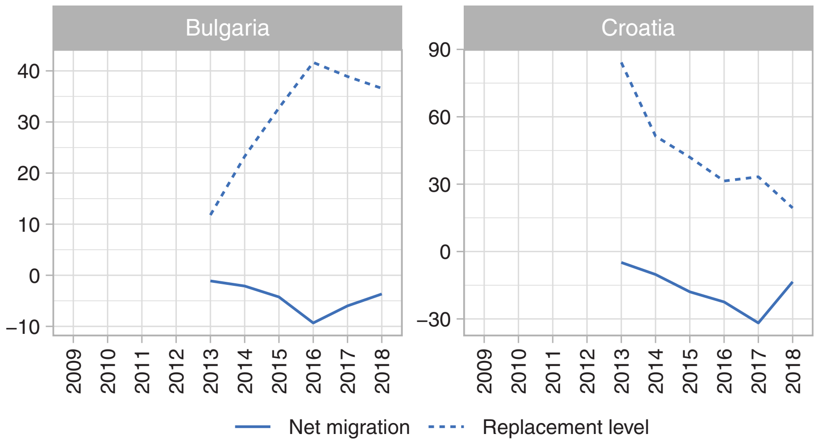


Source: Author's calculations based on Eurostat (2021).

5.7 Balkan countries

Similar to the patterns observed in Latvia and Lithuania, in Bulgaria and Croatia, net migration was negative for all of the years considered (Figure 7). In both countries, under conditions of constant fertility, mortality and migration, population size would fall to zero over the long run. In Bulgaria, the net migration replacement level in 2018 was significantly lower than the (0.66% of the population, i.e., minus natural increase) net migration level, which would have produced zero growth in that year (Tables 1 and 2). The TFR in Bulgaria fell rapidly over the 1988–1997 period to reach a very low level (1.09). While the TFR partially recovered over the 1997–2009

Figure 7:
Net migration and net migration replacement level (000s) Bulgaria 2013–18 and Croatia 2013–18



Source: Author's calculations based on Eurostat (2021).

period, it changed very little over the 2009–2018 period (Eurostat, 2020; Frejka and Gietel-Basten, 2016). The observation that the net migration replacement level in 2018 in Bulgaria was significantly lower than the level that would have immediately produced zero growth may be attributed to the latter having been affected by the impact of past very low fertility (and other factors) on the age structure, whereas the net migration replacement level was influenced by the TFR in 2018 (1.55) having been significantly higher than it was in previous years, and the value of this measure is unaffected by the population age structure. In contrast, in Croatia, the net migration replacement level in 2018 was only marginally higher than the net migration level that would have produced zero growth in that year (Tables 1 and 2).

6 Discussion

The feasibility of preventing long-run population decreases through sustained changes to immigration differs from country to country within Europe. For a considerable number of mostly northern and western European countries, the use of net migration to prevent long-run population declines would appear perfectly feasible. The recent levels of net migration in Sweden, Iceland, Belgium and Luxembourg have consistently been well above the net migration replacement levels. Assuming their fertility and mortality rates and net migration levels remain constant, the populations of these countries will grow considerably larger. In Germany and the Netherlands, a continuation of 2018 patterns would lead to population increases over the long run;

but a reversion of net migration to the lower levels observed in some of the years in the 2009–17 period would, if sustained, lead to population decreases over the long run. In Switzerland, Norway and Denmark, reverting to and sustaining net migration at certain recently observed levels would be sufficient to prevent population decreases over the long run, assuming neither fertility nor life expectancy decreases. None of these countries faces the prospect of immediate population declines.

By contrast, in all of the eastern European countries considered and in Finland and Italy, the population is projected to decrease considerably if net migration, fertility and mortality remain constant at 2018 levels. Indeed, in some of these countries,[22] extinction would occur over the long run if net migration, fertility and mortality remain constant. The populations of Estonia, Czechia and Slovakia have grown in recent years. In some of these countries that have net migration consistently below the replacement level, the influence of the age structure on natural increase means that net migration below the replacement level would suffice to temporarily prevent a population decrease in the immediate future. However, assuming fertility and mortality remain constant at 2018 levels, none of the net migration levels observed over the 2009–2018 period (if sustained) would prevent population decreases over the longer run. Nonetheless, on a per capita basis, even the highest net migration replacement level (observed in Italy) is lower than the net migration per capita recently observed in Sweden. Could any of the countries with net migration consistently below the replacement level consistently emulate the recent high net migration rates recorded in Sweden, and thereby prevent population decrease? In Italy, this would entail maintaining a level of net migration that would exceed any of the levels it recorded before the Great Recession. In most of the eastern European countries included in this study, on a per capita basis the 2018 replacement level of net migration that, if sustained, would prevent a long-run population decrease is no higher than the net migration per capita that was actually recorded in 2018 in Germany, the Netherlands and Switzerland. Whether these countries in eastern Europe, which are poorer and are often less liberal in terms of attitudes towards immigrants, would be able and willing to sustain net migration at a rate that is comparable to the rates observed in northern and western European countries, which are richer, more welcoming, and therefore more attractive to immigrants, appears doubtful (Janicki and Ledwith, 2021; Kreko and Enyedi, 2018). Moreover, given the freedom of movement within the EU, even if larger numbers of immigrants were to be admitted to these countries, many of them might not stay (Lindley and Van Hear, 2007).

The prevention of long-run population declines is not synonymous with increases in net migration: this aim could, at least in theory, be achieved by increases in either fertility or life expectancy (Parr, 2021). A resumption of the pre-Covid-19 trend of general decreases in mortality rates over time would tend to reduce net migration replacement levels. Further declines in fertility levels would increase the

22 Specifically, Bulgaria, Croatia, Latvia and Lithuania.

net migration replacement level, whereas future increases in fertility levels would have the opposite effect. This paper's results for Germany illustrate that increases in ages at birth can reduce the net migration replacement level. The recent reductions in fertility at younger reproductive ages observed in many European countries, and the related possibility that period tempo effects have distorted the TFR downwards, is one of the reasons why future increases in in the TFR in European countries should not be ruled out completely (Bongaarts and Sobotka, 2012). As was observed in Germany between 2011 and 2018, if such a 'recuperation' of cohort fertility occurred, the associated reduction in the net migration replacement level would be the product of both a 'TFR level effect' and an 'age at birth effect'. The potential contribution of the latter type of effect to preventing population decreases may not be widely recognised and warrants further investigation.

The expressed aim of a considerable number of governments of European countries to 'raise fertility' is another reason why future fertility increases should not be ruled out (UNDP, 2019b). The evidence on the effects of public policies on fertility rates appears mixed, and has been much debated in the literature (Bergsvik et al., 2021; Frejka and Zakharov, 2013; Gauthier, 2007; Parr and Guest, 2011). In the eastern European countries where net migration is positive and below the replacement level (i.e., Czechia, Estonia, Hungary and Slovakia) and in Italy, the constant TFR that, in combination with constant net migration at its current (i.e., 2018) level would produce long run zero population growth lies within the 1.78–1.99 range. In other eastern European countries, such as Bulgaria, Croatia, Latvia and Lithuania, fertility above the (NRR below1) replacement level will be needed to prevent long-run population decreases if the current negative levels of net migration continue (Parr, 2021). Given the lack of convincing evidence that public policies have achieved large and sustained increases in fertility, the prospect that fertility will increase to the required levels appears implausible in most, if not all, of these countries.

While this paper has only illustrated net migration replacement levels corresponding to certain recently observed combinations of fertility and mortality, the method may also be used to simulate what the net migration replacement level would be under other 'what if' scenarios for future fertility and mortality. For example, this paper's method may be used to simulate the stationary population sizes and net migration replacement levels corresponding to assumptions used in well-respected projections, such as those of the United Nations, or the effects of a 'recuperation' of fertility on such outcomes (Bongaarts and Sobotka, 2012; UNDP, 2019a). Such simulations have the potential to enhance our understanding of population dynamics. Indeed, the current understanding of the results of population projections may be buttressed by the comparison of assumed fertility-mortality-net migration combinations to net migration replacement levels. For example, the projected increase for the population of Sweden shown by the UNDP (2019a) medium variant could be explained by showing that it involves above replacement level combinations of net migration, fertility and mortality throughout the projection period.

This paper's method for estimating the net migration replacement level offers a number of advantages over other approaches that have been used in the literature.

First, it simply and immediately conveys the implications of the net migration level for long-run population growth; there is no need to refer to (or to run) projections to see whether net migration would generate long-run population growth. Second, this paper's estimation of 'replacement migration' is based on a flat level for net migration, as opposed to the (implausible and irregular) time-varying trajectories produced by the UNDP method (Bijak et al., 2013; Craveiro et al., 2019; UNDP, 2000). This paper's simpler trajectory for net migration may be better suited to informing public debates and deliberation on policy formulation relating to immigration levels. Third, the 'same as the current' total population scenario this paper's method considers may be more closely aligned with public perceptions of zero population growth than the zero growth of the female reproductive age population plus momentum-driven changes (more commonly increases) to the population at older ages that would occur under a cohort replacement scenario (Berelson, 1990). Fourth, unlike the cohort-based methods, this paper's method can illustrate the implications of observed year-to-year variation and simulations of plausible future changes in fertility and mortality for the net migration replacement level. Finally, this paper's method refers to the long-run sustainability of the population size, as opposed to maintaining a constant size over an (arbitrarily chosen) shorter period.

Certain properties of this paper's estimates of replacement migration are worth noting. First, in combination with constant fertility and mortality, a projection with constant replacement level net migration will ultimately approach ('asymptotically boomerang' towards) its initial size. However, the projected population size will differ somewhat from its current level in the interim. Thus, while constant net migration at the replacement level (combined with constant fertility and mortality levels) may be a recipe for little change in the population size, it is not a recipe for a perfectly flat trajectory for population size. Second, while equal in size, the stationary population generated by constant replacement level net migration has a different age structure to that of the current population. The stationary population will generally be older than the current population, because it will be shaped by current levels of fertility and mortality, which are lower than the past levels that have shaped the current population. Thus, the 'replacement' stationary population typically has fewer people in the younger age groups and more people in the older age groups than the current population. Third, this paper considers migration formulated as the difference between immigration and emigration counts (as used in population projections by, for example, the UNDP, 2019a and the ONS, 2022). This paper's method may be modified to consider the formulation of migration as a combination of the immigration counts and a rate of emigration, as used in the Eurostat (2020) projections;[23] or formulations in which immigration counts and emigration and

23 Eurostat (2020) formulates emigration assumptions in terms of age-sex-specific rates, and further disaggregates projected emigration by destination country. While assumed immigration by age and sex is independent of the number of immigrants by age and sex in the destination country, it is dependent on the projected emigration by destination country. The net migration replacement level is a measure that is based on data for a single year: i.e. it is not a projection.

fertility rates differ between the foreign-born and the native-born (Feichtinger and Steinmann, 1992; Rogers, 1990).

While the value of the net migration replacement level is derived from real and recent data, as with other synthetic measures, such as period life expectancy at birth, the TFR and the net reproduction rate, the interpretation of its value assumes hypothetical future stability in all data input values. As is the case for any other pre-specified scenario for the long-run future, fertility and mortality are highly unlikely to remain stable at the recently observed levels. Nonetheless, for demographers to just vaguely refer to the possibility that some positive net migration level could counterbalance the effect of below replacement level fertility on population size, without providing any indication of what that level might be, would not be particularly useful to public debate or deliberation on policies relating to population decreases. Furthermore, in the absence of quantification, inappropriate or even alarmist characterisations of the migration level that would prevent population decrease in the absence of a TFR close to the replacement level may pass without due scrutiny. This paper's results offer not only a quantification, but also international contextualisation of the requisite levels. For example, rather than being characterised as 'massive', as has been done, for example, by Demeny (2016), the net migration that would prevent long-run population decrease for any of the countries covered in this paper may be seen as 'on a per capita basis no greater than the typical (pre-Covid-19) levels of net migration of Sweden, Canada and Australia' (UNDP, 2019a). When seeking to answer the question of whether the replacement migration level of Italy, for example, is 'unmanageable', it might be useful to consider the apparent success of the management of such per capita levels of net migration in these other countries (Gesano, 1994).

While it is hoped that the presentation of net migration replacement level in this paper will enhance the understanding of population dynamics for the populations it has considered, it should not be assumed that the replacement level is necessarily the most desirable level for net migration, or that the 'optimum' population size is the current population (Parr and Guest, 2014; Striessnig and Lutz, 2013). The social evaluation of migration levels should extend beyond a consideration of their implications for the trajectory of population size to also take into account their implications for a range of other population-related outcomes, including age structure, spatial distribution, human capital, labour force participation and productivity (Lutz and Gailey, 2020; Guest and Parr, 2020; Parr and Guest, 2020). In theory, such evaluations should consider a wide range of both economic and non-economic (e.g., environmental) aspects of the effects of migration on human (and, some would argue, other species') wellbeing, the impact of migration on both the origin countries and the destination countries of migrants, how the differing effects of migration on different population subgroups (particularly disadvantaged subgroups) and intergenerational equity are weighed up, and how these effects are considered across long periods of time (Parr, 2018). Such broader considerations are beyond the scope of this paper.

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How much would reduced emigration mitigate ageing in Norway?

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Abstract

Population ageing is a topic of great concern in many countries. To counteract the negative effects of ageing, increased fertility or immigration are often proposed as demographic remedies. Changed *emigration* is, however, rarely mentioned. We explore whether reduced emigration could mitigate ageing in a country like Norway. Using cohort-component methods, we create hypothetical future demographic scenarios with lower emigration rates, and we present (prospective) old-age dependency ratios, population growth and shares of immigrants. We also estimate how much fertility and immigration would have to change to yield the same effects. In different scenarios, emigration is reduced for the total population and for subgroups, while also taking into account that reduced emigration of natives will entail reduced return migration. Our results show that even a dramatic 50% decrease in annual emigration would mitigate ageing only slightly, by lowering the old-age dependency ratio in 2060 from 0.54 to 0.52. This corresponds to the anti-ageing effect of 15% higher fertility, or one-quarter extra child per woman.

Keywords: emigration; ageing; population size; population projections; population policy

1 Introduction

Ageing is a challenge facing low-fertility countries across the world. According to the United Nations (2022a), the number of people aged 65 years or older worldwide will more than double from 771 million in 2022 to 1.6 billion by 2050. In Europe and North America as well as in Eastern and South-Eastern Asia, more than 25% of the

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population will be aged 65 years or older by 2050 (ibid). The old-age dependency ratio (OADR), which equals the number of persons aged 65 years or older divided by the number of persons aged 20 to 64 years (the "working ages"), is also projected to increase from 0.17 in 2022 to 0.29 in 2050 worldwide. In Eastern and South-Eastern Asia and in Europe and North America, the OADRs in 2050 are expected to be around 0.5, or 50 persons aged 65+ per 100 persons aged 20–64 (United Nations, 2022b). In Norway – the country this paper focuses on – the OADR is expected to increase from 0.3 in 2020 to almost 0.5 in 2050 (Syse et al., 2020; Thomas and Tømmerås, 2022).

Population ageing may pose challenges for countries at multiple levels. A larger elderly population relative to the population of working ages is likely to increase the pressure on public and private old-age support and transfer systems as well as on the health sector (OECD, 2021; United Nations, 2020a). It is feared that future long-term care demands will exceed the resources of the family, the welfare state and other caregivers, both in quantity and in complexity (Lorenzoni et al., 2019; Muir, 2017), which could, in turn, affect the sustainability of the welfare state (OECD, 2019). Hence, the prospect of higher OADRs has been met with concern in many countries, particularly in the Western world and in Eastern Asia.

Several measures for managing the consequences of population ageing have been discussed. Some of these are non-demographic, such as lifelong education and health care for all, facilitating savings and healthy lifestyles, promoting employment among women and other low-employment groups, and raising retirement ages. Other measures are aimed at altering the demographic trends by directly affecting the determinants of demographic change.

1.1 Demographic remedies for ageing

Although there are several determinants of demographic change in a country – fertility, mortality, immigration and emigration, working in tandem with the age and sex distribution, to shape the future size and composition of the population – in most national policy debates concerning population ageing, only fertility and immigration are discussed. However, both of these "remedies" have drawbacks that warrant consideration.

The decline in *fertility* to below two children per woman has been met with concern in many advanced economies (Sobotka et al., 2019). In 2015, 66% of European governments and almost 40% of Asian governments had policies in place to raise fertility or impede further decline (United Nations, 2018). However, substantial long-term fertility increases are difficult to achieve. Policies aimed at increasing fertility tend to have a larger effect on the timing of births than on the total number of children born (Bergsvik et al., 2021). Although studies have found some correlation between extensive public support to families and higher fertility (e.g., Wood et al., 2016), the answer to the question of whether the higher fertility is caused by the costly policies or by favourable economic conditions that made such policies possible is not obvious.

And although (quasi-)experimental studies have suggested that certain policies may affect fertility, the future effects of these measures may be limited if their coverage is already wide (such as day-care in many Western countries), or these measures may have unwanted side effects, such as reducing female employment (Bergsvik et al., 2021). Moreover, changed fertility is linked to questions about climate and global sustainability. Higher fertility and, hence, a larger world population will make it more challenging to meet global food needs and to reduce global warming and biodiversity loss (Bongaarts, 1992; Bongaarts and O'Neill, 2018; Casey and Galor, 2017; Crist et al., 2017; O'Neill et al., 2010; Reher, 2007; Tamburino et al., 2020; Wilmoth et al., 2022; Wynes and Nicholas, 2017).

Increased *immigration* can reduce population ageing in the short term, since immigrants often arrive in their twenties or thirties. However, measures to increase immigration may be politically controversial. Furthermore, increased immigration has limited effects on ageing in the long term, because immigrants who remain in the destination countries also get older. Studies on replacement migration have generally concluded that to prevent low-fertility countries from experiencing demographic ageing, the volumes of immigration – or positive net migration – that would be required would have to be far higher than in the past, and would likely be politically unfeasible (Bijak et al., 2008; Blanchet, 1989; Heleniak and Sanchez Gassen, 2016; Paterno, 2011; United Nations, 2001). In the long run, immigration has tended to affect population size far more than its age structure (Alho, 2008; Bujard, 2015; Murphy, 2016); and in the even longer run, stable population theory posits that populations with sustained below-replacement fertility and constant immigration eventually become stationary, with age structures that depend on the distribution of the immigrants' arrival ages (Arthur and Espenshade, 1988; Espenshade et al., 1982; Schmertmann, 1992).

For completeness, we should also mention the effect of *mortality* on population ageing. If the long-term trend of mortality decline halts, or if mortality increases, especially in the older age groups in which deaths most commonly occur, population ageing would be counteracted. As shown by Lutz and Scherbov (2003), future old-age dependency ratios are sensitive to different future mortality trends. However, measures to actively prevent further increases in remaining life expectancies are not on the political agenda, and are unlikely to be proposed.

The literature on how changed *emigration* can affect future ageing in a Western country like Norway is scarce. There are several potential explanations for why this is the case. First, many of today's ageing nations are characterised by more immigration than emigration, and while immigration has received considerable scholarly attention, there is much less research on emigration from Western countries. Second, as data on emigration are often inadequate, and many countries and agencies instead rely on net migration figures when, for instance, projecting future migration (Cappelen et al., 2015), it is difficult to make projection scenarios in which only the rates of emigration change.[1] Third, given that leaving a country is now considered a fundamental human right, reduced emigration may be considered equivalently hard to achieve (and as controversial) as the other demographic components mentioned above. Nevertheless, countries have policies in place that may affect the incentives to emigrate or to stay, as we discuss towards the end of this paper.

The scarcity of research on emigration from wealthy countries, including on its effect on ageing, is mirrored in a lack of interest from policymakers in Western countries.[2] It is, however, documented that emigration (or negative net migration) can affect ageing in some typical net emigration countries, such as in Central American countries in close proximity to the United States (García-Guerrero et al., 2019) and in Eastern European countries (Botev, 2012; Fihel et al., 2018; Philipov and Schuster, 2010; Potančoková et al., 2021; Rees et al., 2012). Although emigration usually makes a population older, whether this is actually the case depends on the ages of those who leave and of those who remain (Gavrilov and Heuveline, 2003; Parr, 2021), and on the fertility and mortality of the emigrants and of those who remain (García-Guerrero et al., 2019).

Over the last decades, several studies have presented comprehensive scenarios for Europe's population development and ageing with different sets of assumptions regarding – among other factors – emigration and immigration, or net migration (Bijak et al., 2008; Marois et al., 2020; Potančoková et al., 2021; Rees et al., 2012). These studies often applied different scenarios for intra-EU (or intra-European) migration and migration between EU/Europe and the rest of the world, and they based their emigration scenarios on observed emigration rates (which may be adjusted up or down in different scenarios). In the scenarios, changed intra-EU emigration *from* one country would affect intra-EU immigration *to* another EU country, making it hard to estimate how a change in emigration only would affect a country's ageing rate.

This paper assesses whether reduced emigration could mitigate a country's population ageing challenges, using Norway as a case study and applying the official model for population projections employed by Statistics Norway. This model uses high-quality register data covering the entire population, and it allows us to estimate the effects of changed emigration, rather than of changed net migration only. Moreover, it allows us to explore how much each of the other components of demographic change (fertility, mortality and immigration) need to change in order to yield the same effects on ageing as reduced emigration. To our knowledge, this has not been done in the literature before. We show how reduced emigration affects a multitude of population measures, including the share of immigrants in

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1 Many also provide a "zero net migration" alternative, often used to calculate the demographic effects of migration. This may, however, be misleading (Bouvier et al., 1997), since different people leave and enter the country during a given year.

2 At the regional level, however, a number of policies have been implemented that aim to directly affect out-migration from shrinking and ageing parts of the country.

the population and other indicators of ageing, such as the prospective old-age dependency ratio (POADR). Furthermore, we add to the literature by estimating how reduced emigration for certain subgroups only would affect the different measures of ageing and the immigrants' share, while also taking into account that the reduced emigration of natives would result in lower return migration back to Norway.

1.2 The Norwegian context

The ageing trend in Norway is similar to that of many other Western countries. Of the Norwegian population of about 5.4 million in 2022, elderly aged 65 or older comprised 18%. As shown in Figure 1, the Norwegian population is expected to continue to grow in the future, but at a slower pace than in the previous decades. The share of elderly (aged 65+) is projected to increase to 26% by 2050, and the OADR is projected to increase from 0.31 today to 0.49 in 2050, according to the main alternative in Statistics Norway's 2020 population projections (Syse et al., 2020). This is shown in the lower left panel of Figure 1. The lower right panel of the figure shows that both immigration and emigration have increased considerably over the last decades, and that they are expected to remain at relatively high levels in the future, with more immigration than emigration.

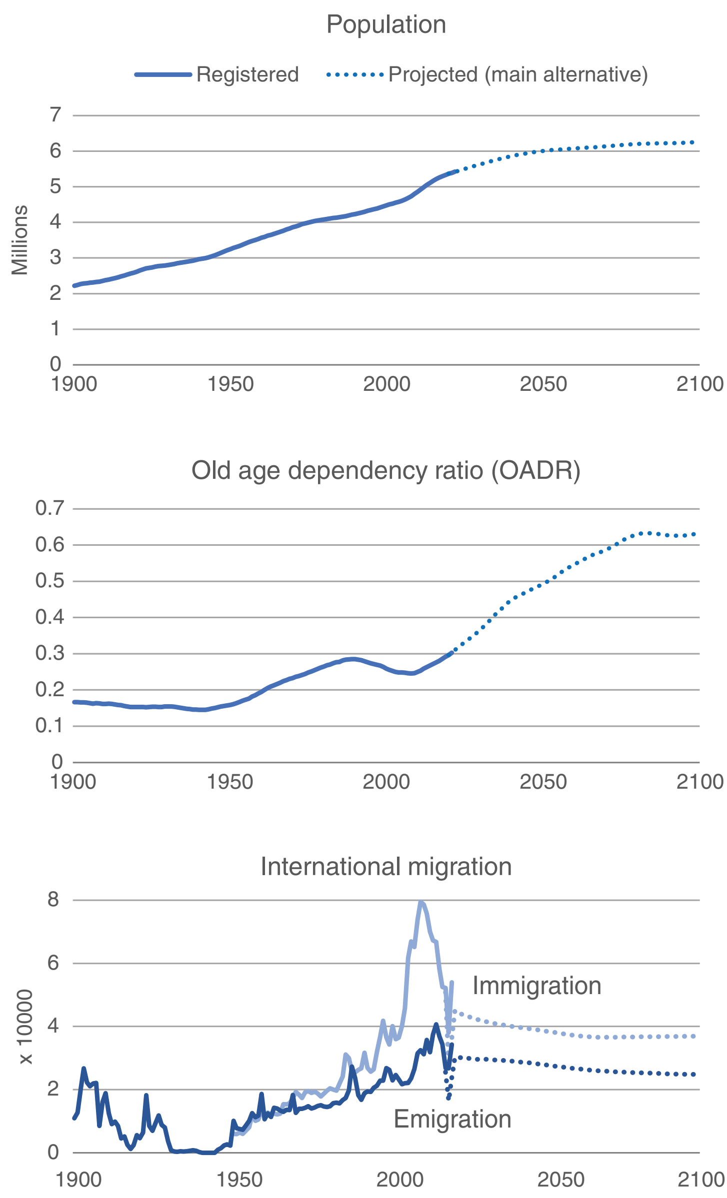
Like in many other countries, policymakers in Norway worry about the consequences of population ageing. In 2019, the prime minister expressed concerns about declining fertility (the Norwegian TFR decreased from almost two in 2009 to around 1.5 in 2019), and encouraged Norwegian couples to have more babies (Solberg, 2019).

Changes in emigration have not been part of the Norwegian discourse about remedies for ageing. However, as Figure 1 shows, about 30,000 individuals emigrate from Norway every year. This corresponds to about five emigrations per 1000 inhabitants. That rate is higher than the crude emigration rates of some other European countries, like Italy, Portugal and France, but it is clearly lower than the rates of other countries, such as Iceland, Switzerland, Ireland and Lithuania (see Figure 2).

Around 70% of emigrants from Norway are persons who have previously immigrated to Norway, while 30% are non-immigrants (natives). Most of the immigrants who emigrate have relatively short durations of stay in Norway, and immigrants from other Western countries have higher emigration rates than refugees and family migrants from less wealthy parts of the world. While most non-native emigrants return to their country of origin, especially if they are Nordic, the share of those who move on to a third country is also relatively high (almost 50%) among immigrants born in a less wealthy country such as Pakistan, Vietnam or Somalia (Pettersen, 2013; Skjerpen et al., 2015).

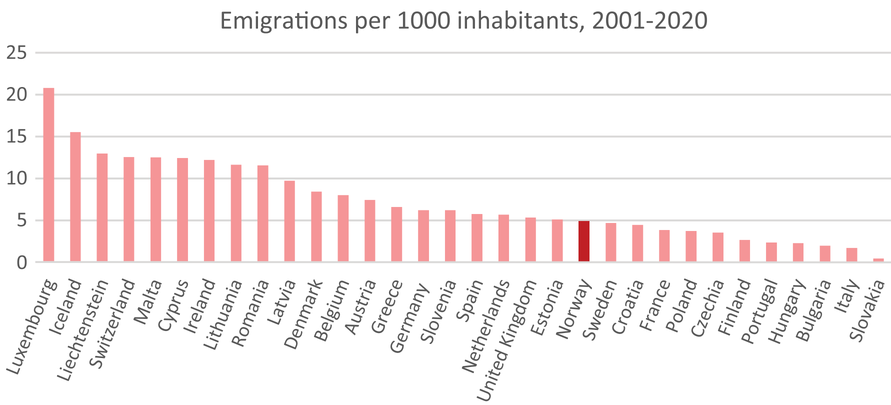
Most emigrants from Norway are 20–40 years old or below age 10 when they leave Norway. As summarised in Figure 3, the mean age of people who emigrate from Norway is almost 30 years, which is about five years higher than the mean age

Figure 1:
Norwegian population size, OADR, immigration and emigration 1900–2100 (projected in the 2020 main alternative)



Source: Statistics Norway.

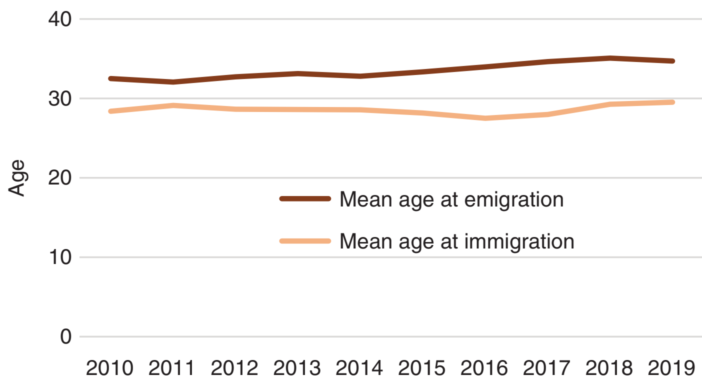
Figure 2:
Emigrations per 1000 inhabitants, 2001–2020



Source: Eurostat.

of those who immigrate. This age difference also means that women who emigrate have on average fewer remaining years for childbearing than women who immigrate. Appendix Figure A.1 shows emigration by age, in absolute numbers and per 1000, for immigrants and natives (non-immigrants). The figure indicates that the emigration rates are clearly higher for immigrants than for natives, at all ages.

Figure 3:
Mean age at emigration from and immigration to Norway, 2010–19 (based on immigrations and emigrations at ages 0–90 years)



2 Data and methods

In this study, we apply the projection model used in the official Norwegian population projections. Here, we first present the official model, and then explain how we use this model to explore the demographic effects of changed emigration rates.

2.1 The Norwegian population projection model

The Norwegian population projections are based on detailed data from the Norwegian population register, which has data on all immigrations and emigrations at the individual level, as well as on other demographic events. The projections, and the data and methods used, are further described by Syse et al. (2020). In short, the model applies deterministic cohort-component methods, and emigration is projected using registered emigration rates (the last 10 years) for different subgroups by age, sex, immigrant background and (for immigrants) area of origin (see Footnote 3) and duration of stay in Norway.[3] Future emigration from Norway is calculated from these fixed rates being applied to the projected future population of Norway. Emigration is projected to decrease slightly (cf. Figure 1 and Appendix Table A.1), mainly because of a declining share of immigrants with a short duration of stay. The other components of population change (fertility, mortality/life expectancy and immigration) are projected using a mix between expert judgements and separate models (Lee-Carter/ARIMA for mortality and a separate econometric model for immigration, Cappelen et al., 2015). Future immigration is calculated separately for three different origin areas (Western countries, Eastern EU and the rest of the world; see specification in Footnote 3), as well as for natives returning to Norway. While the total fertility rate (TFR) is projected to increase from 1.5 to a long-term level of about 1.7 children per woman, and life expectancy is projected to increase from around 81 years for men and 85 years for women to 89 and 91 years, respectively, in 2060, future immigration to Norway is projected to decline somewhat, from around 52,000 to a long-term level of around 37,000 annually.

As most emigrants are of childbearing age (cf. Appendix Figure A.1), lower emigration will also affect the number of births, since people who do not emigrate experience age- and sex-specific probabilities of both giving birth and dying.

[3] An "immigrant" is defined as a foreign-born person with two foreign-born parents and four foreign-born grandparents who has immigrated to Norway to stay for at least six months. The areas of origin are (i) *Western countries*, which comprises all of the Western European countries, i.e., countries that were part of the "old" EU (pre-2004) or the EEA and the EFTA, as well as the US, Canada, Australia and New Zealand; (ii) *Eastern EU*, which comprises the 11 countries in Eastern Europe that became EU members in 2004 or later (Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bulgaria and Romania); and (iii) the *rest of the world*, e.g., the rest of Eastern Europe, Africa, Asia (including Turkey), South and Central America and Oceania (excluding Australia and New Zealand). The legal opportunities for entering Norway and the demographic behaviour differ somewhat for immigrants from the three origin country groups. For more details, see Syse et al. (2020), box 7.1.

Whereas the age- and sex-specific probabilities of dying are the same for all subgroups in the model, the fertility rates differ between immigrants and the rest of the population, and (for immigrants) by area of origin and duration of stay in Norway.[4]

2.2 How we use the model to explore changes in emigration

In this paper, we use the official medium projections ("main alternative") as a baseline. In our first investigation of how reduced emigration affects ageing, we run the projection model with a hypothetical scenario in which all emigration rates are reduced by 50%, while the baseline assumptions are used for all the other components (i.e., fertility, mortality and immigration). Second, we run the model while changing each of the other components of demographic change (one at a time), with the aim of obtaining the same OADR in 2060 as the 50% reduction in emigration rates. We also explore the (even more) hypothetical scenario in which all emigration from Norway is stopped. Furthermore, we investigate the effect of a reduction in emigration rates for certain subgroups only (immigrants vs. natives, younger vs. older age groups).

The changes in the demographic components employed in these scenarios are large, and are, admittedly, not the most plausible ones. However, the relationships between them may provide useful information about whether a change in emigration could be an anti-ageing formula. To apply somewhat more realistic scenarios, we also make projections in which emigration is reduced for both immigrants and their Norwegian-born children, and one in which 50% lower emigration among natives leads to 50% lower return migration of natives, due to the smaller "pool" of native Norwegians living abroad. In all the other scenarios, the assumptions about future immigration to Norway are the same as in the official population projection (our baseline).

To summarise, we run the population projection models until 2100 with the following scenarios:

- The official projections' main alternative – our baseline scenario
- 50% lower emigration rates (for the whole population)
- Higher immigration (that yields the same OADR in 2060 as 50% lower emigration)
- Higher fertility (that yields the same OADR in 2060 as 50% lower emigration)
- Higher mortality (that yields the same OADR in 2060 as 50% lower emigration)
- No emigration (for the whole population)
- 50% lower emigration rates for certain subgroups only:
    - Only older persons (aged 50+)
    - Only younger persons (aged 0–49)
    - Only immigrants (all ages)

[4] Although emigrants in real life may be selected on fertility, as has been shown by Anelli and Balbo (2021) for Italy, the Norwegian population projection model does not account for such a phenomenon.

- Only immigrants and immigrants' children
- Only natives
- Only natives, with 50% lower return migration of natives

In each scenario, we explore the following measures of population change (# indicates number of persons):[5]

- Old-age dependency ratios (OADR) – # aged 65 years+/# aged 20–64 years
- Prospective old-age dependency ratios (POADR) – # in age groups with life expectancies of 15 or fewer years/# aged 20+ years with life expectancies greater than 15 years
- Population count – the size of the population
- Share of immigrants in the population – all immigrants and by three different areas of origin (see Footnote 3).

Table 1 shows historical figures of the above measures of ageing and the immigrants' share for 2020 (the baseline year for our projections) and 2022 (the most recent year).

In addition to the measures listed above, we assess how the future numbers of births, deaths, emigrations and immigrations differ between the scenarios (statistics for 2020 and 2022 are displayed in Table 1, whereas the results from the respective scenarios are shown in Appendix Table A.1).

3 Results

3.1 Reducing emigration by 50% will slow OADR growth by 10%

The results from our first analyses, in which the baseline (the main alternative from the official population projections) is compared with a scenario with 50% lower emigration rates, show that this reduction decreases the old-age dependency ratio (OADR) in 2060 from 0.54 to 0.52 (Table 2). This is still clearly higher than today's 0.31. Hence, with 50% lower emigration, the increase in the OADR from 2020 to 2060 would be 10.4% lower than in the baseline alternative.[6] Other ageing measures (median age, share aged 65+ years and aged 20–64 years and the TDR, see Appendix Table A.2) show a similar pattern, with 50% lower emigration leading to only a slim reduction in ageing. Moreover, the prospective old-age dependency ratio (POADR), which is designed to account for changes in longevity so that the threshold between "working age" and "old" changes as people live longer (Sanderson

5 We also investigate effects on some other measures of ageing; median age, share of population aged 65+ years and aged 20–64 years and total dependency ratio (TDR). These results are shown in the Appendix.

6 This calculation is based on non-rounded figures of the OADRs in 2020 (0.2964), baseline 2060 (0.5432) and the 50% lower emigration scenario in 2060 (0.5175).

Table 1:
Descriptive statistics, measures of ageing, population size and population composition in Norway, 2020 and 2022

	Registered statistics	
	2020[a]	**2022[a]**
Old-age dependency ratio (OADR)	0.30	0.31
Prospective old-age dependency ratio (POADR)	0.16	0.14
Population count (Pop count)	5,367,600	5,425,300
Percentage share of immigrants in the population (Share imm)	14.7	15.1
. . . from Country Group 1 (Western)	3.0	3.1
. . . from Country Group 2 (EastEU)	3.6	3.7
. . . from Country Group 3 (RestWorld)	8.1	8.3
A description of component changes[b]		
Emigrations	25,600	33,300
Immigrations	50,900	53,000
Net migration	25,300	19,700
Births (# and TFR)	54,500 (1.53)	56,100 (1.55)
Deaths (# and e_0)	40,700 (82.9)	42,000 (83.2)

Notes: Population counts have been rounded to the nearest 100. [a]Status per 1 January for all population count figures, whereas figures pertaining to the components reflect changes in the previous year, i.e., 1 January 2019–31 December 2019, and similarly for 2021. [b]The figures shown are those used in the projections, and they differ slightly from the registered figures. This pertains to immigrations and emigrations, since multiple migrations are removed (but the net migration is comparable), as well as to life expectancy at birth (e_0), which is calculated slightly differently, and is based on end-of-year ages at death.

and Scherbov, 2010), is only slightly affected: i.e., it goes down from 0.22 to 0.21, compared with 0.16 in 2020. In 2100 (lower part of Table 2), when many of the "emigrants" who never left will have grown old, the OADR in the scenario with 50% lower emigration (0.62) is even closer to the baseline OADR (0.63). Even a total stop of all emigration from Norway (right column in Table 2) only reduces the OADR from 0.54 to 0.49 in 2060 and from 0.63 to 0.60 in 2100.

3.2 A 50% reduction in emigration corresponds to 25% more immigration or one-quarter child more per woman

Table 2 further shows that reducing emigration rates by 50% would have the same effect on ageing in 2060 (OADR of 0.52) as increasing the annual immigration by 25%, increasing all mortality rates by 20%, or increasing the total fertility rate (TFR) by 15% – which corresponds to one-quarter child per woman for natives (from 1.70 to 1.95).

While the effects of increased immigration or increased mortality are relatively similar to those of decreased emigration on most of the different ageing measures,

Table 2:
Population projections for Norway in 2060 and 2100 in the official scenario (baseline), in a scenario with 50% lower emigration, and in scenarios with changes in the immigration, fertility and mortality assumptions (that yield the same OADR in 2060 as 50% lower emigration)

		Baseline	Emigration −50%	Immigration +25%	Fertility +15%	Mortality +20%	No emigration
	2020	**2060**					
OADR	0.30	0.54	0.52	0.52	0.52	0.52	0.49
POADR	0.16	0.22	0.21	0.21	0.22	0.20	0.19
Pop count	5,367,580	6,127,100	6,736,800	6,491,100	6,506,200	6,026,800	7,524,400
Share imm	14.7	19.0	21.5	20.9	17.9	19.0	24.5
. . .Western	3.0	3.1	4.2	3.5	2.9	3.1	5.8
. . .EastEU	3.6	4.0	4.5	4.3	3.8	4.0	5.2
. . .RestWorld	8.1	11.9	12.8	13.1	11.2	11.9	13.5
	2020	**2100**					
OADR	0.30	0.63	0.62	0.61	0.57	0.61	0.60
POADR	0.16	0.24	0.23	0.23	0.21	0.22	0.22
Pop count	5,367,580	6,349,300	7,503,100	7,057,800	7,402,200	6,265,800	9,118,400
Share imm	14.7	16.8	18.9	18.8	14.4	16.7	21.4
. . .Western	3.0	2.8	4.0	3.2	2.4	2.8	5.7
. . .EastEU	3.6	2.5	2.8	2.7	2.1	2.4	3.2
. . .RestWorld	8.1	11.5	12.1	12.9	9.9	11.5	12.5

Notes: The population counts have been rounded to the nearest 100. For additional age measures (median age, total dependency ratio (TDR), share aged 65+ years, share aged 20–64 years) see Appendix Table A.2.

increased fertility stands out as having a more rejuvenating long-run effect. This can also be seen in Appendix Figure A.2 and in the age profiles in Appendix Figure A.5. The effect of increased fertility on the OADR occurs later (when the additional children start reaching their twenties) and lasts longer than in the other scenarios. Hence, whereas reduced emigration may postpone the rise in the OADR in the first decades, increased fertility reduces the ageing challenges more in the long run.

Moreover, reduced emigration has a stronger effect on population growth than the other scenarios. In the −50% emigration scenario, population growth from 2020 to 2060 is 80% higher than in the baseline scenario, which is more than in the scenarios with higher fertility or immigration (and is clearly more than in the scenario with increased mortality).

3.3 Less emigration results in more Western immigrants

Different scenarios give different population compositions by immigrant background. The share of immigrants in the population is highest in the scenario with reduced emigration, and the composition of immigrants also changes; the share originating from Western countries (Country Group 1) increases the most (in relative terms), whereas the share originating from the rest of the world (Country Group 3) is higher in the scenario with higher immigration than in the scenario with 50% lower emigration. As Western immigrants have the highest emigration rates, reduced emigration rates would keep a larger share of the relatively mobile Western immigrants from leaving Norway.

The results from the second part of our analyses – in which we investigate the effects of reduced emigration for certain subgroups only – show that the strongest effects on both ageing and population size can be observed when we limit the reduction in emigration rates to those below age 50 (see Table 3, Figure 4 and Appendix Figures A.3–A.5). The effects of the other subgroup analyses are less pronounced for both the ageing measures and the population counts. The effect of the reduced emigration of immigrants (particularly if we include their Norwegian-born children) on population size is larger than that of the reduced emigration of natives, whereas this is not the case for population ageing.

However, if the emigration of natives is lower, the number of natives abroad who can potentially return "home" will shrink. In the scenario in which 50% lower emigration among natives is coupled with 50% lower return migration among natives, the effects on population ageing as well as on population size and composition are minuscule.[7]

The different scenarios presented above also result in different projected numbers of births, deaths, immigrations and emigrations. These are shown in Appendix Table A.1.

Figure 4 illustrates how the different scenarios vary across the two main dimensions in our analyses, population size and ageing (the OADR being our primary measure – for results on the POADR, cf. Appendix Figure A.4). The two upper panels show the projected results for 2060, while the lower panels display the corresponding results for 2100. The left panels compare a 50% reduction in emigration with the corresponding changes in the fertility, immigration and mortality assumptions, while the right panels present a comparison of the reduction in emigration rates across various subgroups. Thus, the figure summarises the main results from our analyses. First, although reducing emigration by 50% can mitigate ageing somewhat (reducing OADRs by around 10%), it will by no means stop it. Second, the anti-ageing effect (in 2060) of 50% less emigration corresponds to that of 25% more immigration or one-quarter child more per woman. Moreover, reduced emigration has a stronger effect on population size than the corresponding changes in fertility, immigration and mortality. Finally, whereas reduced emigration among young people has the strongest anti-ageing effect, reduced emigration among natives has a negligeable impact if lower return migration is also taken into account.

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[7] These results depend in part on whether or not we add a time lag before reducing the return migration. Without a lag (as shown here), ageing is actually slightly higher and population growth is slightly lower than in the baseline alternative.

Table 3:
Population projections for Norway in 2060 and 2100 in the official scenario (baseline), and in a scenario with 50% lower emigration for all and for certain subgroups only, 2060 and 2100

			Emigration rates reduced by 50% for certain groups only						
		Baseline	For all	Only older (50+)	Only younger (0–49)	Only immigrants	Only immigrants +children	Only natives	Only natives, –50% return immigration
	2020	**2060**							
OADR	0.30	0.54	0.52	0.56	0.50	0.53	0.53	0.53	0.55
POADR	0.16	0.22	0.21	0.23	0.21	0.22	0.21	0.22	0.22
Pop count	5,367,580	6,127,100	6,736,800	6,192,100	6,665,000	6,485,600	6,586,400	6,276,600	6,090,500
Share imm	14.7	19.0	21.5	19.6	20.8	22.3	22.0	18.5	19.1
. . .Western	3	3.1	4.2	3.3	4.0	4.3	4.3	3.0	3.1
. . .EastEU	3.6	4.0	4.5	4.2	4.3	4.7	4.6	3.9	4.0
. . .RestWorld	8.1	11.9	12.8	12.1	12.5	13.3	13.1	11.6	12.0
	2020	**2100**							
OADR	0.30	0.63	0.62	0.65	0.60	0.64	0.63	0.62	0.64
POADR	0.16	0.24	0.23	0.25	0.23	0.24	0.24	0.24	0.24
Pop count	5,367,580	6,349,300	7,503,100	6,421,500	7,413,600	6,910,000	7,167,000	6,675,900	6,217,900
Share imm	14.7	16.8	18.9	17.4	18.3	20.5	19.8	16.0	17.2
. . .Western	3	2.8	4.0	3.0	3.7	4.3	4.2	2.7	2.9
. . .EastEU	3.6	2.5	2.8	2.6	2.7	3.0	2.9	2.3	2.5
. . .RestWorld	8.1	11.5	12.1	11.8	11.9	13.2	12.7	11.0	11.8

Notes: The population counts have been rounded to the nearest 100. For additional age measures (median age, TDR, share aged 65+ years, share aged 20–64 years) see Appendix Table A.2.

Figure 4:
Ageing (OADR) and population size in Norway in 2020 and 2022 (black dots) and projected in 2060 (upper panels) and 2100 (lower panels). Scenarios with changes in all demographic components (left) and with 50% lower emigration for subgroups (right)

4 Discussion

Although the scenarios presented above are hypothetical, a comparison of different scenarios can be useful for demographers and policymakers, and can, more generally, inform the public debate on the relationship between emigration, population size and population ageing.

To our knowledge, the previous literature has not provided estimations of how the anti-ageing effect of changes in emigration would correspond to changes in fertility, immigration or mortality, or estimations of how reduced emigration would change a population's share of immigrants.

Our conclusions about the limited effect of emigration on ageing add to the literature that has demonstrated that there are no demographic "solutions" to ageing (and that has tended to focus on other components of demographic change). For instance, Chamie (2022, page 1) called the ageing of human populations "an inescapable demographic future"; and Coleman (2008, page 468) argued that "population ageing cannot be 'solved' ". Potančoková et al. (2021) concluded that declines in the potential labour force and population ageing are clearly unavoidable in all of the EU's macro-regions, and that neither increased fertility nor increased migration are viable strategies for halting population ageing. Thus, these authors advised policymakers to aim to improve economic activity and productivity to accommodate for and adjust to the projected ageing, rather than to attempt to affect the demographic trends directly. Likewise, Marois et al. (2020) concluded that demographic ageing is unavoidable, and recommended that European policymakers instead try to change labour force participation, improve educational attainment and work towards the better economic integration of immigrants.

Our estimates of how much reduced emigration would mitigate ageing in Norway can also be compared to estimates from similar studies on traditional net emigration countries. García-Guerrero et al. (2019) found that future (net) emigration from Central America would have a very limited effect on ageing in Mexico and Honduras, a somewhat larger effect on ageing in Guatemala and the largest effect on ageing in El Salvador. They also showed, however, that even in El Salvador, the no-migration alternative would not prevent ageing, but would merely reduce it (by roughly 15–20%). Furthermore, our conclusion that reduced emigration has a stronger effect on population size than on ageing is in line with results from Potančoková et al. (2021). They found that while zero intra-EU migration would reduce the population decreases in Eastern EU from 18% to 10% and in Southern EU from 8% to 6% by 2060, the effects on the total age dependency ratios would be relatively minor.

4.1 Limitations and strengths

Our conclusions are built on several assumptions that may be questioned. Furthermore, our analyses have other limitations as well. First, our measures of population ageing, dependency and support are relatively simple, relying to a large extent on chronologic age, and not on, for instance, information about whether people are in the labour force, or about their productivity, as this information is not included in the Norwegian population projections. However, ageing and dependencies are not solely driven by demographic factors. When considering the future challenges of ageing societies, the actual "dependency" and "support" of older and younger age groups will be of crucial importance. Other studies (e.g., (Bijak et al., 2008; Marois et al., 2020; Potančoková et al., 2021; Rees et al., 2012) have made projections that also take labour force participation and education into account, and most have concluded that the challenges associated with population ageing are less overwhelming when we consider the likely future development of these factors. For instance, Marois et al. (2020) showed that when labour force participation and education are included as additional variables, the projected increase in the dependency ratios is markedly lower. The authors thus concluded that the fears associated with the coming economic burdens of ageing have been unduly exaggerated by the use of conventional age dependency ratios. Other studies have, however, emphasised that the burdens will be large in terms of health and long-term care (LTC) costs (see, e.g., Marino et al., 2017 for LTC costs and Lorenzoni et al., 2019 for health costs), and in terms of costs relating to old-age pensions, driven primarily by the demographic changes associated with ageing (OECD, 2021). While Lorenzoni et al. (2019) suggested that the demographic effects account for just over a quarter of the projected growth in health expenditures, Marino et al. (2017) pointed out that there may be a stronger relationship between LTC spending and demographic change, given that a high share of LTC patients are elderly.

The OADR – our main ageing measure – appears to reflect the current situation in terms of the number of pensioners relative to the (potential) labour supply fairly well: across the OECD countries, the average effective age of labour market exit was 63.8 years for men and 62.4 years for women, albeit with considerable variation (range: 58.1–68.2) (ibid). Moreover, although the remaining life expectancy at the average age of labour market exit increased sharply between the 1970s and 2000s, it has stabilised over the past two decades as the life expectancy gains in old age have been offset by increases in the age of labour market exit. However, these trends might change in the future, and if we compare our results for the OADR vs. the POADR for the different scenarios, we see that although they largely mirror each other in relative terms (i.e., in both measures, reduced ageing is observed most markedly for the "no emigration" scenario in the first half of the period, before the 15% increase in fertility scenario takes precedence), there are some differences worth noting. For one, the 20% increased mortality scenario limits ageing considerably more when measured by the POADR rather than by the OADR. On the one hand, a benefit of the OADR is that it estimates fairly accurately the future labour supply and number of pensioners, whereas it might reflect health and LTC costs less well. The POADR, on the other hand, is likely to overestimate the future labour supply and to underestimate the future number of pensioners, but it may better reflect expenditures and resource needs relating to health and LTC. The projected life expectancy in Norway is quite high, and by the end of the century, the age cut-off for the numerator in the POADR is 80 years. Even in scenarios with healthy ageing and prolonged working lives, such a high age is unlikely to be relevant for pension and labour supply estimations.

4.1.1 Interlinkages between emigration and other demographic events

To isolate the effects of changes in emigration, we have reduced emigration without changing the other demographic measures of fertility, mortality or immigration in all our scenarios (except for the one in which we also reduce native return migration). As the only interlinkages go through the rates applied in the projection model, the people kept from emigration are subject to the model's fertility and mortality rates, and hence can contribute to the number of births or deaths. Apart from that, in all our core scenarios we have assumed that reduced emigration does not affect fertility rates and mortality rates in Norway, and that it does not affect immigration.

However, in the real world, immigration and emigration are usually closely linked, but the direction in which they are linked is not obvious. On the one hand, they may be positively correlated, as less emigration of natives would mean a reduced "pool" of possible native returnees. This mechanism is what we have tried to capture in the scenario with reduced native return migration. Furthermore, if Norway reduced the attractiveness of emigrating (by, for instance, limiting the welfare entitlements that can be taken out of the country), this could also reduce immigration, because it would likely make it less attractive for temporary migrants to enter the country. Low immigration might also reduce population pressure, and hence reduce incentives for emigration (Coleman, 2008).

On the other hand, lower emigration can go hand in hand with *higher* immigration: if, for example, emigration goes down because life in Norway becomes more attractive, immigration could increase for the same reason. Previous studies have shown that immigration to and emigration from Norway are affected by many of the same macro-economic factors, such as unemployment and income levels in Norway and in the origin countries (Cappelen et al., 2015; Skjerpen et al., 2015), but with the opposite effect, with better conditions in Norway compared to those in other countries leading to increased immigration and reduced emigration.

4.1.2 Generalisability

It is certainly possible to imagine situations in which reduced emigration could limit ageing to a larger extent than we have found, particularly in countries with very high emigration rates. In general, as indicated by Figure 2, emigration rates are often relatively high in countries with small populations, like Luxembourg, Iceland and Liechtenstein. The emigration rates from these countries have recently been around 10–15 per 1000, while Norway's rates have been around five per 1000. Hence, the rejuvenating effect of reducing emigration from these high-emigration countries can be expected to be larger than the 10% reduction in OADR growth that we have found in Norway. However, it would hardly stop the ageing process, in line with the findings of García-Guerrero et al. (2019) for Central America. Furthermore, if the emigrants from these European high-emigration countries are mainly natives who will eventually return, emigration's long-term effect on ageing will be more limited in these countries as well.

4.2 Can policymakers change emigration trends?

Although our results show that lower emigration cannot stop ageing in Norway, measures aimed at reducing emigration could help to address the challenges of population ageing. Hence, a relevant question is whether it is actually possible for policymakers to reduce emigration in a liberal and democratic society like Norway.

Historically, European states have long traditions of regulating the exit of their people. Until the post-World War II period, emigration was not perceived (socially and legally) as a right, and the states were in full control over the international mobility of their subjects (Weinar, 2019). In the post-World War II period, the approach to individual rights changed, and liberal Western democracies made emigration a fundamental human right. Hence, prohibiting emigration is now considered highly problematic. However, that does not mean that countries do not have policies in place that either encourage or discourage emigration. According to a United Nations survey, 20% of governments (26% in Europe and North America) reported having policy measures that sought to lower the emigration of citizens (United Nations, 2020b). Some of the policies are targeted directly at the retention of particular groups, such as the highly skilled (McLeod et al., 2010; Toma and Villares-Varela, 2019; Wickramaarachchi and Butt, 2014).

Moreover, a wide range of policies in other fields could also impact emigration trends. Most notably, immigration policies regulating conditions for immigrants' residence permits are closely linked to emigration, since individuals who lack permission to stay are expected (or forced) to leave the country. Furthermore, any measures that make staying in a country more attractive will also reduce the incentives to emigrate. For immigrants, whether they experience a welcoming or an unfriendly culture can incentivise them to stay or to leave. Policies aimed at improving the labour market integration of young people and of immigrants – including measures that facilitate the recognition of immigrants' skills, measures that help immigrants avoid mismatch between their skills and the jobs they get and improve their educational attainment, and general economic policies aimed at increasing employment (Marois et al., 2020; Potančoková et al., 2021) – can increase labour participation while also reducing the incentives to emigrate.

Hence, policymakers who want to reduce emigration do have some tools available. Some of these tools are linked to international agreements on mobility and to policies regarding residence permits and the integration of immigrants, and to general economic policies.

4.3 Which demographic remedy for ageing should be preferred?

As has been shown in this paper, no single demographic remedy is likely to stop ageing in a country like Norway. However, reduced emigration, higher immigration and higher fertility can contribute to a somewhat slower process of population ageing, and policymakers could consider measures encouraging all of these trends in order to meet future population challenges – in addition to important changes in labour market participation, productivity, etc.

Furthermore, policymakers should assess whether the greater challenge is population ageing or population decline. As we have shown, changes in emigration have a more pronounced impact on population size than on ageing in the Norwegian context.

Although some tools are available for policymakers who want to reduce emigration, achieving a reduction of 50% – the main scenario we explored – may prove just as hard or as controversial for policymakers as increasing fertility by one-quarter child per woman or increasing immigration by 25%. As in all policy-related questions, when comparing the different demographic remedies, the expected benefits of reducing ageing (and increasing population growth) should be weighed against the costs of the proposed policies. Reduced emigration may have several advantages compared to other demographic remedies; for example, it has little effect on environmental sustainability since does not add extra people to the earth as increased fertility does, and it may be less politically controversial than increased immigration. Some of the political measures that could reduce emigration may also have other beneficial effects, such as the better integration of immigrants, reduced labour market mismatches and higher employment rates, which could, in turn, place the society in a better position to handle population ageing.

Cost-benefit considerations should also take into account the costs and the benefits for other countries, and for the migrants themselves. The migration patterns that are most beneficial for one country may not be optimal for other countries. For instance, less emigration by young people would reduce ageing in Norway, but it would have the opposite effect in the emigrants' destination countries. These cost-benefit considerations should also include costs and benefits at the individual level for the (potential) emigrant, as well as for her/his relatives and friends.

Hence, policy measures aimed at reducing emigration should be carefully chosen, and preference should be given to policies that have low costs for individuals and other countries, and that – independent of their effects on emigration – are likely to improve the society's ability to meet the challenges associated with population ageing.

5 Conclusion

While largely overlooked in many discussions on demographic "remedies" for ageing, reduced emigration could be viewed as a welcome anti-ageing formula, with several advantages: unlike increased fertility, it does not normally result in more children to feed and raise, and it does not add extra people to the world, which is likely to be beneficial for global sustainability. And, unlike immigration, which often implies receiving newcomers with little knowledge of the host country's language and culture, reduced emigration may be less controversial, since it implies holding on to individuals who have already lived for some time in the country (natives or immigrants).

In this paper, we have explored the link between emigration and ageing, which is an understudied phenomenon in a Western European context. Our main conclusions are that even a 50% reduction in all emigration from Norway would only slightly reduce ageing (by reducing OADR growth by around 10% until 2060), but it would have a considerable effect on population size (80% higher population growth). Hence, reducing emigration may be a more forceful remedy for depopulation than for ageing. Furthermore, a 50% reduction in emigration rates would have the same effect on ageing up to 2060 as 15% higher fertility (one-quarter child per woman) or 25% lower immigration.

Although there are policy tools available that may affect emigration, and although some of the measures that could reduce emigration – such as the better integration of immigrants, reduced labour market mismatches and higher employment rates – have the added benefit of also placing the society in a better position to handle population ageing, it may be difficult in a democratic society to reduce emigration as much as has been proposed in our hypothetical scenarios. Still, our paper contributes to the literature on the demographic drivers of population change and ageing, in which the effects of emigration are often superficially treated.

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Appendix

Figure A.1:
Emigration from Norway 2010-2019 by age for immigrants and non-immigrants (natives). Absolute number of emigrations (left) and emigrations per 1000 (right)

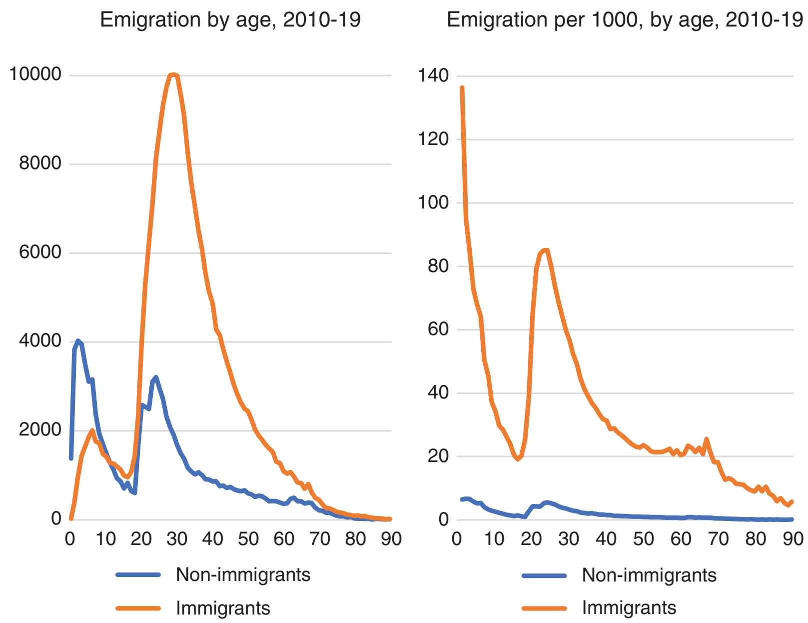


Figure A.2:
Projected old-age dependency ratios (upper panel) and population size (lower panel) in Norway, in the official projections' Main alternative ('Baseline') and in scenarios with lower emigration, higher fertility, higher immigration and higher mortality

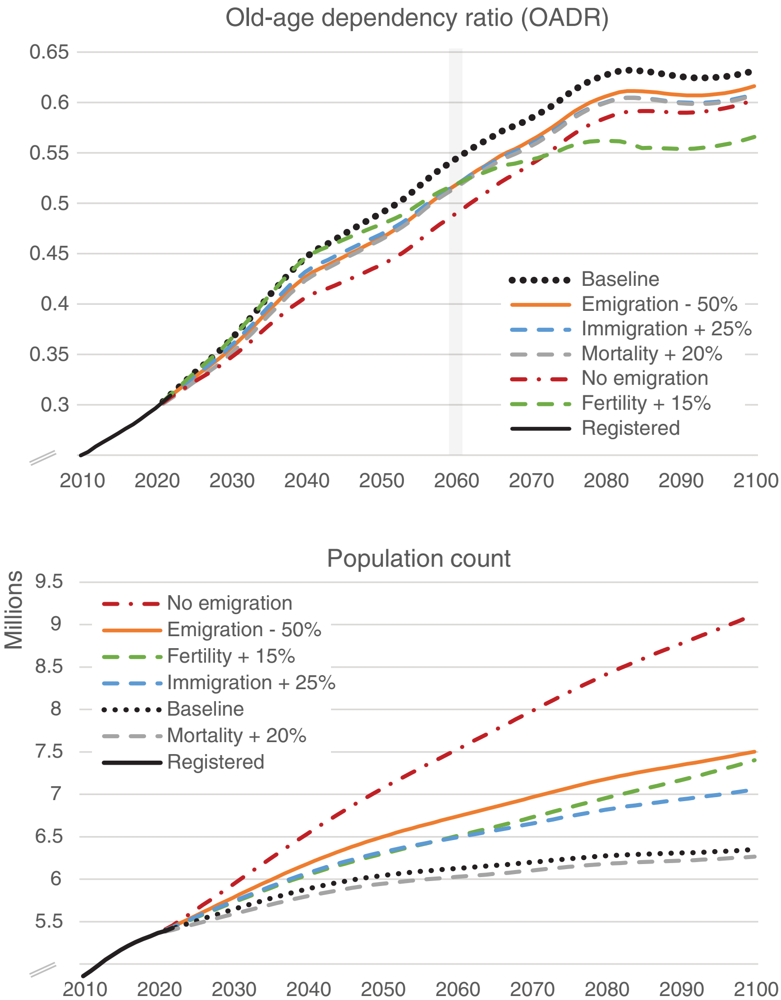


Figure A.3:
Projected old-age dependency ratios (upper panel) and population size (lower panel) in Norway, in the official population projections' Main alternative ('Baseline') and in scenarios with 50% lower emigration for certain subgroups only

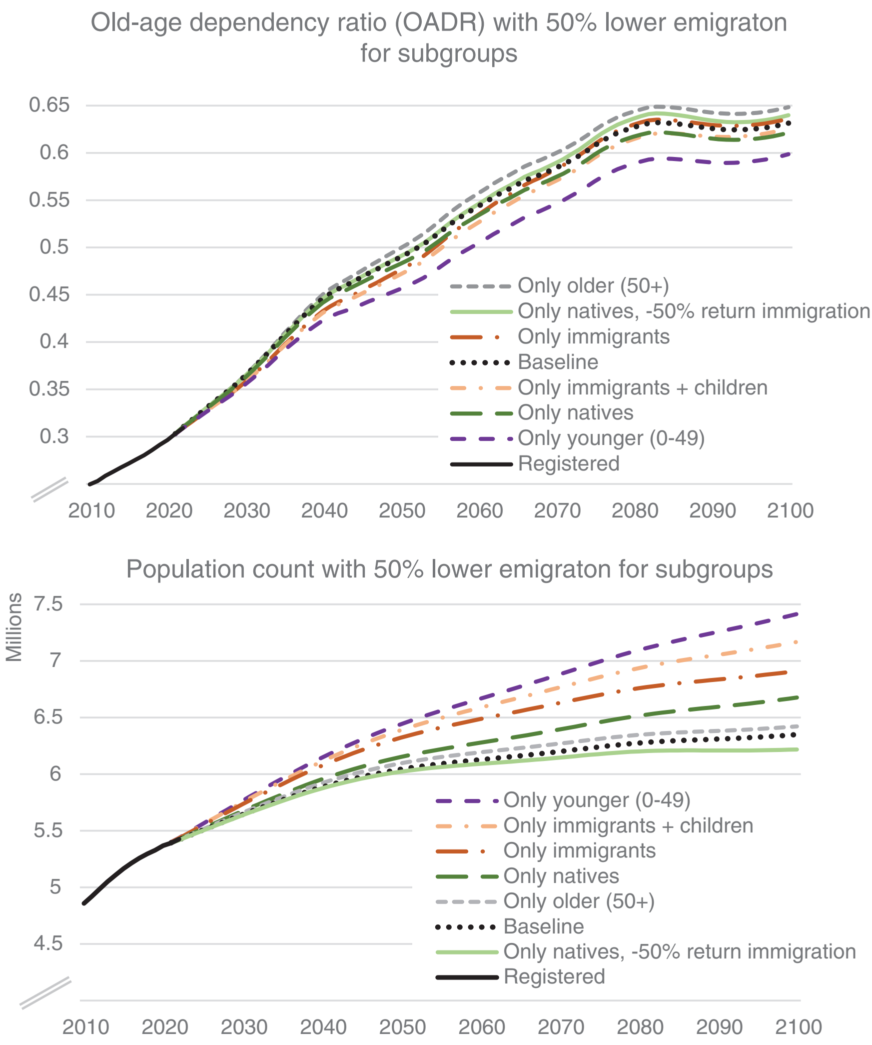
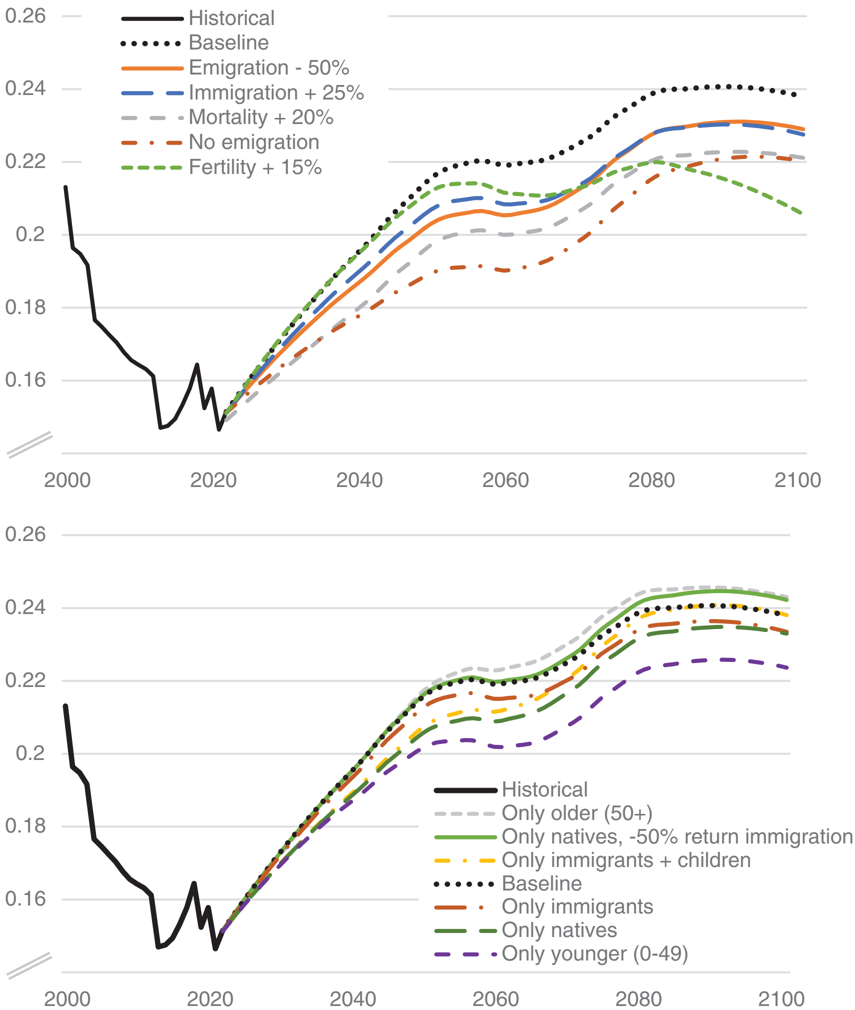


Figure A.4:
Smoothed prospective old-age dependency ratios (POADRs) in Norway, registered and projected, based on 15 or fewer years remaining life expectancy



Note: The upper panel shows our main alternatives, whereas the lower panel shows additional alternatives for subgroups. The estimates have been smoothed using LOESS, a nonparametric method for smoothing a series of data in which no assumptions are made about the underlying structure of the data (cf. https://www.itl.nist.gov/div898/handbook/pmd/section1/pmd144.htm). In the current figure, a smoothing parameter of 0.5 was employed. Also note that the axes in this Figure differ from those shown in Figures A.2 and A.3.

Figure A.5:
Population in Norway by age, registered in 2020 and projected in different scenarios in 2060 and 2100

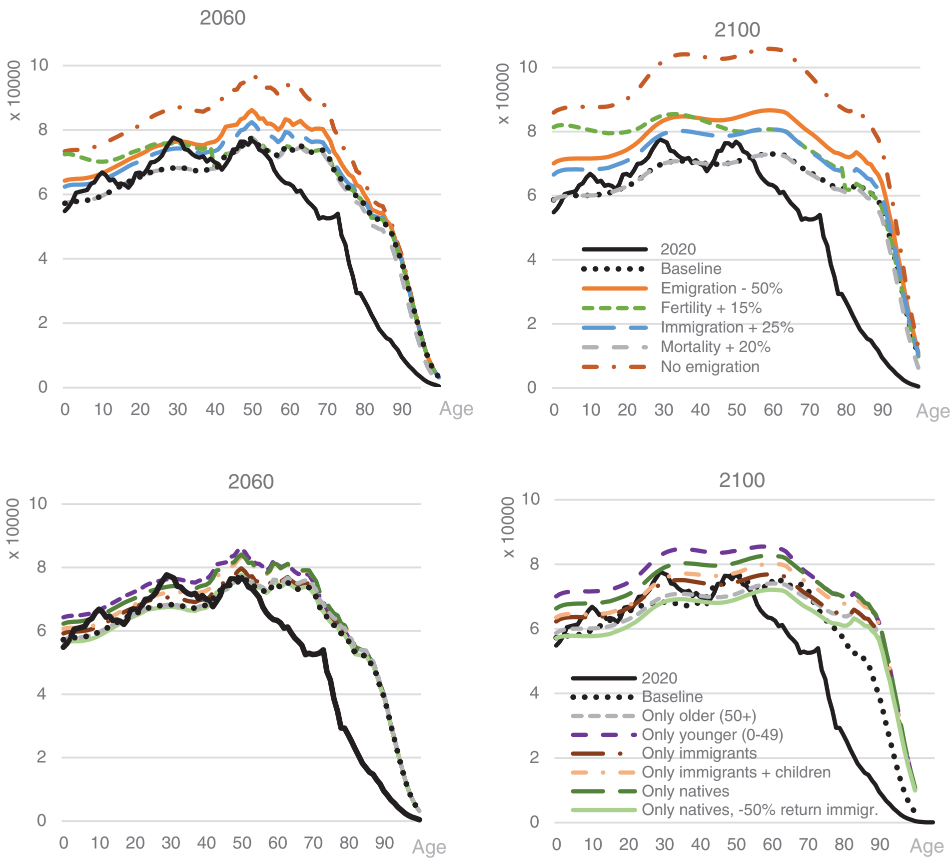


Table A.1:
An overview of the components (in terms of counts) in 2060 and 2100

							Emigration rates reduced by 50% for certain groups only					
	Baseline	Emigration −50%	Immigration +25%	Fertility +15%	Mortality +20%	No emigration	Only older (50+)	Only younger (0–49)	Only immigrants	Only immigrants +children	Only natives	Only natives −50% return immigration
2060												
Emigration	25,900	15,500	30,600	27,100	25,800	0	23,700	18,200	20,400	18,300	23,100	22,800
Immigration[a]	37,200	37,200	46,500	37,200	37,200	37,200	37,200	37,200	37,200	37,200	37,200	33,100
Net migration	11,400	21,700	15,900	10,100	11,400	37,200	13,600	19,100	16,900	18,900	14,100	10,300
Births	57,200	64,300	62,300	72,700	57,100	73,700	57,200	64,300	60,700	62,300	59,200	56,600
Deaths	61,800	63,800	62,400	61,800	61,800	66,200	63,100	62,400	63,400	63,400	62,200	61,800
Natural increase	−4600	500	−100	10,900	−4600	7400	−6000	2000	−2600	−1100	−3000	−5100
2100												
Emigration	24,000	14,800	29,100	26,300	24,000	0	22,000	17,400	19,600	17,800	21,300	20,800
Immigration[a]	36,900	36,900	46,100	36,900	36,900	36,900	36,900	36,900	36,900	36,900	36,900	31,900
Net migration	12,900	22,100	17,100	10,600	12,900	36,900	14,900	19,500	17,300	19,100	15,600	11,100
Births	58,300	69,800	66,200	81,200	58,300	85,700	58,300	69,800	63,200	66,000	62,000	56,900
Deaths	65,900	74,900	70,100	66,300	65,300	87,200	68,000	72,400	72,000	72,700	68,000	65,900
Natural increase	−7600	−5100	−3900	14,900	−7000	−1500	−9600	−2600	−8800	−6800	−6100	−9000

Notes: [a]Includes (return) immigration of natives.
Since all projected figures are inherently uncertain, the counts have been rounded to the nearest 100. Compared to Statistics Norway's June 2020 projections, minor deviations are observed in the counts for emigrations, births and deaths, as the model has been modified technically in 2021 and the updated model has been used in our work. The technical adjustments pertain to the future distribution of emigrants and immigrants by age and sex.

Table A.2:
Additional age measures (median age, total dependency ratio (TDR) and share of population age 65+ and 20–64 years) in different scenarios

		Baseline	Emigration −50%	Immigration + 25%	Fertility + 15%	Mortality + 20%	No emigration
	2020	**2060**					
Median age	39	47	46	46	44	46	45
TDR	0.69	0.92	0.90	0.90	0.95	0.89	0.87
Share 65+	17.5	28.3	27.3	27.3	26.6	27.2	26.2
Share 20–64	59.2	52.1	52.8	52.7	51.4	52.8	53.6
	2020	**2100**					
Med. age	39	48	48	47	45	48	47
TDR	0.69	1.02	1.00	1.00	1.00	0.99	0.98
Share 65+	17.5	31.3	30.8	30.5	28.3	30.5	30.4
Share 20–64	59.2	49.6	50	50.1	49.9	50.2	50.4

			Emigration rates reduced by 50% for certain groups only						
		Baseline	For all	Only older (50+)	Only younger (0–49)	Only immigrants	Only immigrants +children	Only natives	Only natives, −50% return immigration
	2020	**2060**							
Median age	39	47	46	47	46	47	46	46	47
TDR	0.69	0.92	0.90	0.93	0.88	0.91	0.90	0.91	0.92
Share 65+	17.5	28.3	27.3	28.8	26.8	28	27.6	27.9	28.4
Share 20–64	59.2	52.1	52.8	51.7	53.1	52.5	52.6	52.3	52.1
	2020	**2100**							
Med. age	39	48	48	49	47	48	48	48	48
TDR	0.69	1.02	1.00	1.03	0.98	1.01	1.01	1.01	1.02
Share 65+	17.5	31.3	30.8	31.9	30.2	31.6	31.2	31.0	31.7
Share 20–64	59.2	49.6	50	49.3	50.4	49.7	49.8	49.9	49.6

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The triple burden of depopulation in Ukraine: examining perceptions of population decline

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Abstract

In February 2022, Russia invaded Ukraine, leading to severe population loss as millions exited the country and casualties mounted. However, population decline in Ukraine had been occurring for decades due to the triple burden of depopulation: low fertility, high mortality and substantial emigration. Ukraine had also already experienced years of armed conflict and large-scale displacement after the Russian-backed separatist movement, which started in 2014. This study investigates perspectives on depopulation using online focus groups conducted in July 2021, seven months before the current invasion. We compared discussions in eastern Ukraine, including in rural villages, the IDP-receiving city of Mariupol, the large city of Kharkiv and occupied Donetsk. Participants observed that cities were growing at the expense of rural areas. The situation in Donetsk was bleak due to mass emigration, but some participants pointed to a recent increase in births. Overall, the participants acknowledged the triple burden of depopulation in Ukraine, and the consequences of population decline, such as a shrinking labour force and rapid ageing.

Keywords: depopulation; Ukraine; low fertility; emigration; population decline

1 Introduction

Russia's war against Ukraine has brought immense suffering to the Ukrainian population. Direct aggression has killed tens of thousands of Ukrainian soldiers and civilians, and countless others have died due to indirect causes, such as lack of medical care, disease and malnutrition. The threat of violence has led to the largest

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displacement in Europe since World War II, both inside and outside the country. The scale of the refugee flow has been staggering – as of January 2023, eight million people had left the country, which is more than the entire population of Norway or Finland (UNHCR, 2023). Another six million people had been internally displaced, with most fleeing to western or central Ukraine (IOM, 2023). Such conditions have also undoubtedly led to a sharp decline in fertility, as childbearing has been postponed indefinitely. These factors have created a vortex of population decline, exacerbating a population process that had been long underway.

Although Ukraine's population crisis is clearly evident now, the process of depopulation has been unfolding for decades (Coleman, 2022; Romaniuk and Gladun, 2015). Ukraine has had one of the highest rates of population decrease in Europe, with only Latvia and a few Balkan states recording similar declines (Eurostat, 2022). However, unlike most countries experiencing extreme population decline, Ukraine's population is relatively large. In 2020, Ukraine was the eighth largest country in Europe (sixth if Russia and Turkey are not included). Ukraine's population peaked at 52 million around 1993, and has been steadily declining since; however, due to the lack of an accurate census, the exact size of the population remains unknown. Ukrainian demographers have long been concerned about all three factors impacting the population structure (e.g., Chuiko, 2001; Steshenko, 2001); a phenomenon that we call the "triple burden of depopulation": low fertility, high mortality and significant emigration. Population decline has also been a subject of media reports (e.g., Golub, 2018; Kramar, 2019), and has even been satirised in the movie "Deserted Country" (Gritsyuk, 2020). However, little is known about whether the Ukrainians themselves have been aware of depopulation or consider it to be a problem.

Ukraine is also one of the few countries with low fertility to experience war. Even before Russia's invasion in February 2022, Ukraine had experienced eight years of armed conflict. In 2014, fighting broke out in eastern Ukraine, which led to the effective secession of two areas of the "Donbas" region where three million people reside. These territories were unknown entities and no international recognition until Russia recognised them in February 2022. The war in the Donbas forced 1.8 million internally displaced persons (IDPs) to leave their homes and flee to other regions of Ukraine or Russia (Mykhnenko et al., 2022). Although some IDPs settled permanently in other parts of Ukraine and others returned home, many were caught in a situation of "protracted displacement" that continued for many years. Thus, Ukraine's population has been declining not only due to natural decrease, but also in the context of conflict and substantial population displacement.

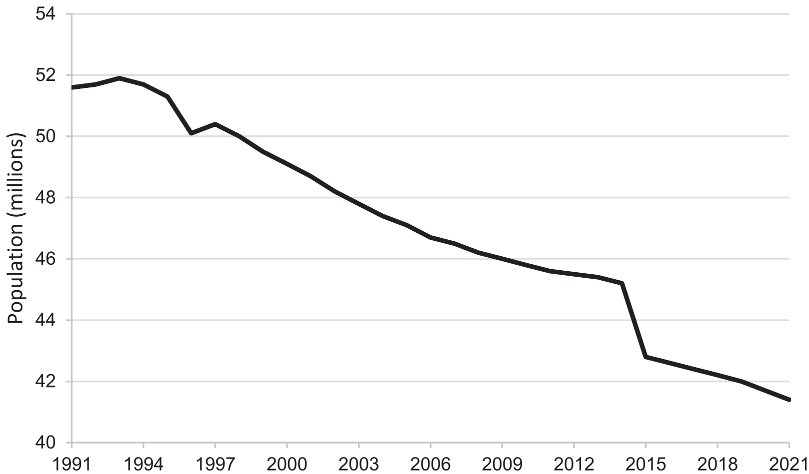
Although population decline in Ukraine has been widely acknowledged, demographic research on the country has been largely missing from the academic discourse, partially due to the lack of reliable and conventional statistical indicators. Thus, alternative approaches are needed to understand population decline in Ukraine. In this study, we used focus group methodology to investigate general perceptions of low fertility and depopulation. Focus group research aims to explore social norms and attitudes in greater depth than possible with surveys, yielding insights into how people think about social processes. The conversational format allows for multiple opinions and perspectives to emerge, which can then feed into explanations for why population change is occurring (Perelli-Harris and Bernardi, 2015).

Our focus groups took place in July 2021, eight years after the start of the original conflict in eastern Ukraine. Working with a Ukrainian research agency, we conducted 16 focus groups online. The groups were divided by gender and took place in urban and rural areas. We were particularly interested in the experiences of individuals who fled the conflict. Thus, we conducted six focus groups with IDPs and six focus groups with residents of regions bordering the conflict area. We also had the unique opportunity to conduct four online focus groups with residents of Donetsk, the largest city in the Donbas. Although focus groups have conventionally been conducted in person, the online methodology provided several advantages. First, we would not have been able to conduct face-to-face focus groups in Donetsk, because neither we nor the Ukrainian survey agency were allowed to visit this area. Second, because many people had become accustomed to online communication during the pandemic, we found that the participants were comfortable participating in the discussions and sharing their attitudes. The discussions were lively and informative, providing a glimpse into everyday life in these regions.

Our study explored whether and how Ukrainians perceived population decline, their stated reasons for the decline, and whether they thought it had negative social and economic consequences. We aimed to answer the following general research questions: (1) Had the focus group participants perceived a change in their local surroundings over the past few years? (2) Did the participants' perceptions differ depending on whether they were living in rural or urban areas? (3) How did the participants in Donetsk, in the Russian-backed separatist territory, view population change in their city? (4) Was population decline in Ukraine seen as a problem? (5) How did the participants perceive the causes of population decline, and its consequences for the country? Although anthropologists have attempted to describe and find meaning in the emptiness of shrinking settlements in eastern Europe (see, for example, Dzenovska's project on Emptiness, 2018, 2022), few studies have approached the topic through a demographic lens. Doing so can help us better understand whether and how a society recognises population dynamics, and the challenges associated with population decline.

Six months after our focus groups were held, Russia invaded Ukraine, destroying the homes and lives of our focus group participants. When originally choosing our research sites, we deliberately focused on eastern Ukraine, which was close to the contact line, and the region where the majority of IDPs had settled. As of the time of writing in November 2022, these areas have been severely impacted by Russia's aggression. Kharkiv is under constant shelling, and half of the city's 1.5 million residents have fled. The villages along the edge of the previously frozen conflict have become the front line in battles reminiscent of World War II. Mariupol has been completely obliterated in one of the most protracted and heinous assaults of the war. Thus, although we do not know the fate of our participants, we assume that all have had their lives turned upside down and have been forced to leave their homes, some for the second time in their lives.

Figure 1:
Population of Ukraine (millions), 1991 to 2021



Source: State Statistics Service of Ukraine (2022).

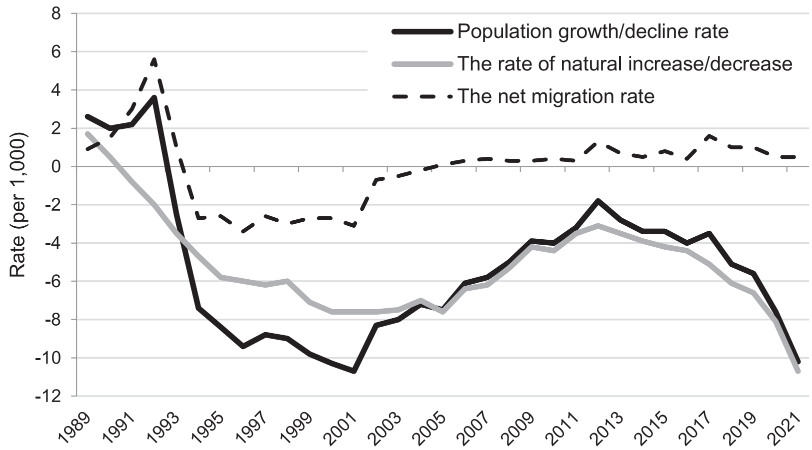
2 Background

2.1 Depopulation in Ukraine

As can be seen in Figure 1, Ukraine's population was just under 52 million when the country gained independence in 1991. The population then steadily decreased until 2014, when it underwent a sharp contraction due to the removal from official statistics of the occupied territories in the Donbas. By 2021, the population was estimated to be around 41 million, which represents a loss of over 10 million people in 20 years (State Statistics Service of Ukraine, 2022). As discussed above, Ukraine has been experiencing a "triple burden" of depopulation; however, the main reasons for the decline in population are reflected in the rate of natural decrease (Figure 2). Since the collapse of the Soviet Union, the rate of natural change has declined primarily due to the very low fertility rates of the late 1990s and early 2000s.[1] In 2001, Ukraine reported the lowest fertility rates in the world, with the TFR reaching 1.1 (Perelli-Harris, 2008, 2005). Although this fertility decline was due in part to the postponement of first births, the majority of the initial decline was attributable

[1] While the evidence is limited, historical studies suggest that depopulation in Ukraine started in the period after World War II (Romaniuk and Gladun, 2015). For example, one study reported that the population in eastern and southern Ukraine declined by 28% between 1951 and 1987 (Pallot, 1990). Similarly, for urban areas in eastern Ukraine, the emergence of low fertility has been traced to the postwar period (Hilevych, 2016, 2020).

Figure 2:
Population growth, natural increase, and net migration, 1989 to 2021

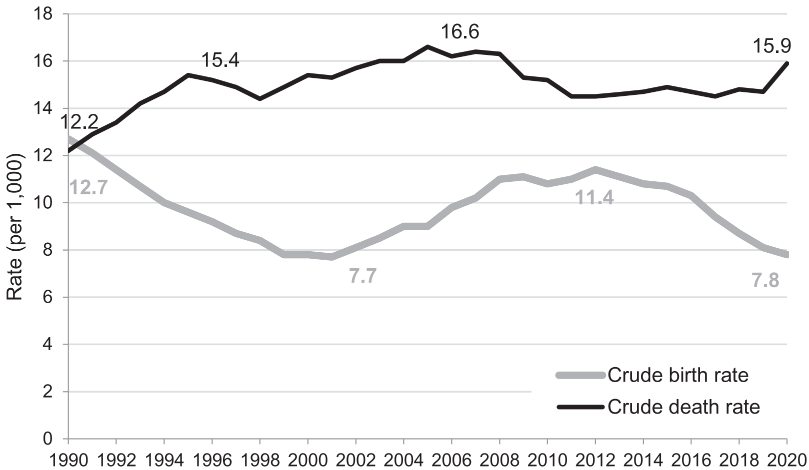


Source: State Statistics Service of Ukraine, courtesy of Nataliia Levchuk, Ptoukha Institute for Demography and Social Studies, Kyiv

to fewer second and higher order births (Perelli-Harris, 2005). Increases in mortality also contributed to the natural decrease, as male life expectancy dipped to around 61 years. In 1992, the crude birth rate fell below the crude death rate (Figure 3). However, in the early 1990s, when the Soviet Union was collapsing, the population growth rate increased due to an influx of migrants. Subsequently, the net migration rate dipped again, reflecting Russians returning to Russia as well as labour migration. Thus, in the late 1990s, the population growth rate was as low as −10.7.

After 2001, the crude death rate stabilised and the crude birth rate started to increase again. Like other eastern European countries, Ukraine has had a policy of providing new mothers with childbirth payments and maternity leave. This policy has been in place since 2005, with some adjustments over time (Perelli-Harris, 2008). Although the maternity benefits in Ukraine are not as extensive as maternity capital in Russia, the aim of the policy has been to increase fertility rates. Starting in 2010, the maternity benefits increased with each successive child (Wesolowski and Billingsley, 2022). By 2012, the TFR had risen to 1.53 (State Statistics Service of Ukraine, 2019). While some of the recuperation was due to the end of tempo distortions from first birth postponement, the quantum of childbearing, including second and higher parity births, also increased (Goldstein et al., 2009). Since 2014, childbirth payments in Ukraine have been set at 41,280 UAH (~1065.18 euros), regardless of the number of births (MISSCEO, 2021). Moreover, in 2019, additional payments were introduced for large families with three or more children (Ministry of Social Policy of Ukraine, 2019). As a result of more births, the natural rate of decline started to increase. Outmigration also stalled and the net migration rate hovered around zero, resulting

Figure 3:
Crude birth and crude death rate, 1990–2020



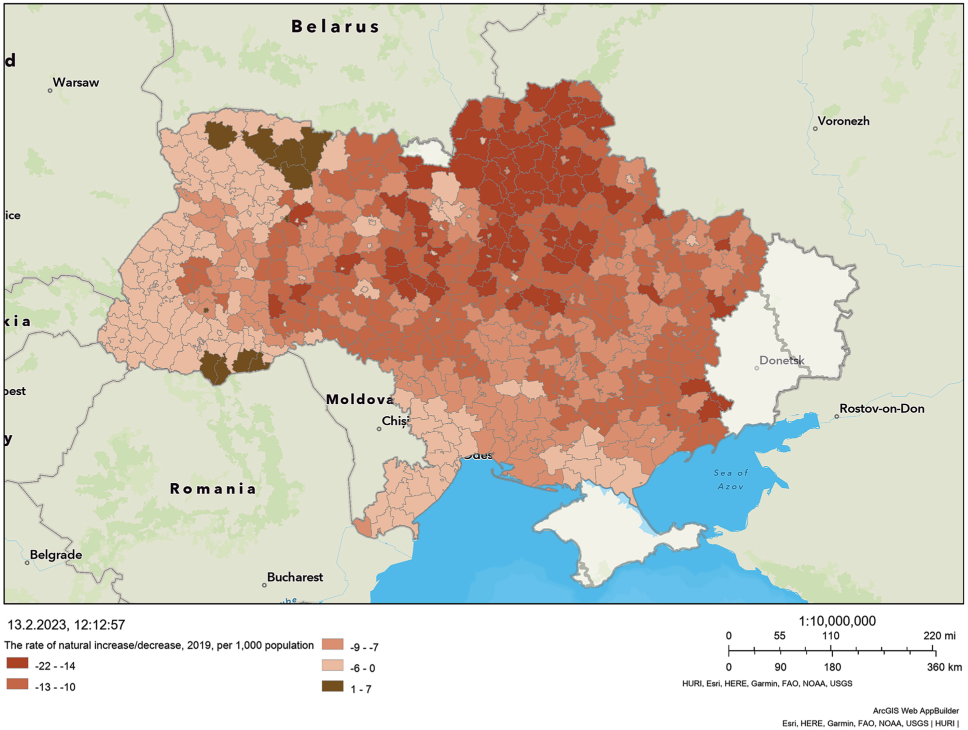
Source: State Statistics Service of Ukraine, courtesy of Nataliia Levchuk, Ptoukha Institute for Demography and Social Studies, Kyiv

in an increase in the population growth rate. However, the rate remained below zero, and peaked at only −1.8 in 2012, which indicates that the population was still shrinking.

Subsequently, despite the aforementioned maternity policies, the population declined as the crude birth rate started to fall again, most likely due to political turmoil, war and instability (Figure 3). The TFR decreased steadily, reaching a low of 1.23 in 2019 (State Statistics Service of Ukraine, 2019). Although the crude death rate was relatively stable throughout this period, the decline in the birth rate was sufficient to again produce a decreasing natural rate of change. And even though some migrants entered Ukraine, including international students and labour migrants from Central Asia (Coleman, 2022), the increase in the net migration rate did not offset the declining natural rate of population change. Finally, during the Covid-19 pandemic in 2019–21, the crude death rate reached a high of 17.3, and the birth rate fell to a low of 6.1, resulting in a decline in both the rate of natural change and the population growth rate. By 2021, when our focus group interviews were held, the rate of population decline was as steep as it had ever been (−10.7), signifying that the population was declining rapidly.

It is important to note that Ukraine's population decline has not been spread evenly across the country, as some areas have been shrinking rapidly while others have been growing. Figure 4 shows the rate of natural change across Ukraine, with darker red indicating a natural population decrease of −22 to −14 per 1000 people, and dark green indicating a population increase of one to seven. According

Figure 4:
Natural increase/decrease rate by region, 2019



Source: MAPA. Digital Atlas of Ukraine (HURI), courtesy of Nataliia Levchuk. https://harvard-cga.maps.arcgis.com/apps/webappviewer/index.html?id=5143021e6379448c966900096f21b5e3.

to the map, the northern and central regions were the most likely to experience population declines, while the population increased in parts of north-west and south-west Ukraine. Western Ukraine has long had higher fertility rates than eastern and central Ukraine due to its rural traditional background, which is supported by the Ukrainian Greek Catholic Church. A study using survey data found that inhabitants of these regions also tend to prefer western-type democracy and a market economy, which are, in turn, associated with higher second birth rates (Perelli-Harris and Permyakova, 2018). Moreover, population decline is more likely to happen in rural regions, as increasing numbers of rural residents move to cities. In the eastern regions where our focus groups took place, some of the districts near the contact line had a population deficit, potentially due to continued hostilities and a deterioration of conditions. Below, we point out the extent to which our focus group participants were aware of different regional patterns of population change and compare the perceptions of participants in rural and urban areas.

2.2 War in eastern Ukraine since 2014

Ukraine's population has also been impacted by armed conflict and violence. Russia's annexation of Crimea in 2014 and the rebellion by pro-Russian separatists effectively decreased Ukraine's government-controlled population by around 2.5 million (State Statistics Service of Ukraine, 2019). Millions fled the fighting in 2014; and by 2015, Ukraine was the fourth largest source of new IDPs in the world. Over time, some IDPs returned home, but most remained in Ukrainian territories, resulting in a situation of protracted displacement (defined by UNHCR as lasting at least five years). The Ukrainian government estimated that in 2021, around 1.4 million IDPs were living in the government-controlled areas of Ukraine (UNHCR, 2021). As most of the IDPs settled in the east, we decided to hold our focus groups in that part of the country. Several large cities, such as Kharkiv and Mariupol, grew rapidly due to the influx of IDPs, while rural areas in Ukraine and Donetsk depopulated (UNHCR, 2021) In this study, we capture perceptions of both regional and national population decline in eastern Ukraine before the current full-scale war.

3 Methodology and data

In this study, we use qualitative methods to delve into the reasons why fertility is low and depopulation is occurring in Ukraine. Focus group research is intended to elicit social perspectives, which are essential for understanding context-specific phenomena and generating research hypotheses (Morgan, 1998). A focus group is a small group of individuals (usually 6–8 people) that discusses topics organised around a central theme, with the discussion facilitated by a trained moderator. Because focus groups rely on purposive sampling techniques, they are not representative of the population.

Due to the Covid-19 pandemic and continued fighting in the Donetsk region, it was impossible to hold conventional in person focus groups; thus, the focus groups had to be conducted online using Zoom. The online format resulted in a relaxed atmosphere, as participants were able to join the discussion from the comfort of their home. We employed a survey agency, the Kyiv International Institute for Sociology, to recruit respondents in local public areas (e.g., marketplaces, bus stations), from a database of prior participants, and through snowball methods. The agency conducted an online screening interview to ensure that participants met the criteria (i.e., were aged 18–45) and the quotas for each group: men and women; IDPs and locals. We divided the groups by gender because we wanted participants to feel comfortable discussing attitudes towards partnership formation and childbearing, which often differ by gender. We also divided them by displacement status, because we asked the IDPs direct questions about their experiences with fleeing armed conflict and integration. Four focus groups took place in Kharkiv, a large, well-off city in eastern Ukraine; four were held in Mariupol, a medium-sized city in Donetsk oblast near the contact line; four took place in rural areas in Donetsk oblast, which are also near the contact line; and four were held in Donetsk. Because travel to Donetsk was not permitted, the agency used Computer Assisted Telephone Interviewing to assist with recruitment. Because the majority of residents in eastern Ukraine speak Russian at home, all focus groups were conducted in Russian. Sometimes the participants inserted sentences or words in Ukrainian. The preference for the Russian language did not signify any political views. The participants received a small compensation for taking part in the focus groups. All the names of the participants and their detailed locations (villages and streets) were anonymised. In the translation of the quotes, we used the original spelling used by the participants; e.g., Kharkov instead of Kharkiv. Outside of the quotes, for reasons of consistency throughout the paper, we used Ukrainian spellings of the cities: i.e., Kharkiv, Mariupol, Kyiv, etc. The ethics for the study were approved by the University of Southampton (ERGO ID: 54481.A1).

Each focus group consisted of 8–9 participants; in total, 134 people participated across the 16 focus groups. The discussions were guided by a set of open-ended questions about population decline at national and local levels; partnership formation; and childbearing intentions. The discussions started with questions about the participants' general problems in the past year and their experiences with the conflict in the Donbas or as an IDP. We then asked the participants who had remained in the Donbas about population decline to gauge their perceptions of depopulation in this area. Subsequent questions delved deeper into how the population around the participants had been changing, both in their local area and in Ukraine as a whole. We specifically asked whether they saw population decline in their country as a "problem." The following questions about partnerships and childbearing also added to our understanding of why population had been declining. We probed into whether the participants thought the number of children born in the country was too low, too high or just right, and about the ideal family size in Ukraine. The discussions around what factors influence childbearing decisions provided insights into how micro-level decisions aggregate up to macro-level population processes.

Note that although the discussions flowed freely and the participants seemed to speak openly about their problems and opinions, the political context may have curtailed truly open discussions. While criticism of the "government" was rampant, few participants explicitly expressed support for Ukraine or Russia, and none blamed Putin or the Russian government for the war in the Donbas. One participant noted that people had stopped talking about the war, as it had led to deep divisions between friends and families. This self-censoring was acute in Donetsk, as participants were wary about who might be listening, whether American, Ukrainian or Russian. Although the participants complained about transport, hospital care, obtaining documents and other problems of everyday life, they rarely blamed the separatists or local government, possibly because any protests could compromise their security. In Donetsk, stories circulate about people who have been interrogated or tortured in "basements" for expressing anti-secessionist views (Verini, 2022). Thus, while the narratives below appear to be open and honest, they may have only scratched a superficial surface, while the participants' deeper opinions remained hidden.

Because our main aim was to explore the extent to which people can gauge or understand population change based on personal observation, we asked each focus group the following questions: "How has the population changed in your hometown/village in the past years?" and "Is this change positive or negative?"[2] To the participants residing in Kharkiv, Mariupol and Donbas villages, we also asked a follow up-question concerning the whole of Ukraine: "Do you think that population decline is a problem, and why yes or no?"[3] Note that by July 2021, when the focus group research took place, Covid-19 restrictions in Ukraine had been relaxed, and although vaccinations were only just becoming available, Covid-19 infections were relatively low. The increased activity after Covid-19 lockdowns inevitably influenced how people perceived their surroundings. Finally, although we asked the IDPs about their experiences with displacement, it is important to remember that the IDPs may have moved seven or eight years previously; thus, their observations were more likely to reflect the present situation.

4 Analysis

We started the discussions about population change by focusing on the participants' perceptions of the situation in their local area. Initially, some focus groups struggled to answer our questions, as they did not understand what we meant by "population

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[2] Как менялось население вашего города/села за последние годы? На ваш взгляд, эти изменения положительны или отрицательны?.

[3] Как вы считаете, сокращение населения в Украине в целом – это проблема? Поче му/почему нет?

change". Instead, some participants described the general disposition of local people by, for example, opining that recently people had become "meaner", more "closed" or prone to disorderly behaviour and alcoholism. Once the question had been clarified, the participants described, sometimes in great detail, the population changes they observed, often using metaphors or references to demographic knowledge from the media, Wikipedia and even conspiracy theories. In general, we did not observe differences in perceptions of population based on IDP status or gender, which were the primary characteristics by which the FGDs were split. Instead, perceptions differed by location, reflecting urban-rural differences, and whether the local area had experienced an influx of IDPs or, conversely, depopulation. Below we present the analysis of the participants' discussions of local and population changes based on locality: the urban areas of Mariupol and Kharkiv, rural Donbas, and separatist-occupied Donetsk.

4.1 Perceptions of local population change in the cities of Mariupol and Kharkiv

The participants living in Mariupol and Kharkiv largely shared similar perceptions of population change. While they acknowledged that the total population of Ukraine was decreasing, they thought that the population was declining mainly in rural areas, and not in the cities where they lived. The noticeable increase in population in the cities was due to an influx of various newcomers, most notably of IDPs who arrived after 2014 from eastern Ukraine. While the population increase in Kharkiv was in line with the long-term development of the city since the Soviet era, the changes in Mariupol were more recent. Thus, we observed that the perceptions of population decline differed between the residents of Kharkiv and Mariupol.

"Here the population is changing in different ways"

In Mariupol, the influx of newcomers was a post-2014 development that was for many participants noticeable in their everyday lives. They mentioned longer queues at the shops and administrative institutions; traffic jams; as well as chaos due to the construction of new buildings and housing:

> [New] houses are built from all directions, once one snatches a place for themselves. Traffic jams have not touched us yet . . . but there are cars . . . let's say somewhere in the city centre . . . for example, you can't drive up to the supermarket. There are a lot of people here. [. . .] And my personal opinion is that the city is not designed for this. (P4, FGD-1 Mariupol_IDPs_men)

Despite these practical issues, the influx of newcomers was seen in a positive light, as it brought more professionals to Mariupol. In particular, new businesses, investors and specialists were described by the participants as contributing to the economic growth of the city.

> People came here with their investments and things got refreshed; something was opened, something was launched, money was poured into something, something that was dead before now started working. Again, population density increased in the city. (P2, FGD-2 Mariupol_locals_men)
>
> Active and professional specialists are always a plus. We do not feel that IDPs are more intelligent and are taking away jobs from Mariupolets, because maybe they have some welfare benefits, or something. It feels that, as they say, new blood was added to the old blood and, at the same time, this new blood no worse than the old blood. (P5, FGD-4 Mariupol_local_women)

As the quote below illustrates, the Mariupol residents did not necessarily see increased population density as an issue; nor did they perceive the newcomers as posing a threat or competing for jobs. They also explicitly highlighted the multinational background of the city, and of Ukraine more generally, as being a continuous feature. The professional diversification of the city through new student and professional populations was seen as a positive development for Mariupol:

> Here the population is changing in different ways. Andrei [previous participant] was right when he said that students not only come from Donetsk, but also from other countries. And it seems that people come here to live, and they really do appreciate the kind of city it is. So, the city is still changing and will be transforming in the coming years. In as much as Mariupol started to change, its population also began to change. (P6, FGD-2 Mariupol_locals_men)

The participants acknowledged that the positive development of Mariupol and the boom in its population were occurring because of outmigration from other, predominantly rural areas. However, this was framed not as a regional phenomenon, but as a general trend that that was occurring across Ukraine:

> P4: My attitude is that they [people] should not leave, so that our country would have a normal standard of living, wages and work.
>
> P1, P4 [together]: If only we had some stability.
>
> P6: We are unlikely to have it, this stability. Every year it gets worse and worse.
>
> P4: Factories in Mariupol are operating. But in other cities everything is closed. And in the villages, there is nothing to do at all. [. . .] There used to be fields, there were farms, there were clubs, kindergartens . . . . Now even take those villages near Mariupol . . . . Kindergartens do not work; schools do not work. (FGD-3 Mariupol_IDPs_women)

"The bulk of Kharkiv residents are not Kharkivites"

In Kharkiv, the participants perceived the increased population as putting a strain on resources and infrastructure. Although the city had a well-developed underground metro system, the participants noticed an increase in traffic jams and the appearance of new retail shops, which they associated with population growth. They also mentioned that population pressures were noticeable in the housing market, which had become more competitive for renters and more expensive for buyers.

> Judging from the traffic jams, they have increased in the past five years. If you look from the perspective of the number of retail spaces, kiosks, shops, these numbers also went up. That means that there must be enough purchasing power. There are more people, that's for sure. New buildings are being built; apartments are being bought up. Renting an apartment has become challenging. At rush hour, it's not realistic to leave the city on Friday or return on Sunday. That is, you can see what kind of flow goes to Kharkov. And in the railway, it's the same. You can't just get a ticket [on the spot] to go somewhere, or to come back to Kharkov. And this is given the full-fledged work of the railway. Well, it's my opinion but of course, the number of people has gone up. (P8, FGD-10 Kharkiv_locals_men)

> In addition to my private business, I have worked as a taxi driver during the lockdown. Half of all new buildings are occupied by [people from] Luhansk and Donetsk. That is, you drive into the parking lot of any newbuild, and half are AH and BB [license plates from Donetsk and Luhansk]. As for the real estate market in Kharkov, I think that the newcomers raised [prices in] this segment. But a plus is that mostly economically active people moved here anyway. I think the city only benefited from this. (P1, FGD-10 Kharkiv_locals_men)

The Kharkiv participants thought that the inflow of newcomers to the city reinforced previous migration processes. Even IDPs who had moved to the city within the last few years thought the city was predominantly composed of newcomers. Unlike the participants in Mariupol, however, the Kharkiv participants were sometimes critical of newcomers, especially foreigners from western and other countries, citing the challenges of assimilation.

> My observations have shown that the bulk of Kharkiv residents are not Kharkivites. I even meet people at work . . . . You communicate with them for a long time, you think that they are from Kharkiv. And then he tells you: 'Yes, I came from Vinnitsa'. Or from somewhere else. For me, this is an indicator that the city is developing, the city is alive, the city has some prospects. People come here not only out of necessity, but they also have goals. There are enough jobs. It's good, I think. (P4, FGD-11 Kharkiv_IDPs_women)

> I have also noticed a very large influx of foreigners. From the West and other countries, it is colossal. I have not come across them before, only after I started working part-time in a taxi. And it's not very good, I think. Kharkiv does not benefit from this. People, they live... for example, to compare, people not only from Luhansk who move to Kharkiv, but also from neighbouring areas . . . . People from rural areas are coming to the centre [city of Kharkiv]. I communicate with many people, and these people somehow integrate into the city, and they assimilate. But the foreigners who come here, they do not particularly assimilate neither do they merge into [our] society (P1, FGD-10 Kharkiv_locals_men)

The participants from Kharkiv mentioned that the population increase in their cities came at the expense of surrounding rural areas, which had been suffering from outmigration for decades. The empty towns and villages reflected the loss of opportunities and the decaying infrastructure now widespread across rural Ukraine. Two quotes from the same focus group vividly illustrate this point:

> Cities are growing. But what about the villages? Well yes, the villages are dying out. I know that around Kharkiv, there were many farms that no longer exist. Where did these people go? All of these people are in Kharkiv, their descendants or they themselves. (P4, FGD-10 Kharkiv_locals_men)

> Well, in Kharkov I can take my younger child to school, we have at least four classes, and it's normal. When I visit my parents, where my sister also lives, the schools there are empty. Schools are closed there. So, in the cities, yes, cities are growing. But the villages are dying out. In my case, I have a bit of knowledge of rural areas, as I provide internet there. Schools there are simply . . . damn it . . . they are still open because of those several families . . . because they still have children who are 10 years old, and that's it. (P1, FGD-10 Kharkiv_locals_men)

"There are a lot of women with baby carriages"

We also prompted the participants to think about the reasons why the population had increased in the urban areas. Some participants thought the "overpopulation" coincided with a so-called "baby boom" in recent years. The baby boom could be linked to both the increasing number of people in the cities as well as recent improvements, compared to the conflict period:

> –Well, I noticed, that in 2014–2015, fewer children were born. About three years later, especially in the last year, I noticed a lot of women with baby carriages. Maybe they are from the regions. And for some reason there are a lot of twins. And a lot of people who have two or three children. I have not noticed that there were fewer children.
>
> *And in 2014–2015, according to your observations?*

> –It seems to me that then there was much more uncertainty. Before that, this is how it was. Because of the threat of the war. It was not clear [to people] what's going on. (P7, FGD-12 Kharkiv_locals_women)

Nonetheless, opinions on population trends were mixed, with some participants saying that they saw many children, but also providing anecdotes about their own acquaintances who were not having children.

> Visually speaking about parks, schools, kindergartens, I see that there are quite a lot of children. And it seems to me that there are more of them, visually, compared to the previous year. Although, judging from my conversations, most of my friends, as it were, well . . . do not want to have children. It's because of financial problems. (P2, FGD-1 Mariupol_IDPs_men)

A general concern about having children, and especially about having more than one child, permeated the discussions. These anxieties were often linked to economic uncertainty, the pandemic and the war. The participants mentioned that people they know are afraid to have any children or to have more than one child, as the following quote illustrates:

> It seems to me that the birth rate has fallen. Yes, there are children around. But I want to say that there is a fear of giving birth to more than one child. Maximum two [children]. Two [children] is a ceiling. And three is considered like 'Oh, that's it. What are you thinking about?' One family, one child. If there are two, it's already something like . . . . Three is completely incomprehensible. (P1, FGD-12 Kharkiv_locals_women)

In the majority of the discussions, Kharkiv and Mariupol were described as thriving, vibrant cities, especially since the end of the Covid-19 lockdowns. The population growth in these cities was attributed to immigration, particularly from the Donbas, and to higher fertility. Note that few people in these cities discussed high mortality, even in the context of Covid-19. Although the participants frequently mentioned issues related to poor infrastructure, unemployment and high costs, they did not perceive the cities themselves to be shrinking.

4.2 Perceptions of local population decline in Donbas villages

"*I see more people leaving and empty houses appear*"

The participants living in the rural Donbas were much more concerned about depopulating villages. The triple burden was evident in the participants' narratives; while they focused on outmigration, they also acknowledged that fertility was low and mortality was high. According to the participants, the underlying reasons for the population decline were the lack of job opportunities, the degradation of infrastructure and limited public transport. As a result of these conditions, more and more people, and especially young people, were leaving the villages.

> But still, young people go and look for work in the city more and more. A few [young people] work the soil. More go to the city – Mariupol is not far away. And they drive. [. . .] If before, there were more intercity buses, now there are . . . for example, after seven, even after six in the evening, you will not always be able to get back to the village. The transport has been reduced, as far as I understand. And it is very difficult to get home in the evening. So, one needs to have a job that allows one to get home before dinner. (P1, FGD-8 Don-rural_locals_women)

> I can only speak for my village. Here, it is not . . . it is not such a popular resort that people come here to buy houses and settle down. It is not often that something like this happens. Our location is close to the centre, I mean Mariupol, but still . . . People do not come here in large numbers. Those who do come are not enough. More people leave and go to work somewhere, in other places. Mariupol, and nearby. I see more people leaving [the village] and empty houses appear. (P6, FGD-6 Don-rural_locals_men)

Even the IDPs who first arrived in the area were leaving:

> When the hostilities began, people immediately came to our village. There were not many of them. They left almost immediately . . . let's say, they lived here for a year, a year and a half, and left for somewhere else. (P1, FGD-6 Don-rural_locals_men)

"There are 10–15 times more deaths than people born"

Unlike the urban participants, the rural participants mentioned high mortality as a cause of population decline in their villages. They claimed that mortality was higher than fertility, demonstrating that they were aware and concerned about the trends.

> –Let's say there are 10-15 times more deaths than people born.
>
> *10–15 times?*
>
> –Yes, if three people were born, then up to 30 people die, let's say. Especially with Covid. Well, a lot of people are dying.
>
> *It has affected many, right?*
>
> –Yes, exactly, let's say, people over 50. Well, not very old. (P1, FGD-6 Don-rural_locals_men)

> If the death rate rises, it [population] decreases . . . Now it is for certain that the death rate is high not only among the elderly, but also among the youth. There are numbers . . . they even register [deaths] among children.

> Of course, the birth rate is decreasing, and this is quite normal. But natural growth is also decreasing. (P9, FGD-7 Don-rural_IDPs_women)

High mortality was linked to the war and COVID-19, as well as to structural factors such a lack of professionals in the villages and the amount of money needed to access health care services. This meant that older people on a minimal pension, especially those without any relatives, were the most vulnerable.

> The war has killed youth. Covid has brought down everyone in a row . . . those who had issues with immunity, or other complications, it's not clear why. Then, there is a lack of doctors and their intellectual skills, so to speak, unfortunately. Then, of course, also the material conditions. Because in order to get cured properly, you need money. And if there is no money – let's say a pensioner went there [to a hospital], who has a pension of 4000 UAH (equivalent of 108 EUR), then he will end there . . . without relatives, then that's it [for him]. (P4, FGD-7 Don-rural_IDPs_women)

According to the participants, fertility decline was especially visible at local kindergartens and schools. They also mentioned a lack of higher parity births.

> I think that the birth rate has indeed decreased. I look at . . . my children go to kindergarten. Before, the group was of 20 people, now it is only 12, let's say. The same applies to the schools, where classes are with 12 people. When I was finishing school, we were 30 people in my class. I think the birth rate has definitely gone down. And this has to do with money. (P3, FGD-7 Don-rural_IDPs_women)

> Families used to have two or three children. But now, if young people give birth to one child, they cannot afford any more, or do not dare because of the current situation. [. . .] There are fewer children in schools. Our rural schools were grouped into one in neighbouring villages. So, in our village we have a very good school and a kindergarten. But due to the fact that there are so few children, we will be transferred to neighbouring villages and grouped with the schools from other villages. (P7, FGD-8 Don-rural_locals_women)

In general, both the village and city dwellers characterised the demographic situation in the rural areas as bleak in comparison to that in the urban areas. The rural Donbas participants described how a lack of development and general stagnation constantly reinforced all three population components: people were leaving the villages because of few opportunities; fertility was low because of the reduced standard of living; and mortality was high because professional health care staff had left. Thus, participants in the rural areas clearly indicated that they could feel the consequences of the triple burden of population decline.

4.3 Perceptions of local population decline in Donetsk

"Empty! Empty!"

The situation in Donetsk was even worse. An overwhelming sense of desolation permeated the discussions held in this region. Remember that Donetsk experienced armed conflict in 2014, followed by a massive outflow of people in subsequent years. These population processes were reflected in the participants' descriptions of Donetsk, as well as of the neighbouring towns and villages. They spoke nostalgically of pre-2014 Donetsk, a once-bustling city with nearly two million people that had since been cut off from the world. Now Donetsk felt like a village, with only familiar faces on the streets and few foreigners or newcomers. Residents spoke of empty apartments, deserted neighbourhoods, and eerily quiet streets with few people or cars. The 10 pm curfew, which had been in effect since the start of the war, exacerbated this situation, as it stifled any evening activity or nightlife.

> Empty! Empty! There are now fewer cars on the street during the day than before the war at night. Empty! You walk... there is only one boulevard named after Pushkin – 10–20 people walk along the boulevard, that's all. Now, you go out into the street and it's empty, there really is no one. People come to buy something, and they leave. There already a reflex like that of Pavlov's dog – at 10 o'clock I already want to sleep. (P4, FGD-13 NGCA_men)
>
> P3: The fewer the people, the fewer the facilities, the fewer enterprises are created. Even within the service sector, nothing is developing. Fewer facilities, fewer developments, less life.
>
> P5: It turns out that now, judging from the internal situation, we very much look like some small urban-type settlement, in which ... I don't know ... people come from the nearest villages. Everyone knows each other here. And there is no influx of new people. (FGD-14 NGCA_men)
>
> P5: I went to Rostov(on-Don) [an oblast centre city in Russia, 208 km from Donetsk] for two or three years in a row. If we compare [Donetsk], for example, with the same Rostov, there are people everywhere. You go to the right, there are people; to the left, there are also people. Straight; people too. People are everywhere. You come back here, but it is empty, there is no one. Maybe some people are around during the day. [...] Compared to the same year 2013–14, when everything was fine, there were a lot of people here, many kinds of events and so on. This is very sad. (FGD-14 NGCA_men)

"All the good specialists have left"

Outmigration was clearly one of the main reasons for population decline in Donetsk.

P9: The most active, the visible ones, are leaving. That is, those people who travel, are around and do something. So, those people, they left. And those who sit at home, they do not move anywhere . . .

P6: No, I can say by the number of free apartments in my house that 30% [have left] for sure. So, we now have 30% fewer [people]. In my hallway, specifically, 40% of apartments are empty. This is just in my hallway. So, 30% is the minimum figure. (FGD-14 NGCA_men)

The accounts in Donetsk complemented those in Kharkiv and Mariupol, where participants said that many IDPs were qualified experts. Doctors and medical personnel were the most likely to have left for Ukraine and Russia, partially because the main medical university, which used to be one of the largest in Ukraine, moved to Mariupol (Overton, 2019). As a result, the participants complained that there were not enough experts to provide adequate health care.

I mean the medical school. I have acquaintances who have left since the beginning of the conflict . . . Specialists have left for Ukraine. (P4, FGD-13 NGCA_men)

Many specialists, such as doctors, who were very good, had left. Basically, all the good specialists had left. Apparently, they are well paid now. [They had left] mainly for Russia. (P2, FGD-15 NGCA_women)

"If there is no light in the tunnel, then there is nowhere to go"

Those participants who wanted to leave indicated that they struggled with unemployment, insufficient job prospects and low salaries. But many said they did not have the necessary connections or funds to allow them to pursue opportunities elsewhere. Some also said they could not leave because they had to take care of elderly relatives, or for health reasons. Age was also mentioned as a factor, with people over age 40 more likely to stay and people under age 40 more likely to leave.

People aged 40 and plus, plus, plus . . . they remain; young people leave either for Ukraine or for Russia. Because what are the prospects? Prospects are zero. (P7, FGD-13 NGCA_men)

Those participants who were more comfortable staying usually had a decent job, often online or at a small company; or they did seasonal work in Russia. At the same time, many participants expressed a fear of something bigger looming over them that would force them to leave.

P3: Traveling into the unknown is a double-edged sword. One must decide for oneself. But at this stage of life, for the next maybe five or 10 years, I and my family are not considering such a plan. But life is such a thing that it can turn around at any moment, as with the war. That you pack everything and leave.

> *What about others? Any plans?*
>
> P7: Of course, I want to leave. You know, the difficulties that await upon arrival in another city are not as frightening as continuing to live in the conditions that we now must live in. Young people have a lot of ambition and a lot of potential. And this potential is destroyed [if they work] as waiters – this is a so-so prospect. (FGD-15 NGCA_women)

Some participants reported that they or others they knew had tried to establish themselves in Russia or Ukraine. These were often the more "proactive" groups mentioned before. However, they had felt compelled to return to Donetsk for family, business, housing or other reasons.

> I also went to Russia to visit the relatives. And I worked in Moscow for a while. Basically, I came back because there was no possibility . . . Here I have my own property, but there it is not possible to buy one. Because it takes a long time . . . And to live permanently in a rented apartment is expensive. And a plus is that my parents are here. I had left when the conflict was more acute, but then returned later. Well, anyhow, I am not fixed here, I can go to work at any time if I decide that I urgently need money. Because there are no opportunities to earn money here now. (P6, FGD-14 NGCA_men)
>
> I can't speak for everyone. But if we take our family . . . there was one unsuccessful attempt to leave, and it was not very successful. We could not gain a foothold and stay there. But we haven't tried and won't try to do it again. Because of my parents. [. . .] Because my mother, who travelled with us, upon returning, said categorically: 'I won't go anywhere anymore'. And we would not leave her here alone anyway. (P5, FGD-15 NGCA_women)

We also asked the participants in Kharkiv, Mariupol and rural Donbas about the types of people who had remained in the Donbas. Interestingly, no one inside or outside the occupied territories said people stayed due to ideology, or because they believed the secessionist republics should be independent or part of Russia. The initial responses were always practical and pragmatic – those who stayed behind were pensioners, were responsible for caring for older people, or had families. Those without means or who could not sell their home were unable to leave.

> They do not know how to find themselves in the future. And those who have just graduated from school, where should they go next? With this diploma, where can they go, to South Ossetia? Or to Transnistria? It is not clear where to run. Many students come to Mariupol. Well, again, it's difficult with the [high] prices here. I have a relative who receives a scholarship both in Ukraine and in the uncontrolled territory. People don't like it, but they can't change anything. (P4, FGD-6 Don-rural_locals_men)
>
> Young people leave, but families . . . I don't know, maybe it's difficult for them to leave. There are other reasons, I can't say for sure. Well, because

> housing is a very strong anchor. It [leaving] scares you . . . you don't know if you will find a good job there to feed your family. Well, 'there', I mean - in Ukraine, if you consider our current moment. Good job so you can secure a rental for your family. My parents always call me – 'We have our own housing there, empty'. But we are not going with my husband. For obvious reasons, my husband does not want to go to Donetsk very much. The war is still there. (P2, FGD-3 Mariupol_IDPs_women)

"Giving birth still brings some stability"

Despite the bleak description of Donetsk and the surrounding areas, residents noted that birth rates had seemed to increase in central Donetsk in recent years. Some participants were even optimistic, mentioning their own and their friends' decisions to have a second child.

> –The birth rate has slightly increased compared to 2014. We even decided to have a second child. About two years ago, yes.
>
> *What helped you to decide?*
>
> P2: Husband wanted to (laughs). (P2, FGD-15 NGCA_women)
>
> P4: There is a boom. All my friends began to give birth to a second child, a third. I don't know what it's about. . .
>
> *Interesting, why?*
>
> P4: . . .but a lot, really a lot.
>
> P6: It has to do with the curfew (laughs). (FGD-16 NGCA_women)

Others mentioned that childbearing was encouraged through payments for having children, which gave women a degree of stability, especially if they did not work. The participants openly challenged the idea of being childfree as a choice, suggesting that those who could have children would forego having them only if they did not have money.

> The birth rate has gone up during the pandemic precisely because giving birth still brings some stability. A woman may think that she may lose her job for any reason . . . Then, she takes maternity leave, and there is already some kind of stability for three years, there are at least some payments. At least she's doing something. (P9, FGD-14 NGCA_men)
>
> There are just fewer people of childbearing age. People of childbearing age are the ones who leave [the region]. So those people who can give birth to children, they try to give birth. That's why there are fewer children but more people who can potentially have children. There is no such a thing as childfree; that is, people who do not want to have children. (P9, FGD-14 NGCA_men)

Moreover, as described above, some areas around Donetsk had been devastated by the war. People who lived on the outskirts could still hear the bombs, and, as one participant put it: "Where shooting is still heard, and God forbid, the shooting is still seen, naturally, there will be no children" (P1, FGD-14 NGCA_men). Thus, although birth rates had apparently started to rise in some areas of Donetsk, it was clear that overall, Donetsk was experiencing severe depopulation.

4.4 Perceptions of Ukraine's population decline

The "demographic hole"

After asking about perceptions of local population decline, we explicitly asked participants whether they thought population decline was a problem in Ukraine as a whole. We did not pose this question to participants in occupied Donetsk, given the political situation there. Although some participants had clear opinions, others found the question challenging either because they lacked knowledge or because they distrusted the available information. While some participants referenced statistics from Wikipedia, official sources and mainstream news, others mentioned information from blogs, and even conspiracy theories. Those who referred to official statistics – for example, estimations that 38 million people lived in the country – expressed reservations about the accuracy of the data. Given that Ukraine has not had a census since 2001, such concerns are warranted; however, it was difficult to know whether the lack of trust in statistics was due to a lack of trust in government, in science, or both. In general, the participants acknowledged the difficulty of knowing whom to believe, especially when their own observations were not aligned with the statistics, as expressed by this rural participant:

> Of course, there are enough young mothers with strollers that you can bump into on a street. But according to the statistics, there is only one person born for two dead in Ukraine. This means that the population is decreasing, if one trusts the mass media. But visually it does not seem visible that the birth rate has fallen. So, I don't know what to believe. (P2, FGD-5, Don-rural_IDPs_men)

Despite their scepticism of the data, most of the participants thought that population decline was a problem, using terms such as "catastrophic", a "demographic hole" or "dying out of the nation". Thus, they believed that the declining population was a problem for Ukraine both now and in the future. Some of them described the problem as circular, referring to all three factors of the triple burden of depopulation: low fertility, high mortality and outmigration.

Because of these trends, the participants observed, people did not want to stay in the country.

> This is a huge problem. Because the youths have left, in huge numbers. Some simply died before Covid because of the conflict in the Donbas.

> ... battles claimed a huge number of lives. This is the second factor. And the third one is the coronavirus. Now, I don't know how huge the demographic hole is, but the birth rate is falling, because there is not enough money for anything. Naturally, if you have two children, you will not allow yourself a third one. Of course, this is a problem. If I love my country, I want it to prosper, so that at least something was done here. Not that people only go to sell something on Barabashova (the largest bazar in Kharkiv) or which one is now the biggest where people sell things?! [I want] something to be produced, and that there is science. At our universities we not only have foreigners, but many of them. What about Ukrainians? What will happen in five years? (P6, FGD-12, Kharkiv-local_women)

Some of the participants' descriptions of the link between population and national decline had undertones of xenophobia and racism. The critique above implied that the government was not doing enough for its citizens, while allowing immigration. In addition, declining population was seen as having an impact on cultural and national traditions that were decaying, which, in turn, further motivated people not to stay, but to leave.

> The disappearance of nation, culture and everything else, traditions. Then, if people are leaving their country, this means that they are no longer patriots. They are simply seeking better life possibilities. Because here they feel themselves insecure, deprived and inferior. (P7, FGD-8, Don-rural locals_women)

"If people leave, it means that we can expect nothing good"

The participants, who were of reproductive age, frequently mentioned that emigration had negative consequences for Ukraine, especially because it meant that only pensioners would be left. Indeed, the issue of ageing came up repeatedly, with some participants comparing Ukraine to Europe, citing common worries about the pension system. They argued that the current pension system was not solid and would not survive more than one or two years, as soon no one would be left to pay into the pension fund. Others recognised that fewer active people meant fewer taxes. Thus, living in an "old nation" was clearly an issue of concern.

> And the nation is ageing, unfortunately. Many are becoming pensioners, and young people under 40, who may be useful to the country, to the cities, leave for Poland and other countries. Therefore, it is all very sad. (P1, FGD-2 Mariupol_locals_men)

The focus group participants frequently mentioned emigration, and that many Ukrainians, including their own children and relatives, had left for better opportunities and to earn higher wages. A man from Kharkiv estimated that 10% of Ukrainians were working in Poland, Germany, Czechia and Russia, although he also noted that not all were permanent migrants. The participants also remarked that the people who migrated were the "best population"; i.e., the hardest-working people aged 20 to 35. Many of these migrants had a university or professional education but no prospects in Ukraine, and were thus seeking a higher salary and a better life abroad. These discussions gave the impression that the participants saw Ukrainians as a highly mobile population. However, the participants also referred to this situation with a sense of sorrow and doom.

> "There is no stability [in the country]. If people leave, it means that they can expect nothing good. [. . .] If before some people were indecisive, now everyone leaves". (P1, FGD-8, Don-rural_local_women)

> "I think this is problem for the country, because these guys sell their young heads, their labour force, in another country. And they do not invest it somehow within the framework of Ukraine. Instead, they go and sell their labour force somewhere abroad. They do not do it in their own country". (FGD-5 Don-rural_IDPs_men)

"Our government has done everything it could so that people would not have children"

The participants recognised that the main reason for the population decline was fewer births, and that the number of deaths exceeded the number of births. They also often blamed the government or political situation for the decline in childbearing. Earlier generations had received substantial support from the government, which helped them to raise and educate their children. In recent years, however, raising children had come to be seen exclusively as the parents' problem. According to many participants, the current government was no longer providing social support and was directly responsible for the lack of income, the degradation of education and the poor quality of medicine. In several focus groups, participants quipped that the payments parents received were not enough to buy a "packet of Pampers".

> Our government has done everything it could so that people would not have children. First, low payments. Who will give birth, how will the population be replenished if people don't have children? Children need to be given something, and so on. This is why this is a problem. (P2, FGD-7, Don-rural_IDPs_women)

As in the discussions about local areas, the participants linked the fertility decline to the economic situation, noting how difficult it was for young people to have children. Financial reasons for not having children permeated all of the focus group discussions, such as low standards of living, insufficient income and rising costs. The war was mentioned as a factor leading young people to postpone childbearing. Moreover, the outmigration of youth, and cohabitation rather than marriage, were seen as having an impact on fertility and overall population decline in Ukraine:

> I read some statistics and judging from my friends . . . There are not many children now. In general, there are problems with this in our country. And young people are leaving. This is why we have this birth crisis. If I'm not mistaken, the birth rate is now equal to that in the 1990s. Well, that was the period of my youth. And in my opinion, this is very low. Plus, now there's a war. [. . .] Plus, these civil marriages which, in my opinion, affect the fact that . . . A girl often wants to have a stamp in her passport [a legal proof of marriage], and then have children . . . [If this does not happen] children are postponed. In one word, I feel very sorry. I can't imagine what will happen next. I feel so sorry for our country. (P6, FGD-12 Kharkiv_locals_women)

"We are like cockroaches here"

Surprisingly, references to conspiracy theories around population decline came up in at least six out of 16 focus group. While it is difficult to know how seriously the participants believed these "rumours", they often linked these theories to the state not doing enough, and even being against its own citizens.

> Dying . . . war . . . then the virus, and then . . . plus a bunch of all sorts of other things that push you to not give birth. Because it's hard to 'put a child on his feet'. You can do this with one, but if you have two or three . . . no comment. This is where it all boils down to. And what is all this for? Who is worse off for this? We are like cockroaches here. Those who do all this, they do it on purpose. We have long proven that overpopulation is happening on the Planet Earth. And somehow . . . no one asks us, unfortunately, whether we want to live on not, they mow down everyone in a row. (P4, FGD-7 Don-rural_IDP_women)

The discussions sometimes touched a nerve or became heated, especially when participants talked about environmental and health factors underlying high mortality and low fertility. Some argued that Covid-19 and high mortality were crises that had been intentionally inflicted on Ukraine, and that someone benefited from them financially.

> Due to poor ecology, there are many diseases. There is a lot of infertility now. Therefore, Ukraine is essentially dying out. With such a politics of population destruction from our government – the increase in the utility bills tariffs, with a conflict in the country, no one can make ends meet. I do not want to sound rude but, for example, people who are considerate and conscious, they think ahead, so before they give birth to a child, about how to provide for him. (P4, FGD-1 Mariupol_IDP_men)

Finally, some participants argued that population decline was not a problem from a global environmental perspective, as more people and global overpopulation were putting a strain on ecological resources. They also reasoned that fewer people would be better, because there are not enough jobs for everyone.

> People do not use them [resources] rationally. We harm nature. Again, babies mean diapers, they are made of plastic. We use more, we drink more, we also 'shit' more, pardon the expression. Thus, there should be fewer people, not only in Ukraine, but, in principle, all over the world . . . I am only in favour of reducing the [population] numbers because we need somewhere to live, something to breathe, something to eat. All this only worsens the condition of our land. And I don't understand why it is being done, except for political and economic reasons. Do we need more workers? Is it necessary for the state? On the other hand, if we have more people – do we have enough jobs for them? No one will pay for their education. They say that we need to have more births. To whom do we owe this? What for? It is not clear to me. (P7, FGD-11 Kharkiv_IDPs_women)

5 Conclusions

For several decades, demographers have recognised that Ukraine is facing a "depopulation crisis" (Chuiko, 2001; Steshenko, 2001), and this trend has been the subject of media and news reports (Golub, 2018; Kramar, 2019). Our online focus groups have demonstrated that average Ukrainians have also been aware of this crisis. It thus appears that knowledge of this issue has trickled down to popular consciousness, and has been reinforced through personal observations. The conversations about national population decline were often bleak, permeated by a sense of doom about the future of the country. Depopulation has had dire consequences for Ukraine, as it has led to a shrinking labour force, severe ageing and a general lack of development. The participants also identified the triple burden of depopulation. The main concern raised was about a lack of births, especially of second or third children, as young people were "refusing" to give birth. Participants complained about the toll that high emigration was taking, with the most active young people leaving. Mortality was also mentioned, but it was the least recognised factor in population decline, despite the high number of excess deaths from Covid-19 that had occurred over the previous year (Our World in Data, 2022).

Our focus groups also recognised that the decline in population was uneven across the country, and that even if the nation's total population was declining, certain cities could still be expanding. Participants in all focus groups contrasted the growth in urban areas with the deterioration of conditions in rural areas, and made the direct link between people moving out of villages and into cities. The discourse of the decline of the rural areas in contrast to the growth of neighbouring urban areas is familiar throughout much of Europe (Benassi et al., 2023; Collantes and Pinilla, 2011; Copus et al., 2021). Predictably, our participants complained about the degradation of infrastructure and the lack of resources in rural areas. The rural residents recognised that the decline was due not only to outmigration, but also low to birth rates. They observed that childcare centres were closing and schools from different villages had to be merged. Economic conditions in rural areas prevented residents from wanting more than one child. Rural participants also spoke of high death rates due to older and impoverished residents being unable to obtain adequate health care, along with the devastating impact of Covid-19. Many mentioned they had lost relatives recently, even though the majority of deaths from Covid-19 were yet to come in the winter of 2021–22 (Ourworldindata.org, 2022). Thus, it was clear from the participants' comments that the effects of the triple burden of depopulation in rural areas, combined with poverty and neglect, were more severe in Ukraine than in many parts of rural Europe.

Unlike most other depopulating regions of Europe, the area we studied was also affected by war and years of "frozen conflict". These events visibly shaped the larger regional cities at the expense of population losses in rural Donbas and Donetsk. Although most of the participants in Kharkiv and Mariupol acknowledged that their cities benefited from the influx of specialists and experts, some argued that the increased population was straining infrastructure and resources. While internally displaced persons were usually portrayed in a positive light, some participants, particularly those in Mariupol, were wary of additional population pressures. These discussions are a reminder that even though a country may be depopulating overall, certain regions, and especially urban areas, may still be growing, often due to unexpected migration processes.

We also had the unprecedented opportunity to conduct focus groups with people in the separatist-occupied territory of Donetsk; an area that has been nearly inaccessible to western, or even Ukrainian, researchers. Although this area has been physically cut off from the rest of the world, the online discussions revealed how virtually connected the regions are through the internet, Zoom and social media (although these areas had been increasingly falling under Russian media control). The participants described the types of people who had left Donetsk or who had stayed behind, and how ordinary people were still living. The discussions corroborated the observations of the people who were living in Kharkiv and Mariupol: i.e., that those who remained behind were primarily elderly people, or were individuals who were caring for older people, lacked funds and networks outside of Donetsk, or, in some cases, were financially benefiting from the Russian occupation. Overall, the Donetsk residents acutely felt the population decline in their apartment buildings, on the streets, and in their social networks. They recognised that the shrinking population had led to less diversity and fewer younger people, drastically changing the age structure of the population. Indeed, the participants who remained seemed "displaced in place", with little hope for the future (Rimpiläinen, 2022). As one participant put it, "We are dying out here".

Although our participants often had strident opinions about population change, they also expressed uncertainty in their answers mixed with a lack of trust in statistics and the Ukrainian government. To some extent, these anxieties were warranted, as

Ukraine had not had a census in two decades, and the political situation had long been unstable. However, we were surprised at the pervasiveness and the power of global conspiracy theories in the discussions, which had spread even to rural Ukraine. Statements such as "those who are doing this, they are doing it on purpose" reflected the participants' lack of agency as events such as war, the pandemic, inflation and the economic crisis buffeted their lives. Although our participants described their own individual decisions – e.g., to move or have a child – it was clear they recognised the impact of macro-level shocks on population composition and size, even if they had no explanation for why they occurred.

In conclusion, although our research is not representative of the population of Ukraine, or even of the population of the regions where we conducted the focus groups, the discussions provide evidence that Ukrainians have been aware of population change at both the local and the national level, and that individuals can perceive how major events shape populations. It is important to note, however, that concerns about depopulation were not at the top of our participants' list of problems. Rising costs, under-employment, Covid-19 lockdowns and children's education were considered far more important in Kharkiv, Mariupol and the villages. In Donetsk, curfews, difficulties in obtaining official documents, lost contact with relatives and deteriorating infrastructure were the participants' main grievances (Perelli-Harris et al., 2022). Overall, the participants blamed economic stagnation, government ineptitude, the Covid-19 pandemic and the political impasse for their woes, but not population decline per se. Nonetheless, although population decline was not considered to be the most important issue in Ukraine, when we posed the question to the focus groups directly, the participants recognised that population decline was both a cause and a consequence of Ukraine's larger problems.

To our great sadness, the horrible events of the past year have accelerated Ukraine's population decline in ways scarcely imaginable in July 2021. Ukraine's people have experienced immense turmoil and trauma, especially in the regions where our focus groups took place. Kharkiv, described in our focus groups as a vibrant, bustling and rapidly growing city, has had half of its population move away and is still shelled daily. Mariupol, which residents said would develop and thrive in the coming years, has been completely obliterated. The villages where our focus groups took place are currently occupied by Russians or are experiencing hell on the front line. Their plight is now indicative of the extreme desolation that will occur throughout the Donbas and south-east Ukraine as these regions turn into near-empty wastelands. Most importantly, we must remember the voices of our focus group participants, who have had their lives directly threatened by violence. They have been displaced, destitute, detained, forcibly deported, conscripted into the Russian army or worse. We can only hope that the war will end soon so that Ukraine and its people can rebuild, regenerate and stop the inimical spiral of depopulation.

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Is Spanish depopulation irreversible? Recent demographic and spatial changes in small municipalities

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Abstract

Many small Spanish municipalities (those with less than 2000 inhabitants) experienced population growth during the first decade of the 21st century due to a large influx of foreign immigrants. However, the Great Recession put an end to this trend. The first aim of this paper is to analyse the demographic impact of the new phase of economic growth – known as the "post-crisis" period (2014–2020) – on small Spanish municipalities. The second aim is to carry out an initial analysis of the impact of the Covid-19 pandemic crisis on the growth of these municipalities. The results of a nine-category typology show that during the post-crisis period, the vast majority of villages continued to depopulate, while a minority gained population or had stagnant population figures. The Covid-19 pandemic represented a turning point, with small municipalities as a whole starting to grow again. However, the population did not increase in all categories of villages or in all regions of rural Spain. The results for both periods (post-crisis and Covid-19 pandemic) highlight the growing importance of migration to demographic change in the smallest municipalities.

Keywords: rural depopulation; post-crisis period; Covid-19 pandemics; small municipalities; Spain

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1 Introduction

While Spain experienced strong population growth throughout the 20th century, with the total population increasing from 18.6 million inhabitants in 1900 to 41.1 million in 2001, municipalities with less than 2000 inhabitants experienced considerable population losses due to high levels of migration from the countryside to urban areas. This phenomenon has been called the Spanish "rural exodus". While this exodus began in some areas as early as the 19th century (Recaño, 2017; Silvestre, 2005), it intensified in the first 30 years of the 20th century. Then, after declining during the Civil War and the post-war period, it accelerated again from the 1950s to the 1970s (Collantes and Pinilla, 2019; García-Docampo and Otero-Enríquez, 2012; Gutiérrez et al., 2020; Pujadas, 2007). During this period, industrial, tourist and urban areas – particularly Madrid and Barcelona, but also other large cities and provincial capitals – underwent exponential growth as a result of internal migration. Simultaneously, small municipalities progressively lost population. The 1970s oil crisis and the recovery of democracy coincided with the end of this rural exodus, which occurred largely because of the depletion of demographic reserves. Since then, the main features of the dwindling populations of these small municipalities have been ageing and masculinisation (Comisionado del Gobierno para el Reto Demográfico, 2018), as these towns have not recovered from decades of population losses due to migration. These losses are relevant, as a municipality's population size is a key determinant not only of its ability to provide efficient services, but also of its capacity to reproduce itself and survive demographically (Camarero et al., 2009; Molinero, 2019; Pujadas and Bayona-i-Carrasco, 2019).

The following figures illustrate the long-lasting depopulation process in Spain and the predominance of small municipalities within the Spanish municipal structure. In 1900, 27.5% of the total population of Spain could be categorised as "rural population", a concept applied to municipalities with under 2000 inhabitants by the Spanish National Statistical Institute (INE). In fact, at the time, 77.8% of municipalities in Spain had fewer than 2000 residents. The share of the rural population in the total population had decreased to 15.5% by 1950, and to 8.6%, by 1981. During the 1980s, the decline in the rural population slowed, as the number of people living in these small municipalities was already extremely low. Indeed, the share of the rural population in the total population had fallen to just 7.3% by 2001, and to 5.7% in 2021, when 2.7 million inhabitants were living in small municipalities (last available data). Out of the 8131 municipalities in Spain in 2021, 5871, or 72.2%, had less than 2000 inhabitants. Out of these 5871 municipalities, 61% currently have less than 1000 inhabitants, and less than 1.5 million people, or 3.1% of the Spanish population, live in them, even though these municipalities spatially occupy 40% of the country's territory (Recaño, 2017).

Due to their older population structure, natural growth is negative in the vast majority of the small municipalities; i.e., there are many more deaths than births. In addition, in most Spanish municipalities, internal migration growth is also negative. Therefore, in these areas, foreign immigration is an important determinant of future changes (Bayona-i-Carrasco and Gil-Alonso, 2013a; Camarero et al., 2013). During the first decade of the 21th century, many small municipalities started to grow (Collantes et al., 2014), as large numbers of foreign migrants entered the country in those years. Due in part to this influx of international migrants, the population of Spain reached more than 47 million in 2010. However, this period of demographic growth ended with the onset of the Great Recession. During the period from 2009 to 2014, Spain lost around 500,000 inhabitants, while small municipalities resumed their traditional depopulation trends. In this paper, our first aim is to answer the following questions: What effects did the new economic growth or "post-crisis" phase – defined as the period from 2014 to the onset of the Covid-19 crisis – have on the populations of small Spanish municipalities, and how did these effects differ from those in the economic crisis phase? Did they regain population as a whole? Did some municipalities gain population while others lost inhabitants? Which geographical characteristics of Spanish rural areas were associated with demographic revitalisation, and which were associated with depopulation?

The second aim of this paper is to carry out an initial analysis of the impact of the health and economic crisis caused by the Covid-19 pandemic on population growth in small municipalities. This exercise is interesting because it allows us to investigate whether the pandemic reinforced previous trends in small municipalities, or whether it introduced new demographic dynamics. This question is addressed by comparing the population registered in the *Padrón continuo* (local continuous register) on 1 January 2020 and on 1 January 2021 (the last official data available at the time of writing). Obviously, the Covid-19 pandemic had an impact on all demographic phenomena, increasing the number of deaths in municipalities with older populations, reducing the number of births (INE, 2021), and changing migratory flows. As international immigration slowed down during 2020 due to lockdowns and the closure of international borders (Arango et al., 2021 Fanjul, 2021), internal migration played a more prominent role, both because of its new intensity, and because the direction of flows changed (Del Romero and Arroyo, 2022; González-Leonardo et al., 2022; Recaño, 2020). Focusing on small municipalities is particularly important, as press reports[1] and provisional statistical data (Ajuntament de Barcelona, 2021; IDESCAT, 2022) indicate that there was a population flow from large cities to small

[1] The following are some newspaper articles on the subject: *El éxodo inmobiliario que viene tras el virus: de la ciudad al campo* (The real estate exodus, coming after the covid-19 pandemic: from the city to the countryside, *El País*, 2-5-2020) https://elpais.com/economia/2020-05-01/el-exodo-inmobiliario-que-viene-tras-el-virus-de-la-ciudad-al-campo.html; *El mapa del mayor éxodo desde las grandes ciudades de la última década: así se ha movido la población en la pandemia* (Map of the largest exodus from major cities in the last decade: how population moved during the pandemic, *El Diario*, 15-6-2021) https://www.eldiario.es/datos/pandemia-provoca-mayor-exodo-ciudades-ultima-decada-espana-rural-espana-vacia_1_8041708.html; *El fervor por dejar la ciudad decae al recuperarse la normalidad* (The desire to leave the city diminishes as normality is recovered, *La Vanguardia*, 12-10-2021) https://www.lavanguardia.com/vida/20211012/7783886/ciudades-pueblos-rural-vivir-habitantes-exodo-abandono.html.

towns. These were mainly people who were seeking to escape urban lockdowns and to live in less dense areas with better environmental conditions (Hamidi et al., 2020). We believe that examining whether these new migration flows from cities to rural areas have reversed depopulation trends, and have thus redrawn the spatial patterns that existed before the Covid-19 pandemic, is a good point from which to start predicting the demographic future of small municipalities.

2 Theoretical framework

In a dynamic definition of the term, depopulation refers to a chronic loss of population in a municipality that precludes the possibility that it will recover its previous maximum population size (Johnson and Lichter, 2019). According to Pinilla and Sáez (2017), depopulation is a demographic and spatial phenomenon that can be explained by economic factors, and that can, in many cases, be counteracted only by designing and implementing specific policies for this purpose (Collantes and Pinilla, 2020). Depopulation processes tend to be long-lasting, and to have distinctive features in each country depending on its stage of industrial development and of urbanisation (Bairoch, 1985). Britain led the way in Europe, followed by Belgium and the Netherlands, then by France and Germany, and, finally, by the southern European countries, including Italy and Spain. At the beginning of these processes of industrialisation and urbanisation, the rural population was declining slowly. After the Second World War, there was a period of acceleration in most countries. Like in Spain, rural depopulation began in Italy in the final decades of the 19th century, and accelerated between the 1950s and the 1970s (Del Panta and Detti, 2019). While rural depopulation slowed in the most advanced European countries in the 1960s, in the countries that were lagging behind, including in Spain, it did not start to slow until the 1980s (Collantes and Pinilla, 2011).

Some of the economic causes of rural depopulation are obvious: a change in the economic model, such as a shift from a traditional agrarian society to an industrial and service-based economy, can lead to a rural exodus (Molinero, 2022). However, the causes of rural emigration are diverse. Although economic considerations, and especially the desire to get a better job, are the most intuitive reasons for moving to other areas, some studies have suggested that the reasons why people move from small towns to cities go beyond a desire for better job opportunities. Other potential reasons for such moves include a desire to pursue educational opportunities, personal issues, and the feeling of belonging or the desire for personal experiences in urban areas. Indeed, several multidimensional issues are involved in the process of depopulation, which is always accompanied by social changes in rural communities (Rodríguez-Soler et al., 2020). In addition, in many European countries, low fertility levels and population ageing have led to the expansion of areas with negative natural growth, and particularly of rural areas (Johnson et al., 2015). From a demographic perspective, depopulation tends to be cumulative, as municipalities that have lost population in the past are also among those that are most likely to do so in the future, which contributes to the perpetuation of regressive trends in the rural population (Nieto-Masot et al., 2020; Reynaud et al., 2020).

In rural areas experiencing negative natural growth, a potential population increase can only come from positive migration growth; i.e., from more people arriving and settling in those areas than are leaving them. Moreover, these flows, whether international or national, must be big enough to offset negative natural dynamics. International migration has been one of the main sources of population recovery in small municipalities, both in the United States (Johnson and Lichter, 2019) and in Europe (Kordel et al., 2018; Rye and O'Reilly, 2020). Hence, there is a large body of academic literature that has analysed this phenomenon at both the international comparative level (Jentsch and Simard, 2009; Halfacree, 2008; Hugo and Morén, 2008; Milbourne, 2007) and the individual country level in the last two decades. For instance, in southern Europe (Döner et al., 2020), the cases of Greece (Kasimis et al., 2003), Italy (Reynaud et al., 2020) and Portugal (Fonseca, 2008) have been analysed. Moreover, international immigration settlement patterns in rural areas in Spain have been studied, both in the country as a whole (García-Abad and Otero-Enríquez, 2014; Lardiés-Bosque, 2018; Morén and Solana, 2004; Morén-Alegret et al., 2018) and in specific autonomous communities (Camarero and Sampedro, 2019; Delgado-Viñas, 2019; Esparcia, 2002; Gil-Alonso and Bayona-i-Carrasco, 2021; García-Coll and Sánchez-Aguilera, 2005; Solé et al., 2012). The results of these studies show that the arrival of foreign immigrants in rural areas has helped to counteract population losses; to change population trends; and, in some cases, to even reverse these trends. However, these effects have varied over time depending on fluctuations in the international economy that can lead to population changes (Gil-Alonso and Thiers, 2019). In addition, the effects of the arrival of foreign immigrants have varied across different parts of the country, strengthening long-standing polarisation processes between the more dynamic areas and the more regressive rural areas (Camarero, 2020; Roquer and Blay, 2008). Molinero (2022), for instance, has argued that the former areas are mainly located in peripheral (coastal) provinces, but also in some interior development axes; whereas the latter areas are mainly located in inland Spain. Among these more regressive areas, the author distinguished between "remote" rural areas and "ambivalent" areas, which are also largely located in the interior provinces, but are more economically diverse and resilient. However, changes in the functions of rural space are especially visible in the coastal regions. There, agricultural activities have become less relevant, while industrial activities, including agro-industry related to intensive agriculture, and above all services, have become increasingly important. Indeed, these new activities in the peripheral rural areas have helped them to retain their native populations, while also attracting international immigrants.

Internal migration, which is a key factor in population distribution in many European countries (Rowe et al., 2019) and in the world (Rees et al., 2017), has also had a very diverse impact on rural areas (Rivera, 2020). Generally, most Spanish rural municipalities have experienced negative internal migration growth: i.e., more people have left than have arrived. This internal migration growth has been particularly negative in places where population dynamics are especially regressive; that is, in small municipalities with an older, masculinised population that is decreasing. As more women than men migrate from villages to urban areas, 85% of the municipalities with less than 1000 inhabitants currently have a predominantly male population (Comisionado del Gobierno para el Reto Demográfico, 2018). The opposite trend has occurred in large urban areas, which have, in recent years, become increasingly attractive (Otero-Enríquez et al., 2019) as global centres where human capital is concentrated. These global cities (like Madrid and Barcelona) have attracted highly educated young people, most of whom come from medium and small cities, rather than from small municipalities. Recently, internal migration growth has even become negative in many provincial capitals of inland Spain as a consequence of this brain drain (González-Leonardo, 2021).

However, not all small municipalities have lost population as a result of internal migration. Two categories of small municipalities have received more internal migrants than they have lost. The first category includes municipalities that are located on the periphery of large urban areas (Bayona-i-Carrasco and Pujadas, 2020), or of large, medium or even small cities. For example, the municipalities located around county capitals in Catalonia (Gil-Alonso and Bayona-i-Carrasco, 2021) have benefited from suburbanisation flows. In addition to these small municipalities affected by urban sprawl, there is a second category of rural towns that are located further away from urban areas, and that have also attracted internal immigrants and gained population. This phenomenon, known as “counterurbanisation” (Berry, 1980 Mitchell, 2004), is not common in Spain. It tends to occur in rural areas of great scenic beauty and high environmental value, particularly in those located in high mountains or near the coast. As a result, these areas have managed to develop tourist activities that have enabled them to retain population and attract new inhabitants (Solé et al., 2012). Some of these new residents, called “neo-rurals”, have left the city to move closer to nature; while others have brought their urban lifestyles to the countryside, creating rural gentrification processes (Paniagua, 2002; Solana-Solana, 2006, 2010).

Another factor that can affect the survival of small municipalities is that some are used temporarily by a floating population who live in them for part of the year, mainly on holidays or weekends. The population of these towns multiplies during these periods. “Numerous studies by the Autonomous Communities estimate that, in summer, the rural floating population multiplies on average by 5 or 6. In smaller towns it increases by 2 to 3 times, and in the more tourist towns – which have sports facilities and other attractive elements – it multiplies by 10 times or even more” (Molinero and Alario, 2022: 195).

According to the 2011 census, the percentage of the population in small municipalities who belonged to the non-resident “linked” population was high, ranging from 29.5% for villages with less than 100 inhabitants to 21% in villages with between 100 and 500 inhabitants (Pujadas and Bayona-i-Carrasco, 2019). Many of these part-time residents, who might have been born in the village or come from an urban area, have restored old houses or built new ones, and thus have helped to prevent the abandonment of these small towns. Hence, while the permanent population has been decreasing in these municipalities, the number of houses has been increasing (Molinero and Alario, 2022). This housing stock of secondary homes used by a temporary, floating population is particularly important in the smaller villages. In fact, in many of these villages, there are more secondary homes than main residences (Bayona-i-Carrasco and Gil-Alonso, 2013b).

Therefore, global figures on the rural population crisis reflect a wide range of local situations resulting from the multiple changes that have occurred in the rural areas of Spain since the mid-20th century. The shift from the paradigm of traditional agriculture to the paradigm of productivist, modernised and mechanised agriculture produced a surplus of labour. In response to this change, millions of people migrated from rural areas to cities in search of a better life. More recently, the third paradigm of integrated rural development and territorial cohesion, which is supported by the EU Common Agricultural Policy (CAP), has sought to promote the endogenous development of rural areas: i.e., development leading to the revival of rural areas and the return of people to them. However, these policies have not had the same results throughout Spain, or across Europe as a whole (Molinero, 2022). To make this rebirth possible, the "urban-rural divide" must be eliminated, or at least mitigated. Differences between urban and rural area in terms of socio-economic conditions and the availability of services should be minimised to improve the quality of life and the opportunities of rural inhabitants. Hence, rural inhabitants are calling for better access to the welfare state, and have argued that government services should be fairly distributed to citizens throughout the country, regardless of their place of residence (Camarero, 2022). As teleworking has become more widespread in the wake of the Covid-19 health crisis, some authors have identified a fourth potential paradigm of rural development: that of a complex, open and multifunctional rural society (Molinero, 2022). To assess how far we are from achieving such a shift, we need to know where the country stands. To this end, this paper analyses the emerging spatial patterns of population growth and decline in small municipalities in the 21st century, and the impact of the Covid-19 crisis on them.

3 Statistical sources and methodology

In this paper, microdata from the *Padrón Continuo*, the continuous population registration system that is supervised and coordinated by the Spanish National Statistical Institute (INE), are used. This system provides official population data for Spanish municipalities on 1 January of every year. The 21st-century demographic changes are analysed using population data from 2001 to 2021, which allows us to compare population changes in the period of intense economic growth with those that occurred during the deep economic crisis and the subsequent expansion phase. In addition, the initial effects of the Covid-19 pandemic on population growth are studied. To this end, 5678 municipalities with less than 2000 inhabitants[2] in 2009[3] were selected. These municipalities represented almost 70% of the more than 8000 municipalities in Spain in 2009. A total of 2,791,582 people, or just 6.0% of the Spanish population, were living in these municipalities in that year. Their population in 2009 was taken as a reference because, after years of demographic growth and foreign immigration, this year marks a turning point for the population figures of many of these municipalities, largely due to the effects of the economic crisis.

Besides population stock data, birth and death figures obtained from *Movimiento Natural de la Población* (MNP) microdata were used to calculate natural growth rates by population size and their changes from 2001 to 2019, which was the last year for which data were available at the time of writing. Finally, migration growth was estimated by subtracting natural growth (births minus deaths) from total population growth in a given period.

$$P^{t+n} = P^t + B^{t,t+n} - D^{t,t+n} + I^{t,t+n} - E^{t,t+n}$$

For the analysis, the municipalities with less than 2000 inhabitants were classified according to their population growth during the 21st century. Cumulative annual growth rates were calculated for two periods. The first period, corresponding to the years before the economic crisis, runs from 1 January 2001 to 1 January 2009; while the second period, which covers the years affected by both the deep economic crisis and the recovery, runs from 1 January 2009 to 1 January 2020.[4] The following formula was used for this purpose:

$$\mathrm{r} = \left(\sqrt[n]{\frac{P_{i+n}}{P_i}} - 1 \right) \cdot 100$$

Where n represents the number of years, P_i the initial population and P_{i+n} the final population of the municipality under analysis.

The resulting rates were used to assign the municipalities to nine separate categories. The categories were formed based on whether the municipalities'

2 Analysis is carried out at the municipal level, the unit normally used in these kinds of studies. However, this means that some areas of Spain are underrepresented. This is particularly the case in Galicia and Asturias, in the north-west of Spain, where small rural settlements are grouped into parishes. These parishes are grouped into municipalities containing more than 2000 inhabitants. Therefore, they are not included in this analysis.

3 As 2009 is the first year in which the strong population growth that Spain experienced from the mid-1990s onwards began to slow down due to the Great Recession of 2008, the population on 1 January 2009 is considered as the turning point between the expansion and crisis phases.

4 Twenty-three municipalities were not considered in the analysis, as they were either split or grouped to form a new one during the period under study.

population growth was positive, stable or negative in the first period (2001–2009) and in the second period (2009–2020). This resulted in nine different combinations. In those municipalities where growth ranged from −0.1% to 0.1%, population was considered stable. Table 1 and Figure 4 show the results obtained, and present the geographic distribution of each category.

Finally, in a last section, preliminary data for 2021 were analysed to determine the impact of the Covid-19 pandemic on the municipalities of the typology used in this research. As data on birth and deaths were not yet available at the time of writing, the analysis was based only on *Padrón continuo* stock data.

4 Recent population changes according to municipality size

The Spanish population grew from 41,116,842 in 2001 to 47,385,107 in 2021, according to the most recent *Padrón continuo* of 2021. Thus, over the first two decades of the 21st century, the country gained 6.2 million people, which represents an annual growth rate of 0.71%. International immigration boosted population growth rates in the early years of the century (1.62% from 2001 to 2009). From 2009 to 2020, these population growth rates declined to barely 0.14%.[5] However, not all municipalities followed these patterns, as the international migration boom mainly affected large municipalities. In small municipalities, population growth was also positive from 2003 to 2007, and even increased by 24,000 inhabitants in 2006. Thus, when population size is taken into account, it is clear that the positive population growth stage mainly concerned municipalities with more than 1000 inhabitants. In municipalities with 500 to 1000 residents, population growth was positive, but at much lower levels. Nonetheless, the population growth trend in Spain ended secular population losses in many small municipalities. However, among municipalities with less than 500 inhabitants, there was no such recovery, and the population continued to fall (Figure 1).

During the economic crisis, small municipalities again began to lose population, with the heaviest losses occurring in 2012. From then on, growth rates slowly recovered, but remained consistently negative until the outbreak of the Covid-19 pandemic. The population decreased mainly because foreign immigration fell while emigration increased. Additionally, the *Padrón continuo* data were corrected through the deletion of emigrants who had left Spain a few years previously, but were still

[5] Despite the economic crisis, the total population count in the *Padrón* continued to grow, peaking at 47,265,321 in 2012. It then registered a period of population losses, with the total population count falling to a low of 46,557,008 in 2016. Since then, population numbers have been recovering.

registered in the country. While this process initially affected non-EU citizens only, it was later applied to EU citizens as well.[6]

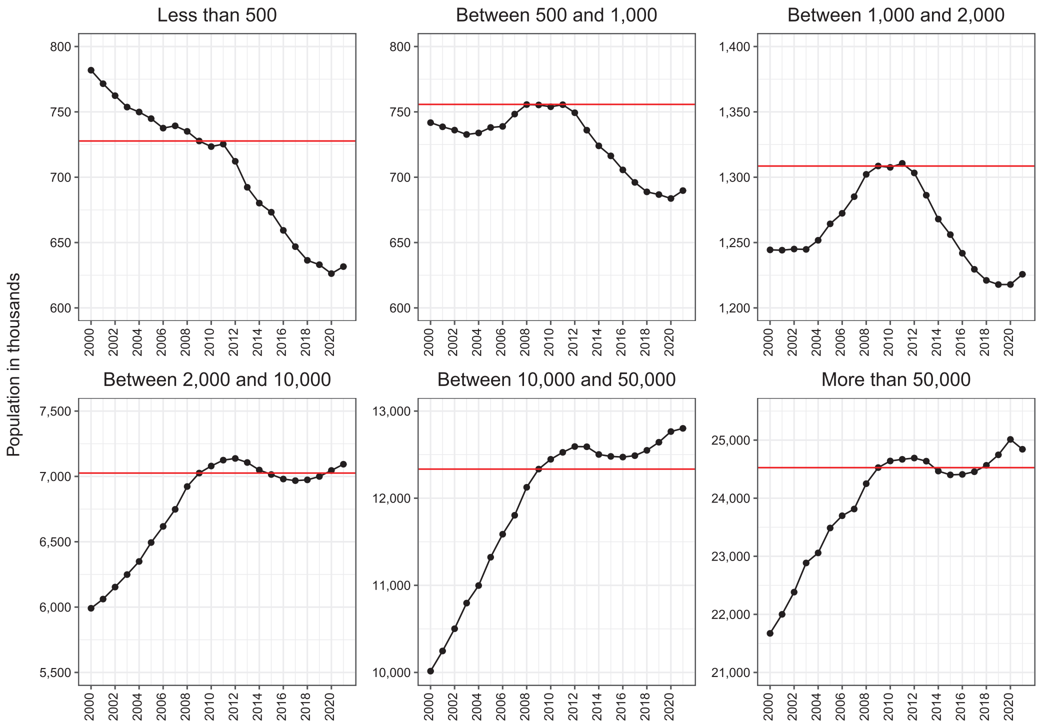
The period of economic crisis was followed by a period of slow economic recovery lasting from around 2015 to 2019, during which the populations of the largest municipalities were growing once again, initially slowly, and then at a faster pace. At the other end of the spectrum, the populations of municipalities with 1000 to 2000 inhabitants barely stabilised, while the smallest municipalities continued to lose inhabitants (Figure 1).

These trends were interrupted by the Covid-19 pandemic. During this period, substantial shares of urban residents wanted to live in less dense areas because of the lockdowns, while cities lost the capacity to attract new residents for the same reasons. These shifts in preferences led to abrupt changes in population. For the first time since 2009, small municipalities started to gain population, while large cities with more than 50,000 inhabitants experienced significant losses (Figure 2). However, whether these developments represent a change of paradigm or a temporary shift in internal migration remains to be seen.

As a result of these changes, the population of municipalities with less than 2000 inhabitants accounted for only 5.7% of the population of Spain in 2021. Thus, these municipalities lost 210,000 inhabitants (i.e., −8.2% of the initial population) over the first two decades of the century. As Figure 2 shows, the relationship between population growth and municipality size was heterogeneous. In general terms, the larger the municipality, the more its population grew; except in the largest cities, where the dominant reason for population loss was suburbanisation. Despite this overall pattern, population growth was positive in a considerable share of the small municipalities during the first period (2001–2009). However, except in a very few cases, population growth was no longer positive in the second stage (2009–2020). Dispersion was even greater in 2020, when, because of the pandemic, the relationship between population growth and municipality size was reversed. In 2020, small municipalities had extremely diverse growth levels – an issue that will be explored in the last section of this paper – with half of municipalities with less than 500 inhabitants even experiencing positive growth. These figures were unprecedented in the 21st century.

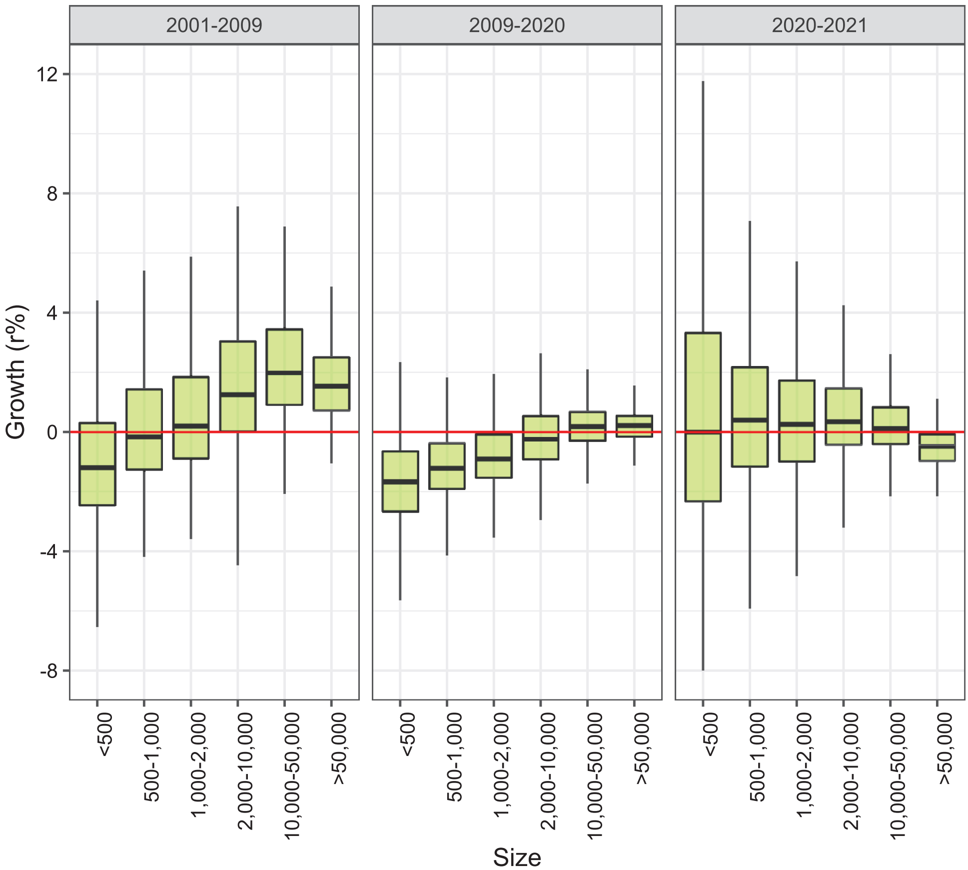
[6] The *Ley de Extranjería* (Foreigners' Act, 14/2003) establishes the process by which *Padrón* registrations expire. Since the law came into force, a non-EU foreigner without a permanent residence permit must renew his or her *Padrón* registration every two years. When this is not done, the foreign immigrant is deregistered (*caducidad de inscripción* or registration expiry). In addition to this change affecting the *Padrón* from 2005 onwards, a similar system, called "*Comprobación Periódica de Residencia*" (Periodic Residence Verification), was introduced for EU citizens or foreigners possessing other residence permits in March 2009, modifying the *Padrón* from 1 January 2013 onwards.

Figure 1:
Population (absolute figures) by municipality size, Spain, 2000-2021



Source: *Padrón continuo* (local continuous register), INE.
Note: The horizontal red line shows the population in 2009, the reference date between 2001 and 2021.

Figure 2:
Boxplot for municipal population growth by period and population size, Spain, 2001–2021



Source: *Padrón continuo* (local continuous register), INE.

5 A typology of small Spanish municipalities

5.1 The nine categories of small municipalities

This section presents a more in-depth analysis of the populations of small Spanish municipalities. To this end, the more than 5000 small municipalities that existed in 2009 were assigned to nine categories according to their population growth in the 21st century, divided in two periods: 2001–2009 and 2009–2020. Table 1 shows the results. The largest category, which includes more than half of all small municipalities (more specifically, 56.9%), is the negative-negative category. It contains more than 3000

Table 1:
Typology of the small municipalities grouped by population growth before and after 2009 (9 categories), Spain, 2001–2020

Typology	Mun. (<2.000)	%Mun.	Population (2001)	Population (2020)	Population (mean)	Total growth	Relative growth
Negative-Negative (− −)	3, 232	56.9	1, 509, 433	1, 105, 064	342	–404, 369	−1.63
Negative-Stable (− =)	59	1.0	23, 031	21, 073	357	−1, 958	–0.47
Negative-Positive (− +)	230	4.1	53, 849	52, 257	227	−1, 592	–0.16
Stable-Negative (= −)	141	2.5	91, 578	79, 913	567	−11, 665	–0.71
Stable-Stable (==)	7	0.1	6, 466	6, 471	924	5	0.00
Stable-Positive (= +)	23	0.4	8, 746	9, 357	407	611	0.36
Positive-Negative (+ −)	1, 278	22.5	654, 749	656, 276	514	1, 527	0.01
Positive-Stable (+ =)	108	1.9	67, 926	79, 170	733	11, 244	0.81
Positive-Positive (+ +)	600	10.6	338, 505	518, 290	864	179, 785	2.27

Source: *Padrón continuo* (local continuous register), INE.

municipalities that lost population in both periods. Currently, 1.1 million people live in these small, ageing and depopulating villages, which have lost more than 400,000 inhabitants in the two decades analysed, and thus around a quarter of their initial population (a negative annual growth rate of 1.63%).

Before 2009, population growth was also negative in two other categories that include a total of 289 municipalities. In the villages belonging to the negative-stable category, population stabilised at around zero growth in the 2009–2020 period; while in the villages belonging to the negative-positive category, the growth trend was reversed, as population started to increase in this period. Even though the trends changed in 2009, the populations of these villages were still lower in 2020 (73,000 inhabitants between the two categories) than in 2001, as their growth rates were low but negative (−0.47% and −0.16%, respectively).

In the next group of municipalities, population remained stable during the first decade analysed. However, these municipalities did not all follow the same trend in the second decade, which places them in three different categories (stable-negative, stable-stable or stable-positive). These three groups represent exceptional cases, as only 3% of all small municipalities fit into them; the stable-negative category is the most numerous of this subgroup, while the stable-stable category is composed of only seven municipalities. A common trend of these three categories is that their municipalities are on average bigger than those of the first three groups.

In the following group, there are approximately 2000 municipalities that grew during the first decade of the century. However, only 853 of these municipalities grew in the second decade. This means that a considerable share of municipalities that grew up to 2009 started to lose population in the second period (positive-negative category). These 1278 municipalities represent 22.5% of the total, and currently have 656,000 inhabitants. Due to this shift, total population growth in these municipalities in both periods was tiny (0.01%), and the final population was slightly higher than the initial population. In addition, there is a small group of 108 municipalities belonging to the positive-stable category that grew moderately (0.81% annual growth rate) during the entire period under analysis.

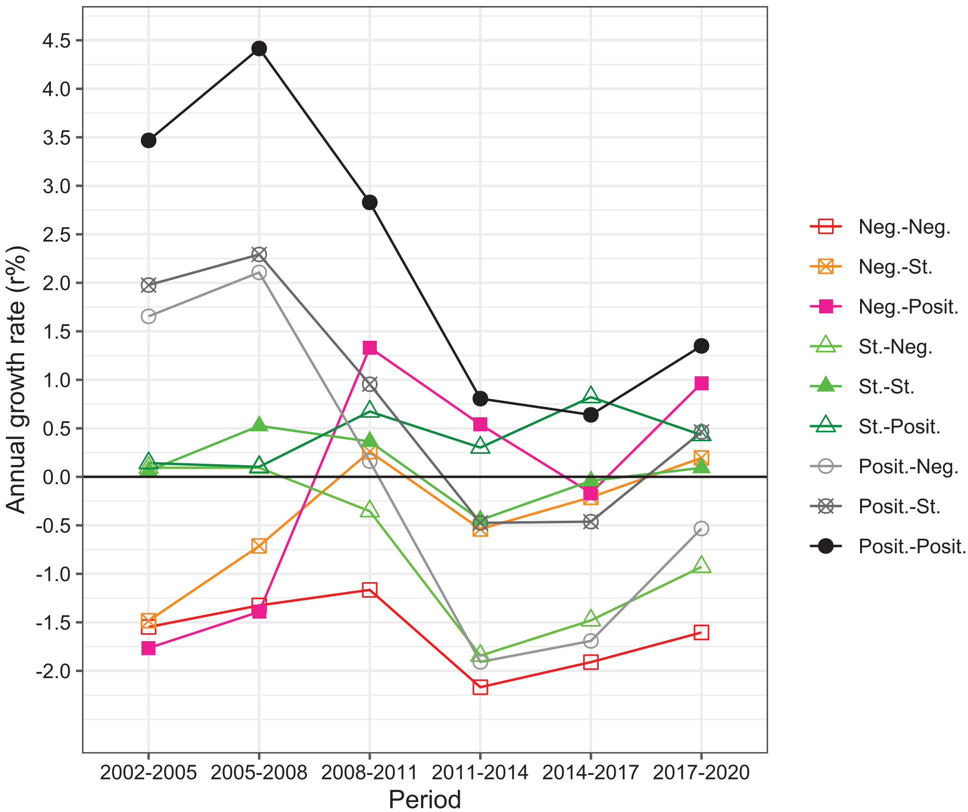
Finally, another group of 600 municipalities (positive-positive category) were able to increase their population in both periods. These small municipalities represent 10.6% of the total, and currently have 518,290 inhabitants. This means that their population expanded by 50% since beginning of the century, and thus at an annual growth rate of 2.27%. Indeed, this growth rate is even higher than that of the country as a whole. However, this exceptional increase partly masks a general pattern of decline (Table 1), as some of the municipalities with less than 2000 inhabitants are located within a large urban area, as defined by the *Statistical Atlas of Urban Areas in Spain* (Ministerio de Transportes, Movilidad y Agenda Urbana, 2021). More specifically, they are villages with (sub)urban dynamics located in peri-urban areas. Therefore, these villages should be considered (sub)urban or peri-urban, but not rural. Even though these 65 municipalities represent barely 1.1% of the municipalities with less than 2000 inhabitants in Spain, we have decided to present some of their results separately, as they exhibit purely metropolitan dynamics. In 2020, these municipalities had a total of 76,832 inhabitants, or 2.75% of the population under study. As they had only 59,558 inhabitants in 2001, they experienced significant growth over this period. Despite being located within metropolitan areas, not all of these municipalities fall into the same typology category. Most of them (37 villages) grew in both periods. These villages account for 6.2% of the municipalities and 12.8% of the population of the positive-positive category, shown in Table 1. There are also a significant number (17) of municipalities in the positive-negative category. These villages account for 1.3% of the municipalities and 3.3% of the population in this category. The remaining 11 municipalities are spread across the other categories, and have little impact on the results of each category. In sum, as they represent a very small share of the municipalities analysed and they hardly affect the overall results, we decided to keep these 65 municipalities within our study population to maintain the homogeneity of the purely demographic selection criterion used.

These results confirmed that the groups are internally very heterogeneous, and that a closer analysis was needed. As an initial step, population growth was divided into six periods lasting three years each (Figure 3). This new perspective highlights how important it was for the most dynamic municipalities to have grown before the onset of the economic crisis. Indeed, while this crisis reduced population growth throughout the country, particularly from 2011 to 2014, the municipalities belonging to the positive-positive category increased their populations the most during the post-crisis recovery period. By contrast, among the municipalities in the negative-negative category, this trend barely changed in the two decades analysed, which underlines their vulnerability from the perspective of population growth.

5.2 Geographical distribution of the typology of rural growth in Spain

Mapping municipalities by typology category allows us to study the importance of geographic location for depopulating municipalities. The area where municipalities were most likely to lose population is the northern plateau, corresponding to the Autonomous Community of Castile and Leon. By contrast, the Ebro valley, the Mediterranean and Atlantic coasts, the archipelagos and Andalusia, plus the central part of Madrid, are densely populated areas where there are scarcely any small municipalities. The villages that grew are mainly situated in Catalonia, the Basque Country and the peripheries of Madrid or some provincial capitals. These are small municipalities that grew through suburbanisation or peri-urbanisation; that is, as a result of city dwellers moving to surrounding rural areas. This phenomenon was particularly intense during the economic expansion phase, which was one of the reasons for the emergence of the “real estate bubble”. This phase ended in 2008 with the start of the Great Recession. As the economic recession reduced the pace of suburbanisation, most of the municipalities that grew until 2009 and then started to lose population are located in these suburban peripheries (Bayona-i-Carrasco and Pujadas, 2020). In sum, the spatial location of a municipality (the north or the south of Spain, along the coast or inland, near a large urban area or in a remote area),

Figure 3:
Population growth rates of the 9 categories of the typology, Spain, 2002–2020



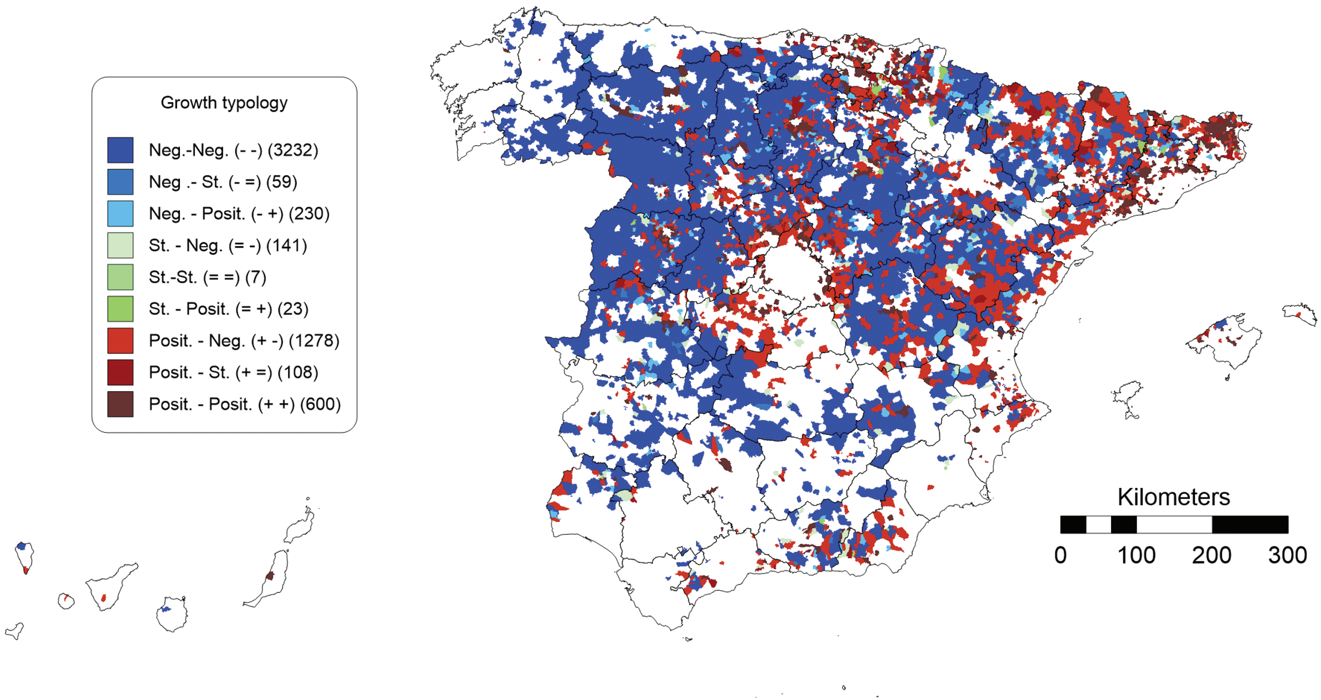
Source: *Padrón continuo* (local continuous register), INE.

together with its size, are key elements for understanding recent changes in small municipalities.

5.3 Increasingly negative natural population growth

Due to the declining birth rate and population ageing, natural population growth has been negative in Spain since 2015. Nevertheless, negative natural growth rates occurred earlier in some Autonomous Communities, particularly in those located in the north of the country: i.e., in Asturias and Aragon since the mid-1980s, and in Castile and Leon and Galicia slightly later. For small municipalities, natural growth was negative throughout all the years analysed, with these municipalities losing around 20,000 residents per year due to natural growth since the beginning of the

Figure 4:
Geographical distribution of the small municipalities grouped by the 9 categories of the typology, Spain, 2002–2020



Source: *Padrón continuo* (local continuous register), INE.

21st century. Like in Spain as a whole, in small municipalities, the number of births peaked in 2009 (18,444), and decreased thereafter. The number of births in 2019 (13,686) was well below that in 2001. On the other hand, the number of deaths (around 35,000 per year) was more stable during the two decades under analysis. Therefore, a total of 372,045 inhabitants were lost due to negative natural growth since 2001. Nevertheless, these deaths were partly compensated for by positive migration growth (145,633 people), resulting an overall loss of 226,412 residents.

In fact, it was only in those small municipalities where total population growth was positive in both decades (positive-positive category) that natural growth was also positive. However, even in these municipalities, natural growth was positive for a few years only, from 2004 to 2016, and then became negative (Figure 5). In the municipalities in the rest of the categories, natural growth was consistently negative due to very low birth rates and rising mortality rates. In the 2001–2019 period, the average crude birth rate in the small municipalities as a whole was 6.28, and the average crude mortality rate was 13.69‰. By comparison, in the municipalities belonging to the negative-negative category, the crude birth rate was particularly low, at 4.31‰. At the opposite end of the spectrum, the crude birth rate of the municipalities in the positive-positive category was 10.47‰, and was thus higher than the crude death rate of 9.41‰ (see the Appendix).

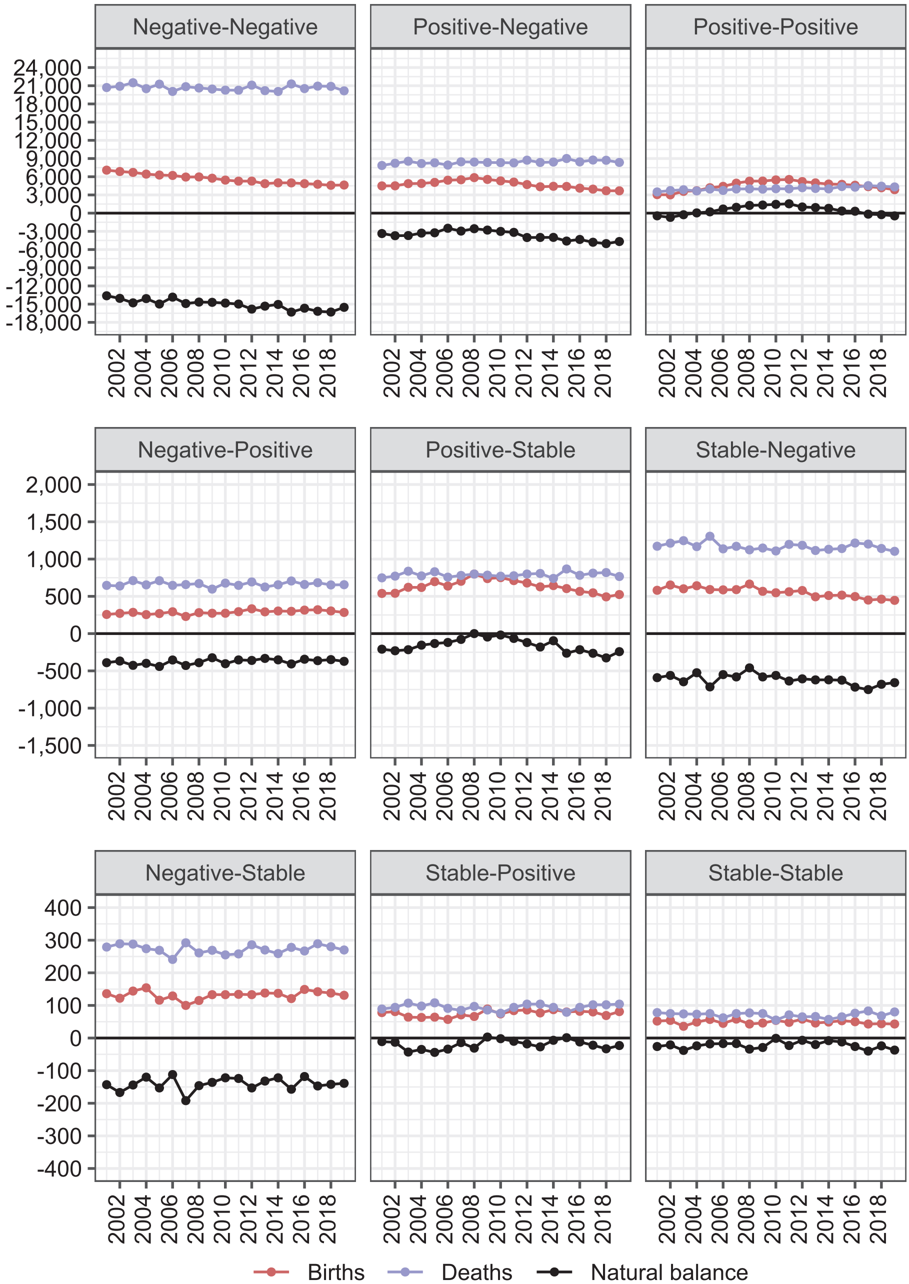
5.4 The unstable nature of migration trends

As natural growth was stable and mostly negative, migratory growth explains the fluctuations in total population growth in the rural areas as a whole, as well as in the diverse categories analysed (Figure 6). Despite alarmist discourses, migratory growth was positive in the small municipalities (+145,633 people) over the two decades. In fact, this figure was higher, at 220,949 inhabitants, from 2001 to 2010. Thereafter, migration growth again became negative, with 102,223 residents being lost from 2011 to 2017. But in 2018 and 2019, migration growth recovered, with 26,907 new residents being added.

The results of the analysis of natural, migratory and total growth according to the nine categories of municipalities can be summarised in three major groups (Figure 6).

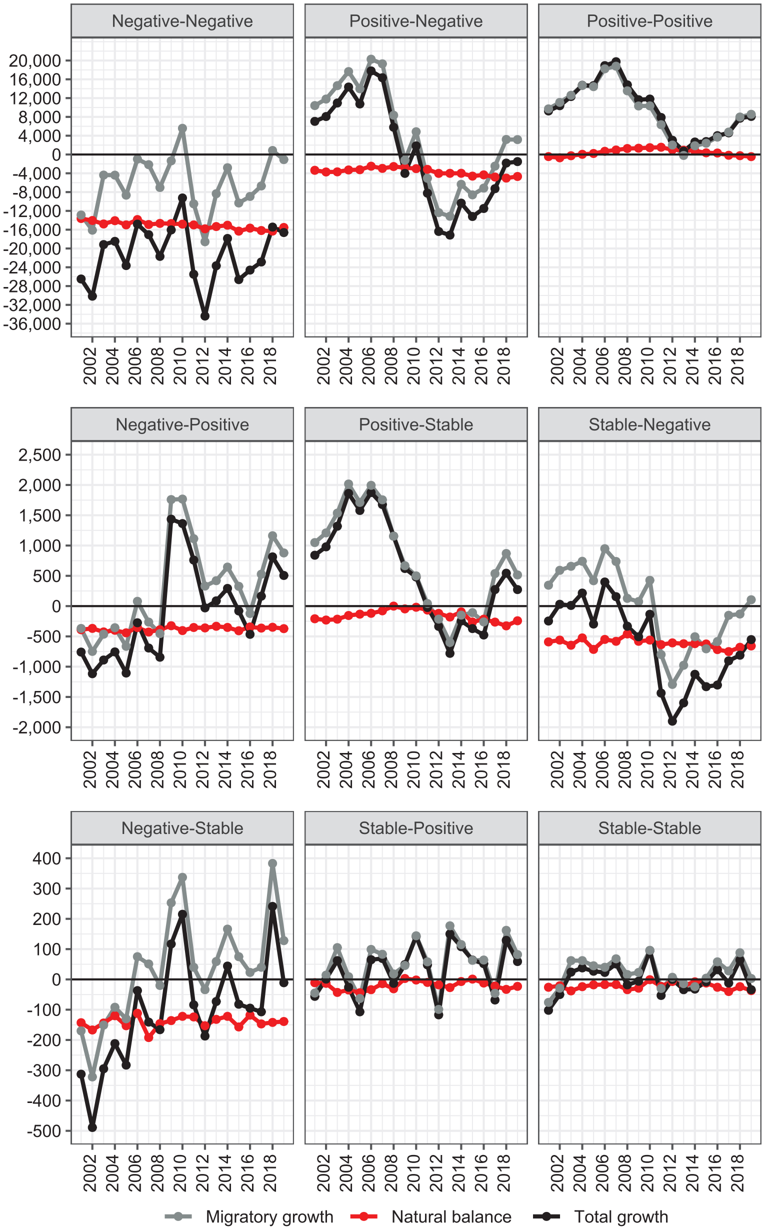
(1) In municipalities belonging to the negative-negative category, decreasing natural growth was accompanied by constantly negative migratory growth. Thus, this group lost 285,000 people due to natural growth and 118,000 people as a result of migratory growth during the 2001–2019 period.
(2) At the other end of the spectrum, both natural and migratory growth were positive in the municipalities in the positive-positive category.
(3) Finally, in the municipalities in the rest of the categories, migratory growth was positive as a whole in the two decades analysed, albeit with substantial fluctuations because of the economic boom and bust phases of the economic cycle. This migratory growth nearly compensated for the largely negative natural growth.

Figure 5:
Births, deaths and natural growth in the typology categories, Spain, 2001–2019



Source: *Movimiento Natural de la Población* (birth and death statistics), INE.

Figure 6:
Total, natural and migratory growth for the typology categories, Spain, 2001–2019



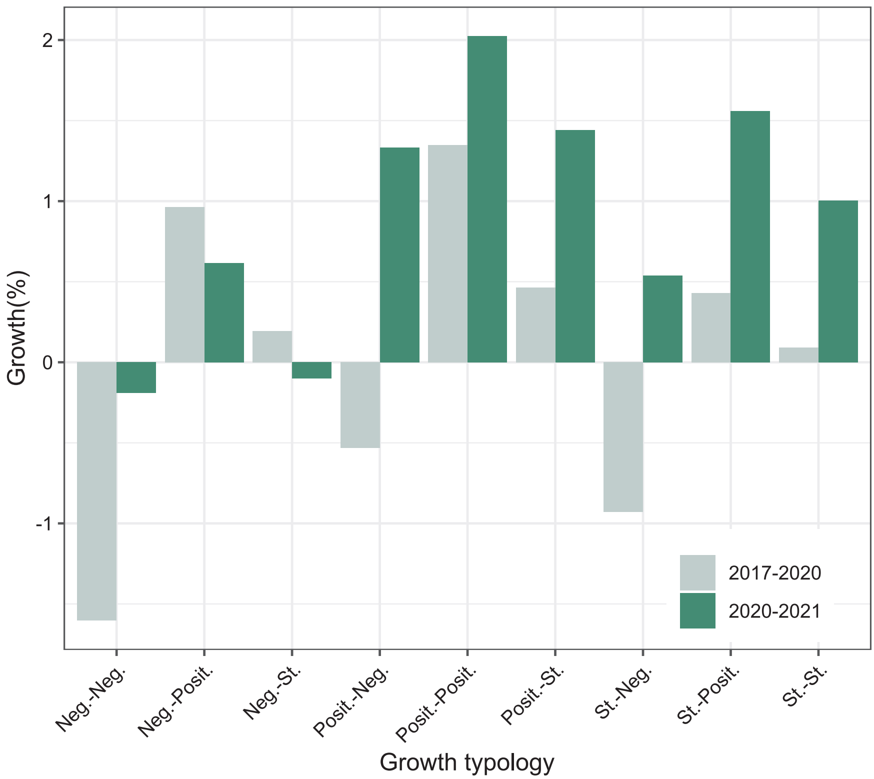
Source: *Padrón continuo* (local continuous register) and *Movimiento Natural de la Población* (births and deaths statistics), INE.

In sum, in a context of mainly negative natural growth, international migratory flow fluctuations were a significant factor in population change in most of the small municipalities analysed.

6 Depopulation and the Covid-19 pandemic: analysing population change during the year 2020

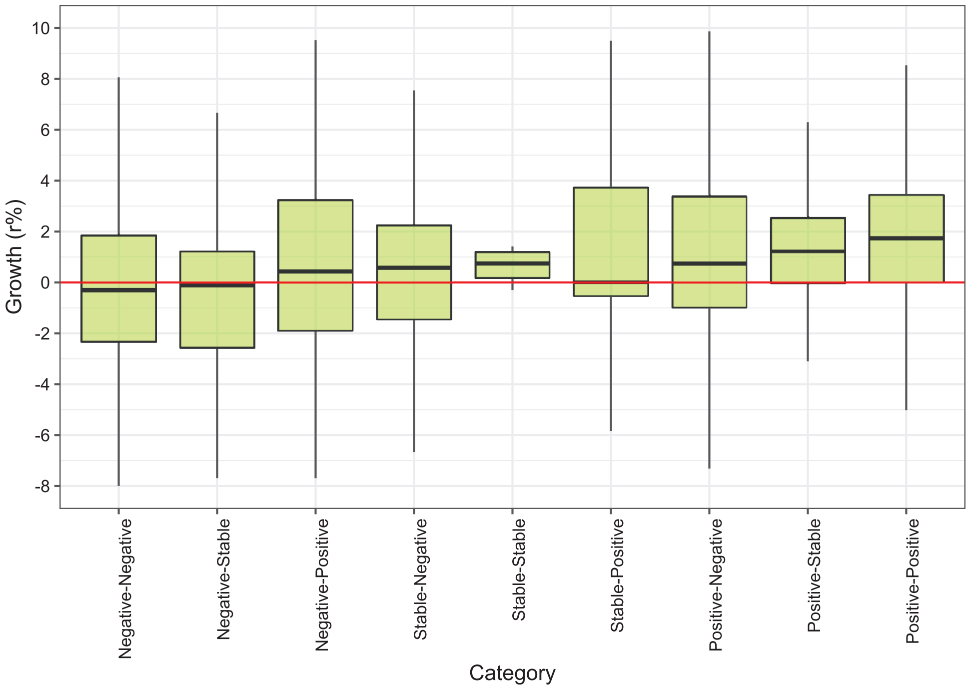
The initial impact of the Covid-19 pandemic on the population distribution throughout Spain can be analysed using *Padrón continuo* data for January 2021. First, it should be emphasised that the population figures for this year broke with some of the previous population trends. Due to internal migration flow changes

Figure 7:
Recent changes in population growth rates for the typology categories, Spain, 2017–2020 and 2020–2021



Source: *Padrón continuo* (local continuous register), INE.

Figure 8:
Boxplot for population growth by category, 2020–2021

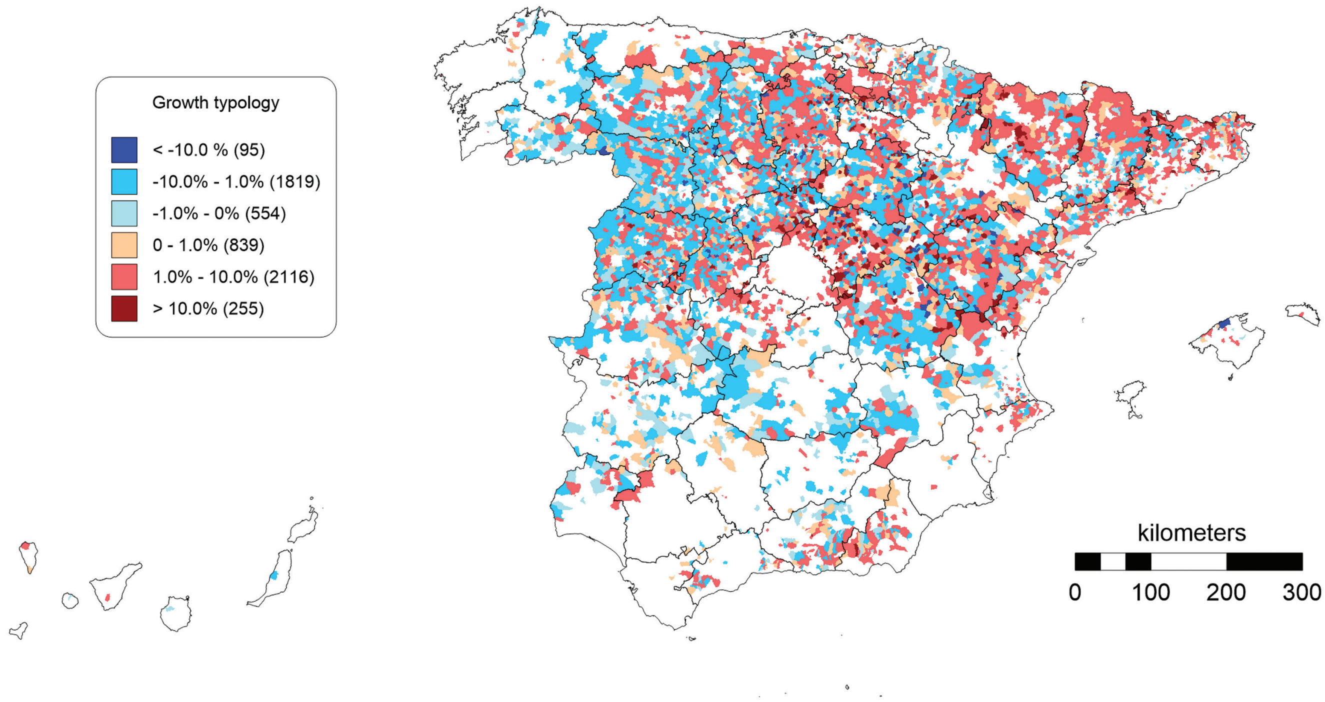


Source: *Padrón continuo* (local continuous register), INE.

(González-Leonardo et al., 2022), increasing mortality and decreasing birth rates, the Spanish cities with more than 50,000 inhabitants lost population (Figure 1). The magnitude of this decline was similar to that of 2013, when, due to the depth of the economic crisis and changes in how the *Padrón* was managed, especially concerning EU immigrants, a loss of around 170,000 inhabitants was reported. Unlike then, when municipalities of all sizes lost population, in 2020, the group of municipalities with less than 50,000 inhabitants gained population. This increase was especially significant in municipalities with less than 2000 inhabitants, which had a 0.77% growth rate (compared to a −0.45% growth rate between 2001 and 2020, see Table A.2 in the Appendix). It was a relevant change for small municipalities, even though it was partly fictitious: the registration of many people in the towns where they had a secondary residence, presumably in order to avoid the lockdowns, contributed to the growth of the registered population in these small towns.

Regarding the spatial patterns of this growth, it can be observed that the pre-Covid-19 trends and those in 2020 are strongly correlated, which means that pre-existing spatial inequalities were reinforced during the first pandemic year. In all the typology categories, the growth rates were higher in 2020 than in the 2017–2020 period.

Figure 9:
Geographical distribution of the recent population growth in small Spanish municipalities, 2020–2021



Source: *Padrón continuo* (local continuous register), INE.

However, two groups, the negative-negative and negative-stable categories, still lost population, albeit at a slower rate; i.e., at a growth rate closer to zero (Figure 7).

Figure 8 shows the distribution of municipalities by population growth rate in greater detail. While more than 75% of the municipalities in the most dynamic categories had positive growth in 2020, the proportion of municipalities with positive growth was less than 50% in the most regressive categories. These growth differences are confirmed, from a geographical point of view, by the map in Figure 9. Indeed, among the municipalities that experienced the heaviest population losses during the two decades analysed, and that continued to lose population in 2020, there are many small villages in Castile and Leon, particularly those in the western provinces; some small municipalities in Aragon, Castile-La Mancha and Extremadura; as well as certain villages situated far from the coast in Galicia, Catalonia and Andalusia.

7 Conclusions

During the first two decades of the 21st century, population growth in small Spanish municipalities showed signs of increasing spatial polarisation. The two main explanatory features of this tendency were a municipality's population size and its geographic location. In general, the smaller a municipality was, the more population it lost in relative terms. However, not all small municipalities lost population. Growth rates were positive in several municipalities, largely because of their geographic location. Previous research on Catalan data showed that only small municipalities situated on the peripheries of large metropolitan areas (benefiting from suburbanisation), or in areas where the economy was based on tourism or agro-industry, were able to maintain positive growth during the period analysed (Gil-Alonso and Bayona-i-Carrasco, 2021). Current results for Spain as a whole confirm the importance of geographic location as a factor in rural population change, and are in line with other researchers' findings for several developed countries. Indeed, rural depopulation is an inevitable process, as societies shift from an agrarian economy in which 70% or more of the active population work in agriculture, to an industrial economy, and later to a service economy. In this context, small villages that rely on tourism (whether on the coast, near ski resorts or in picturesque locations) can maintain or even increase their population. Similarly, some small municipalities may be able to maintain or even grow their populations by interacting with medium-sized or larger localities. Such relationships are clearly visible in small towns located in or near peri-urban areas, and thus in the outer ring of large metropolitan areas. Moreover, such interactions can help to explain the population changes in small municipalities that are located far from urban areas, but that maintain links to them through family, social or economic networks. By contrast, the absence of these types of bonds or of interactions may be expected to act in the opposite direction, leading to the depopulation or total abandonment of smaller villages, especially of those in the most remote rural areas with weak communication networks (Li et al., 2019). The diversity of population dynamics found in Spain by Molinero and Alario (2022), who distinguished between deep/regressive rural areas and dynamic/progressive areas, can also be observed in the United States. While many American counties far from metropolitan areas show negative population growth, there are others that show positive dynamics; and, as Johnson and Lichter (2019) have pointed out, not all of these counties are in tourist or retirement areas. These counties have, however, managed to enhance the value of their resources and establish positive economic and demographic relations with other regions.

Population shifts and economic changes cannot be separated from one another, since the latter is one of the main determinants of population growth through its influence on migratory flows. The population recovery phase that many small municipalities were experiencing in the first decade of the 21st century ended with the onset of the 2008 economic crisis, which led to a reduction in international immigrant flows. In the period after the economic crisis, population recovery was mainly observed in large cities, which are gateways for foreign newcomers and human capital attraction poles, and in intermediate-sized towns, particularly in those located on the peripheries of cities. By contrast, small municipalities were scarcely touched by this population recovery trend. In fact, municipalities with less than 2000 inhabitants have not regained their 2009 population levels, and the smallest ones even continue to lose inhabitants. Their less diverse economies could explain why small municipalities take longer to recover after recessions. Indeed, the post-crisis economic recovery had hardly any impact on most small municipalities.

The Covid-19 pandemic represented a turning point in previous population trends, reversing the relationship between population growth and population size. In other words, big cities were the spatial units that were losing the most people, while small municipalities were growing rapidly due to the arrival of urban residents fleeing lockdowns. In reality, many of these new inhabitants registered in the *Padrón* in a village where they already had a second home, or where they had previously lived (Molinero and Alario, 2022). Regardless of the reasons why, small villages as a whole began to recover. However, population did not grow for small municipalities in all categories or in every region of Spain. At this point, two questions arise. The first is whether these trends will or will not continue; in other words, whether the growth observed in rural areas in 2020 will continue over time, or whether it represents a one-time event attributable to the Covid-19 pandemic. The second is regarding the spatial relevance of this change, since the results of this research seem to show that this new growth has reinforced internal differences between the smallest municipalities and between the different areas of Spain.

The exceptionality of the pattern observed in 2020 underlines the importance of migration growth to population changes. Since natural growth was generally negative in small municipalities for several decades, migratory growth was the component that determined whether the populations of these municipalities grew or declined. Therefore, their dependence on economic fluctuations was strengthened, as migratory flows tend to be extremely sensitive to them.

Finally, the results of our analysis of population dynamics indicate that it will be very difficult for the populations of most small Spanish municipalities to recover.

In these towns, natural growth was nearly always negative, and did not depend on economic fluctuations, but was instead the result of a very old age population structure and a small reproductive-age population. Therefore, it is highly unlikely that the number of births in these municipalities will increase, especially within a context of very low fertility rates. The unstable and selective nature of migration flows should also be taken into account. Thus, it appears that more than half of the small municipalities analysed, or about 3300 of them, representing 40% of all Spanish municipalities, are facing a bleak demographic future. These unpromising prospects, which affect a substantial part of the country's territory, have recently attracted political attention, and have given rise to geopolitical concepts such as "the Spanish Lapland" (Cerdà, 2017) or "the Empty Spain" (Del Molino, 2016), both of which focus on Spanish depopulation. In fact, the latter concept has been turned into a political movement called "the Emptied Spain", which aims to defend the interests of the most depopulated provinces. While it has so far been successful in Teruel and Soria, the movement is seeking influence national politics. The creation by the present Spanish government of a Vice-Presidency for Ecological Transition and Demographic Challenge, which is responsible, among other objectives, for the design and implementation of policies to counteract depopulation, could represent a first sign of progress. Moreover, the Covid-19 crisis has also reminded people of the value of rural spaces, not only in Spain, but throughout the European Union, as many other member states are also affected by rural depopulation. This is why the new President of the European Union, Ursula von der Leyen, has created a Vice-Presidency for Democracy and Demography, with one of its functions being "coordinating work on a long-term vision for rural areas, including on the effects of demographic change on connectivity and access to services".[7] It is this same political impulse that explains why the Next Generation EU Funds for European reconstruction have rural development as one of their objectives, along with social cohesion, integration, inclusion and the reduction of regional disparities. We are, therefore, facing a new political scenario that could open up new opportunities for Spanish and European rural areas.

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[7] Vice-President Dubravka Šuica web page: https://ec.europa.eu/commission/commissioners/2019-2024/suica_en.

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Appendix

Table A.1:
Population dynamics in rural municipalities by categories, 2001–2019

	Births	Deaths	Natural balance	Total growth	Migratory balance
Negative-Negative	106,940	392,555	−285,615	−404,369	−118,754
Negative-Stable	2,505	5,174	−2,669	−1,958	711
Negative-Positive	5,431	12,588	−7,157	−1,592	5,565
Stable-Negative	10,538	22,225	−11,687	−11,665	22
Stable-Stable	928	1,350	−422	5	427
Stable-Positive	1,433	1,808	−375	611	986
Positive-Negative	89,917	159,667	−69,750	1,527	71,277
Positive-Stable	12,040	15,017	−2,977	11,244	14,221
Positive-Positive	85,230	76,623	8,607	179,785	171,178
Rural	**314,962**	**687,007**	**−372,045**	**−226,412**	**145,633**
	Rates (‰)				
	CBR	**CDR**	**Natural increase**	**Growth rate**	**Migratory rate**
Negative-Negative	4.31	15.80	−11.50	−16.28	−4.78
Negative-Stable	5.98	12.35	−6.37	−4.67	1.70
Negative-Positive	5.39	12.49	−7.10	−1.58	5.52
Stable-Negative	6.47	13.64	−7.17	−7.16	0.01
Stable-Stable	7.55	10.98	−3.43	0.04	3.47
Stable-Positive	8.33	10.51	−2.18	3.55	5.73
Positive-Negative	7.22	12.82	−5.60	0.12	5.72
Positive-Stable	8.62	10.75	−2.13	8.05	10.18
Positive-Positive	10.47	9.41	1.06	22.09	21.03
Rural	**6.28**	**13.69**	**−7.41**	**−4.51**	**2.90**

Source: *Padron continuo* (local continuous register) and *Movimiento Natural de la Poblacion* (births and deaths statistics), INE.

Table A.2:
Comparison of population change by category, between 2020 and previous years

	Population			Population growth			
	2001	**2020**	**2021**	**2001–2020**	**(%)**	**2020–2021**	**(%)**
Neg-Neg.	1,516,263	1,109,622	1,107,575	–406,641	–1.63	–2,047	–0.18
Neg.-St.	23,031	21,073	21,052	–1,958	–0.47	–21	–0.10
Neg.-Posit.	54,312	52,642	52,973	–1,670	–0.16	331	0.63
St.-Neg.	91,578	79,913	80,344	–11,665	–0.71	431	0.54
St.-St.	6,622	6,629	6,699	7	0.01	70	1.06
St.-Posit.	8,746	9,357	9,503	611	0.36	146	1.56
Posit.-Neg.	659,086	660,616	669,448	1,530	0.01	8,832	1.34
Posit.-St.	67,926	79,170	80,312	11,244	0.81	1,142	1.44
Posit.-Posit.	339,830	520,307	530,951	180,477	2.27	10,644	2.05
Total	**2,767,394**	**2,539,329**	**2,558,857**	**–228,065**	**–0.45**	**19,528**	**0.77**

Source: *Padron continuo* (local continuous register), INE.

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Neighbourhood effects and determinants of population changes in Italy: A spatial perspective

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Abstract

Population trends in Italy are strongly spatially differentiated, with some municipalities showing a systematic loss of population, and others showing an equally continuous demographic increase. Here, we focus our attention on the spatial dimension of population change, looking at how different socio-economic and demographic dimensions affect population changes, as well as their spatial effects. After performing a preliminary descriptive analysis of the trends of population growth and decline in Italy over the last 40 years and the relevant demographic components, we used a spatial Durbin model (SDM) to investigate the potential existence of a diffusion process and the determinants of the average annual growth rate between 2011 and 2019 at the municipal level. The spatial dimension and local heterogeneities in Italy were found to be highly relevant in the analysis of population decline. Moreover, we examined the relationship between demographic, social and economic factors and the demographic growth/decline of municipalities in the subsequent 10 years. Among the different covariates included in the model, the demographic composition of the population, the female activity rate, the youth employment rate and the presence/absence of a school proved to be strongly related to population growth and decline in Italian municipalities.

Keywords: Italy; spatial Durbin model; spatial demography; local analysis; municipalities

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1 Introduction

In 2007, Reher stated that a decline in population would be the 'key social issue of the twenty-first century' (p. 189). Indeed, the fear of population decline is as old as states themselves, because it has always been considered both a symptom and a cause of failure and weakness (Coleman and Rowthorn, 2011). Most European countries are experiencing demographic decline, especially in their rural territories (Copus et al., 2011), i.e., in the so-called 'shrinking regions' (Espon, 2017; Hospers, 2011). The demographic and territorial landscapes of Italy are shaped by such regions, which should be taken into account when considering the effects of these shrinking places (Del Panta and Detti, 2019). In this paper, we employ the concept of the spatial diffusion process (i.e., spatial contagion) based upon the concept of the first law of geography: namely, that 'everything is related to everything else, but near things are more related than distant things' (Tobler, 1970). This law can be considered the theoretical background to all spatial diffusion process theories (Benassi and Iglesias-Pascual, 2022).

After providing a brief description of the evolution of the average annual growth rates of Italian municipalities from 1981 to 2019, we apply a spatial Durbin model (SDM) to explore how different demographic and socio-economic dimensions are related to each municipality's population growth and decline over the years 2011–2019, considering the direct and the indirect spatial effects of the dependent and independent variables. Our contribution seeks to improve our knowledge of the process of population growth and decline in Italian municipalities by applying a pure spatial analysis approach at a very fine scale. To the best of our knowledge, the SDM has not been previously used to explore population changes in Italy. Other works have used a spatial approach to explore population change in Italy, but the method we apply is original, because it allows for the measurement of the direct and indirect spatial effects (spatially lagged) of the dependent and independent variables on the demographic growth of the population at the municipal level. Thus, our approach may help to clarify the spatial link between all of the variables included in the model.

Italy appears to be characterised by a dual spatial demographic system in which some territorial contexts—typically the large urban centres and their surrounding areas, especially those located in the north of the country—still attract populations from other Italian contexts (internal migration) as well as from abroad (international migration), resulting in systematic demographic growth (Benassi et al., 2019; Strozza et al., 2016); while other territorial contexts, including an increasing number of medium-sized and small municipalities that are located far from the large urban centres and/or that have a low level of accessibility—typically located in southern Italy, and very often in mountainous or inland areas—are characterised by a systematic loss of population due to a negative natural balance and a zero or, as is the case in most of these municipalities, a negative migration balance (Benassi et al., 2021, 2023; Reynaud et al., 2020).

Thus, in Italy, the concept of spatial diffusion is highly relevant (Morrill et al., 1988). According to this concept, the diffusion through space of a given behaviour (demographic decline for example) can occur by contagion (Doignon et al., 2021; Iglesias-Pascual et al., 2022; Morrill et al., 1988; Saint-Julien, 2007). Understanding the spatial dynamics of population growth and decline in Italy is important because both processes have strong policy implications with a wide range of potential consequences (Elshof et al., 2014) that need to be carefully considered by governments. Most rich countries are facing population decline and ageing, albeit with strong heterogeneities between geographical domains within each country.[1] While these countries will have to cope with low fertility and population ageing, the policies aimed at addressing these challenges are still evolving, and often lack a spatial dimension (Ezeh et al., 2012). Daugirdas and Pociute-Sereikiene (2018), focusing on Lithuania, have underlined that depopulation can lead to a decline in social networks and a growing number of social problems, including the social and territorial exclusion of residents and a lack of investment in the peripheral areas. Additionally, population decline is often accompanied by the structural ageing of the population, which has significant consequences for economic growth (Nagarajan et al., 2016). Reynaud et al. (2020), focusing on Italy, have demonstrated that the depopulation process, measured at the municipal level by a simultaneous equation system, is deeply affected by territorial factors, which are often overlooked in analyses of the spatial linkages between depopulation and the local context. In particular, previous results have shown that territorial factors—and especially altitude—greatly affected depopulation rates at the local scale, and that municipalities with a declining population at a given time were more likely to also experience depopulation in the subsequent decade. In their conclusion, the authors called for more refined spatial analysis of the depopulation process in Italy. Thus, our work can contribute to the literature on depopulation by helping to shed light on the peculiarities of the phenomenon within Italy by analysing which factors are related to population decline using a spatial approach that aims to improve our understanding of the spatial patterns of both the dependent and the independent variables.

The remainder of this paper is structured as follows. In Section 2, we review the prominent literature about population decline/growth in Europe and Italy and the determinants of these trends, while in Section 3 we describe our research objective, the data used and the methods applied. In Section 4, we provide descriptive findings on the demographic dynamics of Italy over the last 40 years, which can be useful for framing the current Italian situation. In Section 5, we present the empirical results of the spatial model. Finally, in the last section, we discuss the results and draw some conclusions based on our findings.

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[1] For an analysis of the regional convergence in the process of population ageing across Europe, see Kashnitsky et al. (2017).

2 Literature review

2.1 Heterogeneities in population growth and decline in Europe and in Italy

As the number of rich countries and regions across the world that report a decline in population is growing, over the past decade, both scholars and public policymakers have become increasingly interested in this issue. Both population growth and decline have strong policy implications. Population decline can have a very wide range of consequences (Elshof et al., 2014). Europe is currently experiencing a phase of population decline, which will, according to the latest projections (United Nations, 2022, medium variant), lead to a decrease in the population size of over 21% (157 million inhabitants) by 2100. However, the level of population decline is not uniform across territories (i.e., it is spatially biased), as there are noteworthy differences in the rates and the directions of population change both between countries and between regions and small areas within each country. These diverging trends are expected to continue into the future, which will likely exacerbate current regional and national demographic inequalities (Newsham and Rowe, 2022), thereby reinforcing the idea that dual spatial demographic contexts are detrimental to the construction of a cohesive society (Lobao and Saenz, 2002). All demographic phenomena in Europe, including fertility, are highly heterogeneous at the subnational level. Klüsener et al. (2013a) have investigated the role of states and regions in shaping spatial patterns of nonmarital fertility in Europe since 1960 using a dataset of 497 European subnational regions and smaller countries, and found that the role of states relative to the role of regions declined in the latest period examined (between 1990 and 2007). Among the possible explanations for these changes are increased supranational integration, such as within the European Union; and decentralisation within states leading to increases in variation in subnational contextual conditions.

In the literature, analyses of the patterns of growth and depopulation typically distinguish between rural and urban contexts, as these phenomena tend to be driven by different factors in each of these two contexts. There may be a mutual relationship between urban and rural dynamics, as the decrease in population often leads to migration to urban areas and a parallel exodus from rural areas (Christiaans, 2017), most studies have concentrated exclusively on rural (Kuczabski and Michalski, 2013; Pužulis and Kūle, 2016; Wojewódzka-Wiewiórska, 2019) or urban decline (Haase et al., 2016; Wolff and Wiechmann, 2018). Kabisch and Haase (2011) examined urban population trends in 21st century Europe, and found that the urban agglomerations they studied had not reached a single evolutionary stage of urban development. In particular, the authors observed that thus far in the 21st century, urban revival or reurbanisation has led to population increases in the inner parts of cities, despite ongoing suburbanisation trends; and that, albeit to a smaller extent, a process of desurbanisation has been occurring. Additionally, they found an increase of agglomerations in the urbanisation stage, which has led to an obvious trend towards reurbanisation and urbanisation occurring in parallel. The persistence of a sharp rural–urban dichotomy in research on population decline compounds the problem of a lack of large-scale studies on the topic, as most of the previous research on this issue has consisted of small-scale case studies that provided highly specific accounts of localised population declines (Newsham and Rowe, 2022). Although the urban–rural pattern (in which the urban areas gain population due to people leaving rural areas) is dominant, some studies have noted that not all rural areas are declining at the same pace (Bryden and Munro, 2000). Rizzo (2016), focusing on southern Italy, found that there are some rural areas that have been able to maintain slow population growth. Many of these territories, which have been labelled 'Territori Lenti' (slow territories) (Lanciarini, 2005; Lanzani, 2005), have grown due to large investments in the agritourism sector. Similarly, Collantes et al. (2014), focusing on Spain, found that mass immigration to rural areas before 2008 has contributed considerably to a deceleration of depopulation in these places. Indeed, in some rural areas, immigration flows have actually reversed the previous population trends after decades of steady decline. An important aspect of rural depopulation that policymakers are increasingly taking into account is that moving behaviours are selective (Elshof et al., 2014). It has, for example, been shown that young adults, especially the more talented ones, are more likely than other population groups to leave their area of origin to pursue education or employment opportunities (Rees et al., 1997; Zelinsky, 1971).

Currently, given the spread of communication technologies and the process of space shrinkage (Kirsch, 1995), we believe that scholars should move beyond a focus on urban and rural contexts when studying depopulation. As Reynaud et al. (2020) has emphasised, certain geographical variables of municipalities (e.g., the altitude and the distance from the sea) are crucial in influencing (in negative terms) demographic dynamics, and cannot be easily changed by technological improvements. For this reason, our analysis refers to all Italian municipalities, but considers their spatial attributes by using a spatial weight matrix (i.e., defining a spatial neighbourhood structure). In doing so, we seek to answer the question of whether it makes sense to speak about the existence of a process of spatial diffusion of demographic growth and decline among Italian municipalities.

Within the European context, Italy has always been characterised by demographic and socio-economic territorial divisions. These differences are so deeply rooted that Bagnasco (1977) coined the term 'Tre Italie' to explain the diverging economic development of the Italian macro regions (north, centre and south). Understanding these differences is also important when considering demographic behaviours in relation to both fertility and mortality on the one hand, and migration on the other. In an analysis of the demography of Italian regions, Bonaguidi (1985) found substantial differences in the demographic characteristics of the central and the northern areas of Italy and the southern areas of the country (Dunford, 2002).

Regarding depopulation processes, previous studies conducted at the municipal level in Italy have shown that some municipalities have 'more dynamic' situations, whereas others are characterised by demographic malaise, and are thus becoming smaller and more peripheral (Golini et al., 2000; Reynaud et al., 2020). These processes can lead to a sort of vicious circle of (demographic) marginality that is, to some extent, auto-propulsive and spatially dependent. Benassi et al. (2023) studied the evolution of municipalities in Italy by analysing their levels of growth/decline in four subsequent periods of time over the last 40 years (1981–2019). They found that the number of municipalities that experienced a light or an intense process of demographic decline increased over time through the dynamics of spatial contagion. The authors also calculated the value of global Moran's *I* (1948), and found a positive global spatial correlation in all four periods considered (similar positive or negative values for the average growth rates tended to be spatially clustered). They also showed that the index increased from 0.401 in 1981–1991 to 0.436 in 2011–2019. Based on the local version of the Moran's *I* index (Anselin, 1995), Benassi et al. (2023) also classified each municipality according to their growth rate and the growth rate of the surrounding municipalities, and found an acceleration of spatial clustering. More specifically, they observed that in the last period they considered (2011–2019), the urban and the metropolitan spatial plots expanded, especially in the centre–north, while the areas where municipalities had low growth rates were surrounded by areas where municipalities were distributed more widely, but were circumscribed by precise geographical logics: e.g., the inland territories of Sardinia and Sicily, the Apennine ridge, and the inland areas of Liguria and Emilia near the Apennines and Alpine border areas.

2.2 The determinants of population growth and decline

Most previous studies on population decline concentrated on the levels of depopulation or on the consequences of the process, while failing to acknowledge the process through which decline unfolds (Newsham and Rowe, 2022) and the determinants of that process. Regardless of the territorial scale at which population decline is observed, it is clear that it can be caused by a wide variety of factors (Elshof et al., 2014). Population decline is, indeed, a complex phenomenon that is influenced by a range of political, economic and social factors (Haase et al., 2016). Because of this complexity, population decline can be difficult to predict (Ubarevičiene et al., 2016).

From a strictly demographic point of view, natural decline and negative net migration are the two main factors that lead to population decline. These two trends are intertwined, and, as is well known, each can hasten the other. One of the most frequently studied factors that can contribute to an uneven process of population change is the population age structure (Ubarevičiene et al., 2016). The age distribution of a population reflects many other aspects relevant to its growth or decline, such as its labour market potential and its reproduction capacity. The ageing of rural populations and rapid declines in population size in rural areas are frequently caused by the selective migration of particular age groups (Burholt and Dobbs, 2012; Walford and Kurek, 2008). In a recent contribution on migration, Bagavos (2022) found that the presence of a foreign-born population attenuated population decline trends in eastern and southern European countries, and that it was a driver of population growth in a very limited number of countries. More importantly, Bagavos showed that in western European and Nordic countries, the presence of a foreign-born population turned the expected process of population decline into population growth. The author concluded that the foreign-born population has helped to drive overall population change and growth in Europe, and that this effect is mainly attributable to net migration, rather than to natural change in the migrant population.

In addition to demographic dynamics and structures, economic factors also play a very important role in population decline. Economic decline is often a precursor to population decline, but both processes can become part of a vicious circle (Ubarevičienė and van Ham, 2017) that leads to a downward spiral of the local economy characterised by a decline in tax revenues, service provision and social infrastructure, and the abandonment of homes and factories (Elshof et al., 2014). In the debate about the link between patterns of growth in rural and urban territories discussed in the previous subsection, it clearly emerges that urban areas are often more attractive because they offer more social and economic opportunities and provide more services for families and individuals than rural areas. Younger age groups are more prevalent in inner-city neighbourhoods, which typically have more sustainable economic and cultural conditions (Ubarevičiene et al., 2016).

Generally speaking, the socio-economic conditions of the different areas are important drivers of the inflow or the outflow of people. According to the neoclassical economic model, most internal migration is a response to job and educational opportunities (Ní Laoire, 2000; Stockdale, 2004). Average salaries, the educational level of the population, the size and the structure of the labour market, the unemployment rate, the number of businesses per capita, the level of foreign investment, and family dynamics or a desire to live in a better environment are the main specific factors identified in the literature as drivers of internal migration (Biagi et al., 2011; Niedomysl, 2008, 2011; Nivalainen, 2004; Schmidt, 2011; Tammaru and Sjöberg, 1999; Ubarevičienė and van Ham, 2017; Westlund and Pichler, 2013).

Among the other social factors related to population decline, some studies have specifically investigated the impact of the proximity of primary schools on the depopulation of inland areas, and have reported contradictory results. Although theoretical considerations suggest that rural school closures will lead to local population decline, most studies have found that school closures have no statistically significant effects or only small effects on population. In an early US study, Johnson (1978) examined four elementary school closures in the Seattle school district, and found ‘virtually no evidence of community deterioration associated with the closure decisions’ (p. 357). Amcoff’s (2012) analyses of 236 rural school closures in Sweden during the 1990–2004 period were based on migration data recorded in the areas around each school. He concluded that there were ‘no statistically significant effects of the closing of rural schools [...] on the migration patterns in the schools’ surroundings’ (p. 58). Elshof et al. (2015) analysed population register data from 553 rural villages in the north of the Netherlands during the 1996–2011 period to determine the impact of the absence or the closures of primary schools in rural villages on the in- and outflows of families with children. They concluded that ‘villages without a primary school, and villages that have experienced the closure of a primary school, have similar influx, but larger outward flows of families with children compared with villages with a primary school’ (p. 625). By contrast, Barakat (2015), studying the province of Saxony in East Germany for the 1994–2007 period, found little evidence of a relevant effect of primary school closures on local population decline, and concluded that expectations of a dramatic impact of school closures on out-migration lack a theoretical foundation.

A recent study by Kroismayr (2019) explored the demographic, economic and social trends in Austrian municipalities in which at least one primary school was closed between 2001 and 2014. Kroismayr investigated the importance of distinguishing between municipalities that had lost their last school and those that still had a school. Surprisingly, he showed that ‘the municipalities which closed their last school were not as badly affected as the concept of the downward spiral would imply, as in our sample the municipalities with one remaining school suffered a much greater loss in the number of families and births’. Thus, he concluded that the presence of a school was of negligible importance. He also showed that the municipalities adopted different coping strategies, and that in most cases, the decline in population was caused by out-migration, rather than by a decline in birth numbers. In particular, he maintained that the populations of inland rural areas were very settled, especially in places where a higher share of the population was working in agriculture. He attributed this pattern to people working in agriculture being less mobile (being reluctant to leave the rural area) and to having more than the average number of children. The study concluded that the depopulation trend may have been even more pronounced in the municipalities in which the share of the population working in agriculture was not high.

Recently, two different studies found that school closures had a statistically significant population effect. In particular, Lehtonen (2021) found a clear negative population effect of rural school closures. His results came from analyses of population data of the areas surrounding (within 5–10 km) municipalities in Finland where 518 schools were closed between 2011 and 2018. Along the same lines, a study by Sørensen et al. (2021) focused on the effects of rural school closures in 2011 on population levels in municipalities in Denmark in the 10 years after the school closures. They concluded that the school closures had a negative effect on the populations of local communities. The authors sought to explain why their results contradicted those of the previous literature by noting that whereas most of the other quantitative studies considered municipalities as the unit of analysis, their analysis considered the communities surrounding the school (Lehtonen, 2021; Sørensen et al., 2021), and used a longer time span (Sørensen et al., 2021).

3 Research objectives, data and methods

Our literature review has provided some key insights: first, that demographic phenomena in Europe are characterised by strong heterogeneities; second, that the traditional urban–rural divide in population growth or decline must be revised, as not all rural areas are declining at the same pace, and trends can vary across neighbouring municipalities even within urban areas; and, third, that individualised factors can affect the growth and the decline of the populations of different territories.

In line with these findings, we first describe the annual growth rates of Italian municipalities from 1981 to 2019 to reveal the existence of territorial heterogeneities at a municipal level, and to determine whether urban and rural areas display consistent patterns. We then concentrate on our main research objective, which is to individualise the demographic, social and economic factors related to the growth and the decline of population at the municipal level. To realise this objective while considering the spatial dimension, we apply the SDM (Elhorst, 2014).[2]

The SDM is the model that is most compatible with the concept of (spatial) diffusion processes, because it implies that the neighbourhood structure has an influence that is not simply assumed, but that can actually be estimated. It is important to clarify that these spatial lag models are designed to produce indirect evidence of diffusion in cross-sectional data (as in our case). This type of model has recently been used in other demographic studies that investigated the geographical variation in fertility and international migration in Spain (Sabater and Graham, 2019); the diffusion patterns of fertility in Italy at the sub-regional level (Benassi and Carella, 2022; Vitali and Billari, 2017); and the geographical variation of mortality rates in the United States (Yang et al., 2015).

The quantitative analysis was carried out on a dependent variable and a set of covariates. The variables were computed at the local (municipality) scale. The dependent variable was the annual growth rate (‰) of the population for the 2011–2019 period. The covariates referred to 2011 values.

For the computation of the dependent variable, we used population data from the 2011 Population and Housing Census and the 2019 pre-census data from population

[2] For the sake of brevity, we present here only the results of this model, although we actually estimated four different models: ordinary least squares (OLS), a spatial error model (SEM), spatial autoregressive models (SAR) and a spatial Durbin model (SDM). The classical OLS was estimated only in order to have a benchmark model, as it allowed us to evaluate the coefficients, but it did not account for any spatial effect. Between the three spatial models we estimated (SEM, SAR and SDM), we opted for the SDM because, as is explained in the text, it was the best from a formal and a substantive point of view at describing the spatial diffusion process of population growth and decline in Italy, as it allowed us to include the lagged values of the covariates. In comparing the four methods, we can see that even though the results of the different models clearly differed, there were no noteworthy variations in the signs of relationship of the covariates. We also computed some fitting indices, such as the Akaike Information Criterion (AIC) (Akaike, 1973, 1974), and the SDM proved to be the model that best fit our data. All of the results of the other three methods are available from the authors upon reasonable request.

registers. We chose to use data from pre-census population registers instead of data from the permanent census or the revised population registers for reasons of internal coherence. It is important to note that the permanent Italian census data represent a temporal break in the series of population census data, as they mark the first time in Italian history that census data have been collected without using a traditional approach. All of the data, including the geographical data (shape files), were downloaded from the Istat website. In the SDM, the regression coefficients are decomposed into direct and indirect (spatial spillovers) effects (Golgher and Voss, 2016). The direct effect 'represents the expected average change across all observations for the dependent variable in a particular region due to an increase of one unit for a specific explanatory variable in this region' (p. 185); while the indirect effect 'represents the changes in the dependent variable of a particular region arising from a one-unit increase in an explanatory variable in another region' (p. 185).

The SDM improves on other spatial models, such as the spatial autoregressive model (SAR), by including not only a spatial lagging of the dependent variable, which captures the effect of spatial contagion of y on itself, but also a spatial lagging of all of the independent variables. In our case, the spatial lagging of the explanatory variables was added so that the characteristics of neighbouring municipalities could have an influence on the annual growth rate of each municipality under analysis. Thus, the SDM allowed for the annual growth rates of the neighbouring municipalities, in addition to their structural characteristics, to determine the growth rate of a municipality. Following Yang et al. (2015), a generic SDM can be written as:

$$y = \rho W_y + \alpha l_n + X\beta + WX\theta + \varepsilon, \quad \varepsilon \sim N(0, \sigma^2 I_n) \tag{1}$$

where y denotes an $n \times 1$ vector of the dependent variable; W is the spatial weight matrix; W_y represents the spatial lagged variable (endogenous interaction relationship); and ρ denotes the effect of W_y, which is known as the spatial autoregressive coefficient. l_n indicates an $n \times 1$ vector of those variables associated with the intercept parameter α. X represents an nxk matrix of k explanatory variables, which are related to the parameter β. WX reflects the spatial lagged explanatory variables (exogenous interaction relationships), and θ denotes a $kx1$ vector of the effects of WX. The error term, ε, follows a normal distribution with a mean of 0 and a variance $\sigma^2 I_n$, where I_n is an nxn identity matrix. The model had been estimated by the maximum likelihood estimation method (Anselin and Rey, 2010).

More specifically, we used a SDM in which the dependent variable (the annual average growth rate of each municipality in the last period, 2011–2019) was placed in relation both to the same 'spatially lagged' variable y (Anselin, 2001; Matthews and Parker, 2013) and a set of covariates measured in 2011 and their spatially lagged values. The independent variables included in the model were linked to four conceptual dimensions associated with depopulation, each of which included a certain number of variables:

(1) demographic aspects: the variables considered in this dimension are the 'percentage of the population under 6 years old' (%), the 'percentage of the population over 75 years old' (%) and the 'percentage of foreign people' (%);

(2) socio-economic mobility: the variables considered in this dimension are the 'percentage of youth living alone' (%), the 'study/work mobility' (measured as the percentage ratio between the resident population who commute daily from their usual residence to their place of work or study and the resident population aged up to 64 years), the 'female activity rate' (%) and the 'youth (15–29 years old) employment rate' (%);
(3) schooling: for this dimension, we considered the 'presence/absence of primary school'; and
(4) economic-productive context: the variables considered in this dimension are the 'share of employees in the agricultural sector' (%) and the 'share of employees in the industrial sector' (%).

All of the variables included in the model stemmed from the Population and Housing Census of 2011, except the data on the absence/presence of schools, which came from the Ministry of Education and Scientific Research.[3] All of the independent variables were measured in 2011. On this last point, the temporal reference of the variables, it should be emphasised that the explanatory variables refer to 2011 (i.e., the beginning of the observation period), while the dependent variable, which is the average rate of change of the resident population, refers to the 2011–2019 period. This approach allowed us, from a technical point of view, to keep endogeneity issues under control. Moreover, from a substantive point of view, this approach enabled us to adopt a (pseudo) causal perspective (i.e., what happened in 2011–2019 depended to a certain extent on what was observed in 2011). A crucial aspect of spatial analysis is the determination of the relevant neighbourhood of a given area: i.e., the spatial units—in our case, the municipalities—surrounding a given data point (area) that would be considered as influencing the observation at that data point. Indeed, these neighbouring areas are spatial units that interact in a meaningful way. This interaction could relate, for example, to spatial spillovers and externalities (Lansley and Cheshire, 2016).

Before arriving at the final model, we tested the effects of many demographic and socio-economic factors. The number of covariates was then set to the minimum that allowed us to control for problems of multicollinearity. As the multicollinearity condition number was lower than 30 in all of the models applied, we can assume that the level of multicollinearity was negligible (Anselin and Rey, 2014). In all of the spatial analyses proposed here, the spatial weight matrix was obtained as a 'Queen' contiguity matrix of the first order: two municipalities (i, j) were considered neighbours $(W_{ij} = 1)$ if and only if they shared a boundary or a vertex geographically. This is the simplest way to approach the concept of neighbourhood. In particular, in this kind of spatial weight matrix, the concept of contiguity is used. We chose this type of spatial weighting matrix for several reasons. First, the use of this matrix is very common, and it is often adopted when statistical units refer to a local scale

[3] These data stem from the Archive of public schools (2019), provided by the Ministry of Education and Scientific Research to Istat. The data we used in the model refer to the year 2011.

(Benassi and Carella, 2022; Iglesias-Pascual et al., 2022; Salvati et al., 2020; Yang et al., 2015). Moreover, contrary to other approaches to spatial weighting, such as the K-Nearest Neighbour (K-NN), we did not have to decide on an arbitrary number of neighbouring municipalities. It should be noted that this kind of spatial weighing matrix is the same as that applied in two previous studies on the same topic (e.g., Benassi et al., 2021; Benassi and Carella, 2022), which can be considered the progenitors of this paper. Therefore, using the same spatial matrix guarantees the coherence and the comparability of the results of these studies. The regression models were estimated using R studio following the procedure in Mendez (2020).

4 Descriptive findings: The demographic dynamics of Italy in the last 40 years from the regional to the local scale

As was shown in the literature review, Italy—in contrast to other European countries—has long been characterised by demographic and socio-economic territorial divisions, and by relevant heterogeneities between territories. Some data on these heterogeneities are shown in Figure 1, in which we avoided the divisions typically drawn between the three macro regions (north, centre and south), and instead used the more detailed partitions currently used in the official statistics to shed light on the differences between the north-east and the north-west within the 'north' macro region, and between the islands and other southern regions within the 'south' macro region.

We can clearly see that in the past, the higher comparative levels of growth in the north and the centre were due to the combination of natural growth and a positive migration balance. Nevertheless, higher natural increase values were recorded in the south and the islands. The tendency towards a decrease in the natural growth rate produced a different effect in each macro region, and a similar pattern can be observed for the internal migration rate. As a consequence, we can see that some macro regions (typically in the north) were less demographically distressed. Especially in recent years, this was also due to international migration flows, mostly to the north of Italy (Benassi and Naccarato, 2018). We do not have long time series data on international migration flows. Nevertheless, we can state that for Italy as a whole in 2019, the migratory balance with foreign countries was positive and equal to 153,273. Migration intensity was relatively high in the north-west (56,068), the centre (42,924) and the north-east (32,826); and was relatively low in the south (17,513), and especially in the islands (3,924).

Obviously, the geographical scale is crucial for detecting the spatial heterogeneity and the dependence patterns of demographic processes. Indeed, the local scale (municipal level) should be adopted to ensure a better understanding of population spatial heterogeneity and spatiotemporal variability, as has been demonstrated by some recent studies on Italian demography conducted at the territorial level (Caltabiano et al., 2019; Salvati et al., 2020). In Benassi et al. (2023), we showed the distribution of the municipalities in Italy by the levels of growth/decline in four subsequent periods of time covering the last 40 years (1981–2019). The number of municipalities that have experienced either a light (annual growth rate per 1000 between ≥ −8.0 and ≤ −2.0) or an intense (≤ −8.0) demographic decline has increased over time. Using this classification, we counted the number of municipalities in each specific condition to evaluate the changes over time (Table 1). We found that the share of municipalities that experienced an intense demographic decline increased progressively from 1981 (18.7‰) to 2019 (25.7‰).

Figure 1:
Demographic trends and dynamics in Italy and macro geographic areas: overview on some indicators 1951–2014

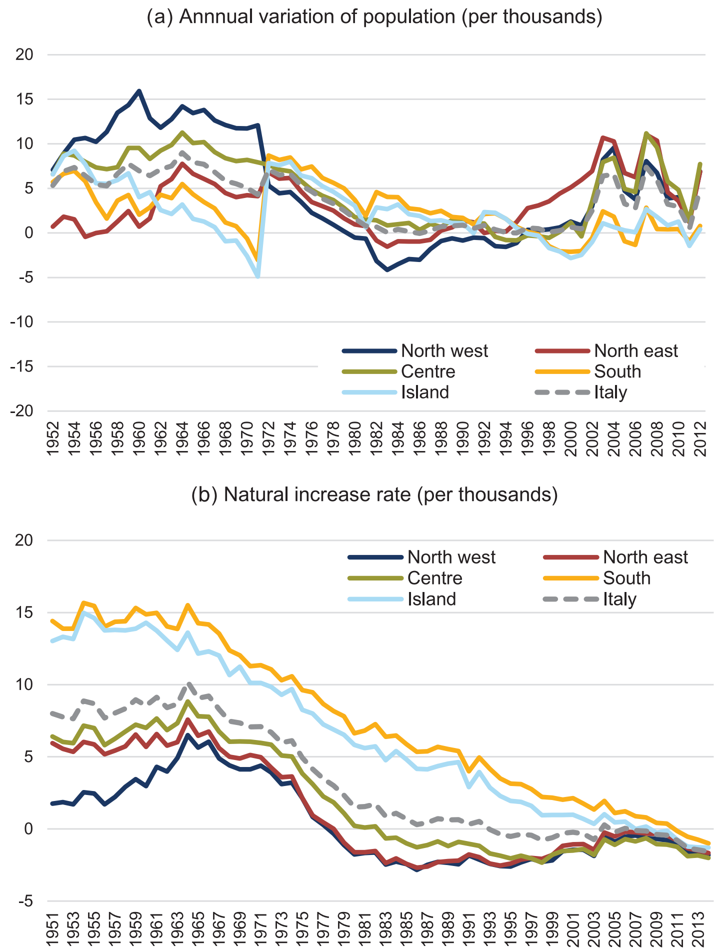
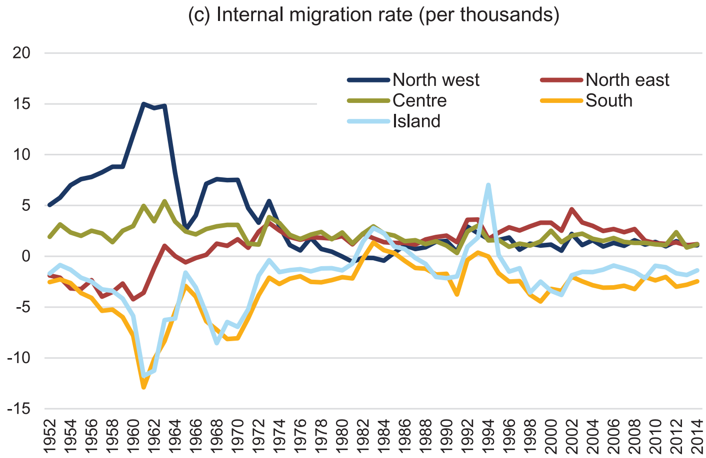


Figure 1:
Continued



Source: our elaboration based on Istat data 'Serie storiche' (https://seriestoriche.istat.it/); for (a), source: Table 2.3.2; for (b), source: Table 2.4.1; for (c), source: Table 2.12.

In the last period, 2011–2019, around 50% of the municipalities belonged to these two categories, and about 6% belonged to the intense decline group.

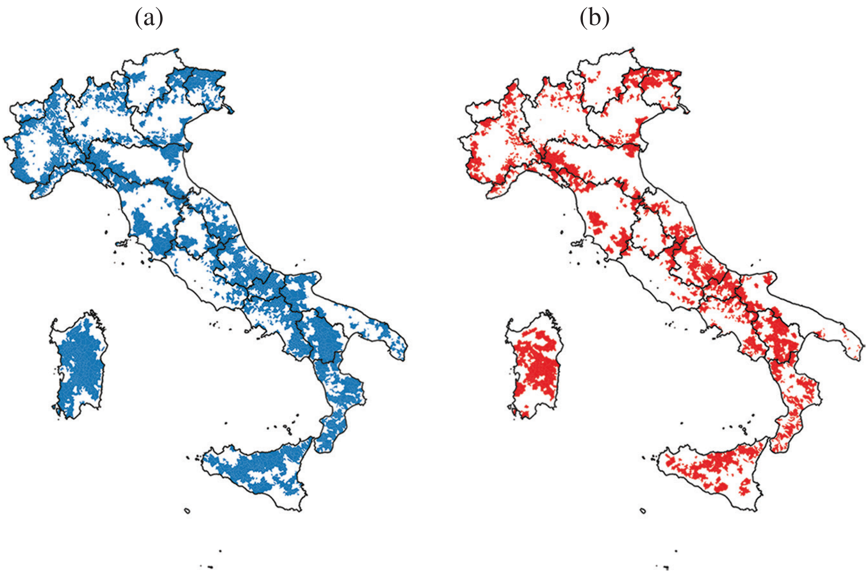
The consequences of those dynamics are summarised in Figure 2(a) and (b), which show the spatial distribution of municipalities in a condition of prevalent or systematic demographic decline, respectively. In the left panel of Figure 2(a), the spatial distribution of municipalities in a condition of prevalent demographic decline is shown; this condition occurred in 3,245 Italian municipalities (41% of the total). The geography of this group of municipalities is clearly spatially dependent, and

Table 1:
Percentage of municipalities by categories of demographic growth/decline

Categories of demographic growth/decline	1981–1991	1991–2001	2001–2011	2011–2019
Intense demographic decline	18.7	17.0	14.7	25.7
Light demographic decline	20.3	20.4	17.5	28.5
Stagnation	18.8	18.4	16.0	20.2
Light demographic growth	22.8	22.8	22.5	18.4
Intense demographic growth	19.5	21.3	29.3	7.3
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Our elaboration based on Istat data. For the years 1981–2011, the data are from census sources. For 2019, the data are from a demographic (pre census) source revised by Istat (https://demo.istat.it/).

Figure 2:
Municipalities in a condition of prevalent (a) or systematic (b) demographic decline, 1981–2019



Source: our elaboration based on Istat data. For the years 1981–2011, the data are from census sources. For 2019, the data are from a demographic (pre-census) source revised by Istat (https://demo.istat.it/).
(a) A municipality is classified as being in a condition of prevalent demographic decline if its average annual growth rate was negative at least three to four times in the 1981–2019 period.
(b) A municipality is defined as experiencing 'systematic population decline' if it had negative annual growth rate values in all four periods.

forms clear spatial patterns. Most of the municipalities in this group are located across the mountain range of the Apennines from the north to the south; in the Alpine areas across the Italian national border in the north-east and the north-west; in the inland areas located further from the sea; and in large parts of the two bigger islands of Italy (in this case, especially in the inland areas). It is interesting to note that the proximity of such municipalities played a role in population decline, and that depopulation affected local contexts from the north to the south of Italy. In the right panel (Figure 2(b)), we show the spatial distribution of the municipalities in a condition of systematic population decline based on the average annual growth rate during the 1981–2019 period. This condition occurred in 1,884 municipalities (23.8% of all municipalities), which means that the risk of a municipality that has already lost population (three times out of four) experiencing additional systematic population losses was quite high, at 58.0%. The distribution of municipalities in this condition creates spatial patterns that are even clearer than before, which can be called the geography of population loss and decline.

From the data reported in Table 1 and the maps in Figures 2(a) and (b), the relevance of space in defining the temporal dynamics of population growth at the local level seems quite clear. Depopulation is an intrinsic spatial process, especially when referring to territorial units (municipalities in our case) that are not independent of each other (Voss, 2007). Indeed, the first law of geography seems to be an important tool for investigating depopulation processes, and should not be ignored in empirical analysis.

5 Empirical findings

We modelled the variation in population that occurred in each municipality in the last period of analysis (2011–2019) using a set of demographic, social and economic covariates. As we already mentioned in the estimation process, we controlled for the role of space, and, in particular, for the spatial proximity of territorial units (i.e., municipalities) using both dependent and independent variables. Table 2 shows the results of the SDM used to evaluate which factors were related to the demographic growth or decline of Italian municipalities, considering both direct and indirect spatial effects.[4] The first important result is that the lag coefficient (Rho) was positive (0.3004) and statistically significant, which indicates that the variation in population was significantly affected by the value it assumed in the neighbouring municipalities. The value and the significance of this coefficient confirmed the spatial nature of the phenomenon, and indirectly indicated the existence of a spatial diffusion process.

Among the covariates included in the model, we could observe that the demographic dimension was significantly and consistently associated with population variation: the age structure was among the main forerunners of population growth/decline. In particular, the percentage of children up to six years of age was positively associated with the change in population between 2011 and 2019, and thus with a demographic increase. Both the direct and the indirect average effects were positive. This means that both the direct and the indirect (spillover) effects tended to boost demographic growth, all conditions being equal. By contrast, a high percentage of elderly people aged 75 years or older was negatively associated with both direct and indirect negative effects. This means that territories in which the percentage of older people was comparatively high tended to be spatially clustered, which, in turn, accelerated the pace of demographic decline (negative effect on demographic growth rates). The effect of the percentage of foreigners was quite interesting. The average direct effect was not statistically significant. However, the average indirect or spillover effect (i.e., the effect of the neighbourhood municipalities on the observed municipality *i*) was positive, which suggests that it had a positive impact on demographic growth.

[4] We estimated a reduced form of the SDM model not including variables related to the demographic dimension. The idea was to test the existence of a possible mediating' effect. Results are quite stable compared to the full model (available from the authors upon reasonable request).

Table 2:
Results of a spatial Durbin model on the average annual growth rates in the 2011–2019 period

					Effects		
Variable	**Coefficient**	**Std. error**	***z*-values**	***p*-values**	**ADE**	**AIE**	**ATE**
Intercept	−2.0537	0.7736	−2.6549	0.0079			
% under 6 years old	0.7226	0.0775	9.3266	0.0000	0.7601	0.8882	1.6483
% over 75 years old	−0.6376	0.0244	−26.1392	0.0000	−0.6449	−0.1730	−0.8179
% foreigners	0.0035	0.0026	1.3582	0.1744	0.0043	0.0196	0.0239
% youth living alone	0.1265	0.0192	6.5897	0.0000	0.1238	−0.0655	0.0582
Study/work mobility	−0.0418	0.0089	−4.7216	0.0000	−0.0416	0.0052	−0.0364
Female activity rate	0.1745	0.0142	12.2543	0.0000	0.1754	0.0196	0.1950
Youth (15–29) employment rate	0.0385	0.0112	3.4296	0.0006	0.0375	−0.0243	0.0132
% workers in agriculture sector	−0.1169	0.0136	−8.5719	0.0000	−0.1201	−0.0743	−0.1944
% workers in industry	−0.0895	0.0123	−7.2808	0.0000	−0.0937	−0.0995	−0.1933
Primary school	0.8612	0.2407	3.5775	0.0003	0.8113	−1.1821	−0.3707
Lag % under 6 years old	*0.4306*	*0.1244*	*3.4616*	*0.0005*			
Lag % over 75 years old	*0.0654*	*0.0381*	*1.7152*	*0.0863*			
Lag % foreign people	*0.0132*	*0.0034*	*3.8670*	*0.0001*			
Lag % youth living alone	*−0.0858*	*0.0314*	*−2.7363*	*0.0062*			
Lag study/work mobility	*0.0163*	*0.0126*	*1.2945*	*0.1955*			
Lag female activity rate	*−0.0381*	*0.0227*	*−1.6825*	*0.0925*			
Lag youth (15–29) employment rate	*−0.0293*	*0.0164*	*−1.7872*	*0.0739*			
Lag % workers in agriculture sector	*−0.0191*	*0.0182*	*−1.0467*	*0.2952*			
Lag % workers in industry	*−0.0457*	*0.0164*	*−2.7821*	*0.0054*			
Lag primary school	*−1.1206*	*0.4520*	*−2.4795*	*0.0132*			
Lag. coefficient (Rho)	*0.3004*			*0.0000*			

Log likelihood: −25395.6
Akaike info criterion: 50837.0
LM test for residual autocorrelation test value: 18.781, p-value: 0.0000

Note: ADE = average direct effect; AIE = average indirect effect; ATE = average total effect.
All effects are statistically significant at $p < 0.05$, except those underlined.

The social dimension also played an important role. The share of young people living alone was significantly associated with an increase in population. The direct effect was positive, while the indirect effect was not statistically significant. This means that while an increase in the percentage of youth living alone in a municipality was positively associated with population growth in the municipality, this was not the case for the neighbouring municipalities. Additionally, mobility played an important role: the ability to reach places of study or of work in a reasonable time was certainly one of the factors that slowed down the depopulation of a territory. At the municipal level, the direct effect of the percentage of the population who moved to reach places of study or work in 2011 was, as expected, negatively associated with the variation in the following years, while the indirect effect was not significant. This means that municipalities where the share of the workforce and/or of students who remained within the city was low (and levels of commuting outside of the municipality were therefore high) were at greater risk of depopulation.

Turning to the employment covariates, we found that both the female activity rate and the youth employment rate were significantly associated with an increase in the population in the last period, with a positive and significant direct effect and no significant indirect effect. The variables concerning the economic-productive environment were also relevant. The percentage of workers in both the agriculture sector and industry were negatively associated with an increase in the population during the last period with both direct and indirect effects. This finding raises important questions about the transformation of the economic structure of Italy, and, in particular, about the industrial and agricultural crisis in the southern part of Italy in recent years.

The presence or the absence of schools emerged as both a cause and a consequence of the decline or the growth of the population of a municipality. All other things being equal, the presence of a primary school in a municipality in 2011 was positively linked to an increase in the population in subsequent years. Interestingly, the direct effect was positive, while the indirect effect was negative. This means that the presence of a primary school in the municipality in 2011 was positively related to population growth in subsequent years, while the presence of a primary school in the neighbouring municipalities in 2011 was negatively related to population growth in the next period. Given the Italian ministerial requirements[5] for the creation of classes, it is the lack of children or a reduction in the number of children residing in the municipality that leads to the closure of primary schools and the movement of families with children to neighbouring municipalities where a school is present. As this vicious circle feeds itself, it appears that making it possible for families to send their children to school is essential to stemming the depopulation of small municipalities, especially in inland areas of the country.

The results of the statistically significant spatial lagged covariates included in the SDM confirmed the spatial nature of the phenomenon, and indicated the existence of a spatial diffusion process (i.e., the effects of spatially lagged covariates on the dependent variables were almost always statistically significant). This means that the variation in population was significantly affected by the value the covariate assumed in the neighbouring municipalities. Specifically, the lagged version of the variables related to the percentage of residents under six years of age and to the percentage of foreign-born residents showed a positive correlation with the dependent variable. This means that a municipality that had neighbours in which the percentages of the population who were young children or foreign-born were higher tended to have a positive demographic growth rate. By contrast, the lagged version of the percentage of young people living alone, the percentage of workers in industry and the presence of a primary school were all negatively correlated with the dependent variable. The explanation for this finding is straightforward: in most cases, a municipality that

5 The requirements for the creation of classes call for a minimum of 15 pupils for primary schools and of 18 pupils for low secondary schools, but both minimums were reduced to 10 pupils for mountainous municipalities and small islands.

had neighbours with higher shares of youth living alone, workers in industry and a primary school was a context of origin for the out-migration of young people, migrant workers and families who settled in the municipalities that had these characteristics. Thus, from these results, the importance of space, and particularly of the concept of being near in space—i.e., the first law of geography—clearly emerges.

6 Discussion and conclusions

In this paper, we analysed the diffusion process for population growth or decline in Italy at the municipal level. Italy, like many other European countries, is characterised by a high degree of territorial heterogeneity, with some areas experiencing population growth, and many others facing population decline. After reviewing the literature on population growth and decline in Italy and analysing the annual growth rates of Italian municipalities from 1981 to 2019, which showed that there was a positive spatial autocorrelation between the municipalities, we used a SDM to investigate which demographic, social and economic factors were related to this pattern of growth/decline at the municipal level. The analysis of the determinants/predictors of the average annual growth rate over the last 10 years at the municipal level showed that the spatial dimension had a strong effect. Moreover, our results confirmed that the demographic composition of the population was strongly related to the dynamics of the subsequent years. It should be recalled that this relationship is mutual, as the interdependencies between the causes and the effects are not linear (Großmann et al., 2013). For instance, in municipalities where the number of young women was higher, the fertility level tended to be higher; and, conversely, in municipalities where fertility (and immigration) was higher, the percentage of residents aged 6+ also tended to be higher in subsequent years, while the percentage of residents aged 75+ tended to be lower.

Also relevant is the contribution of the socio-economic dimension by individuals whose faster—or at least less slow—transition to adulthood is a crucial factor in population growth. Thus, we confirmed that leaving the family of origin is an important transition phase that provides the foundation necessary for family formation (and for the other stages of transition to adulthood), and is therefore an important driver of population growth through fertility (Billari and Kohler, 2004).

Concerning the employment covariates, we found that both the female activity rate and the youth employment rate were significantly associated with an increase in the population in the subsequent period, with positive and significant direct effects and no significant indirect effects. This result is related to the debate on the positive relationship between female participation in the labour market and fertility at the macro level. Although research findings still do not completely agree on the sign of the relationship between female labour force participation and fertility at the micro and the macro levels, they all agree on the importance of economic factors (Alderotti, 2022; Busetta and Giambalvo, 2014; Innocenti et al., 2021; Tocchioni, 2018). The studies by Brewster and Rindfuss (2000), Rindfuss et al. (2003) and

Engelhardt and Prskawetz (2004) were the first to debate the relationship between female participation in the labour market and fertility at the macro level, as well as the changing correlation between the two variables over space and time at the national level. Focusing on regional differences, Busetta and Giambalvo (2014) examined the impact of women's participation in the labour market on the probability of having a first child at both the macro and the micro levels, and found contrasting results at the two levels. More recently, Innocenti et al. (2021) investigated the association between 'economic complexity' (measured using many different economic indicators) and fertility at the province level. They found that fertility was higher in provinces characterised by higher levels of economic complexity.

Among the different covariates we considered, the presence/absence of a school proved to be most strongly related to population growth and decline. We showed that, other things being equal, the presence of a local primary school in a municipality in 2011 had a direct positive impact on the demographic development in the municipality in the subsequent years, whereas the presence of a primary school in the neighbour municipalities was negatively related to population growth in the municipality. The remarkable direct, indirect and lagged coefficient for the presence of primary schools seems to suggest that this factor is extremely relevant for the survival of Italian municipalities. Even if it ignored the timing of the eventual school closure, our model clearly showed that the presence of a school was crucial to the survival of a municipality. These results are in line with recent findings showing that school closures have a negative effect on population growth (see, e.g., Lehtonen, 2021 and Sørensen et al., 2021). The presence of schools, as well as the availability of child care (Klüsener et al., 2013b), are also related to the fertility decisions of couples, which—as was discussed—are important drivers of population growth. Thus, our results seem to show that in Italy, primary schools not only perform educational and other social functions in the community, they also provide a crucial territorial presidium for municipalities seeking to retain population and increase economic activity.

With this paper, we have contributed to the literature on the causes and the consequences of depopulation in two ways. First, we have added to the spatial dimension of the analysis of population decline and local heterogeneities in Italy by providing strong evidence that space matters in defining population growth and decline, and by underlining the importance of considering spatial demography when studying such processes (Voss, 2007). Second, we provided a contribution to the debate on the demographic, social and economic factors associated with population growth/decline by explicitly considering the spatial dimension.

Our results corroborate the existence of strong and essential spatial dimensions of population decline, which should, therefore, be considered in depopulation studies. A further potential development of this work is to estimate the contribution of foreign-born populations to population growth or decline in different territories. We know that the presence of foreigners may slow population decline due to both migration itself (direct effect) and the contributions of the foreign-born population to natural change (indirect effect), as it is well known that foreigners typically have higher fertility rates than natives. From this perspective, a spatial regression model in which the dependent variable is the average annual growth rate of the total population of the i-th municipality, and the explanatory variables are the growth rates of foreign and Italian populations for the same municipality, plus a spatial lag effect, would allow for the evaluation of the net effects that changes in the rates of Italians and foreigners have on the total rate of change, while keeping in check the spatial effect of y on itself (which will still be measured to see whether an element of spatial influence of y on itself remains).

In accordance with Ezeh et al. (2012), we consider further research into the patterns of population growth and decline to be essential, because demographic policies can affect other social systems and social groups, as well as fertility decisions and trends. From this point of view, further modelling improvements are also necessary. Our analysis used global spatial regression models, which, despite representing an improvement on classical ordinary least squares (OLS), did not allow the local spatial variability of parameters to be brought under control and investigated. This is, however, a very relevant aspect that we propose to explore further in future contributions. In particular, it seems necessary to test the use of particular local regression models in which the scale (i.e., the 'bandwidth') is not constant—the so-called multiscale geographically weighted regression model (MGWR; Fotheringham et al., 2022; Oshan et al., 2019). These models will help us to better understand the different metrics at which the explanatory variables act by highlighting local and supra-local effects, as well as by enabling us to map local patterns (Matthews and Yang, 2012; Yang et al., 2022).

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Demographic sustainability in Italian territories: The link between depopulation and population ageing

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Abstract

Since the Second World War, Italy has experienced major demographic changes, including increasing survival, decreasing fertility and higher rates of immigration. These changes have silently and slowly led to important shifts in the structure and the territorial distribution of the population. Thus, like in many other European countries, population ageing and depopulation have become the most relevant demographic phenomena in Italy. In this paper, we studied the relationship between depopulation and ageing in Italian territories in the 1971–2019 period using the census data of the Italian municipalities and applying spatial techniques. We found that high levels of depopulation later result in high levels of population ageing, and that recent population ageing processes are also connected to ongoing depopulation processes, thereby creating a vicious circle.

Keywords: depopulation; population ageing; spatial analysis; Italy

1 Introduction

Depopulation, a process that shrinks a territory's population, and demographic ageing, defined as an increase in the number of older people in a population both in absolute terms and relative to the rest of the population, are two phenomena that are increasingly affecting large portions of Europe (Lutz and Gailey, 2020). These processes are mainly taking place in countries where fertility has reached very low levels, and where many sub-national areas have experienced very high levels of out-migration. This pattern can, for example, be observed in Spain

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(i.e., Alamá-Sabater et al., 2021), Italy (i.e., Reynaud and Miccoli, 2018) and many Eastern European countries (i.e., Lukic et al., 2012). Since the last century, various demographic changes have led to important variations in population growth, numbers and structure. As a result of these shifts, current populations, especially in certain areas, are characterised by a sharp decrease in growth and an intense ageing process. The Italian population is an interesting case to examine in the European context because it is among the populations experiencing the most intense population ageing and depopulation processes. Nonetheless, there has been relatively little research on the topic of depopulation in Italy (e.g., Reynaud and Miccoli, 2018; Rizzo, 2016), whereas it has attracted more attention in Spain and some Eastern European countries.

The similar dynamics of the depopulation processes – in particular the decline in fertility and the consequent negative natural balance – have caused and are causing a serious imbalance between the older and the younger generations in Italy, making the country's population one of the oldest in the world (Golini, 2000). These depopulation processes, which are also due to negative net migration, particularly among young people, are more widespread in rural areas, where significant ageing processes have taken place.

In Italy, depopulation is not a new or a recent phenomenon (Golini et al., 2000), as depopulation processes were occurring in specific territories in the early 1900s. However, over time, and especially since the 1970s, the demographic determinants of depopulation have changed, as new demographic and social processes have combined with depopulation processes. The areas affected by population decline have changed as well: new areas have begun to undergo depopulation, and are thus being added to the areas that were already experiencing this phenomenon; while other areas are no longer losing population, and are instead experiencing a new phase of demographic dynamism.

The aim of this work is therefore to examine the existing relationship between the two phenomena in Italian territories in the 1971–2019 period. Specifically, we are trying to understand whether and how population growth has affected the ageing levels in these territories, and whether and how having a large older population at a certain date has affected population growth.

The Italian context represents an interesting case for analysis because of its aforementioned demographic dynamics and the differences between its territories. Therefore, the analysis is carried out at a sub-national level by considering the lowest administrative level (Local Administrative Units, LAU), the Italian municipalities.[1] Furthermore, in the last considered period, in particular from 2011 onwards, the

[1] Italy is divided into five major socio-economic regions (NUTS 1, according to the Eurostat Nomenclature of Territorial Statistical Units): North-West, North-East, Centre, South and Islands. The country is composed of 20 regions (NUTS 2); 110 provinces (NUTS 3); and about 8000 municipalities (LAU), which are the low-level administrative divisions of the country. Throughout the paper, general reference will be made to the North, indicating the North-West and the North-East; and to the South, indicating both the South and the Islands.

effects of the economic crisis had an impact on demographic dynamics, which, in turn, exacerbated population ageing (Reynaud and Miccoli, 2019) and intensified depopulation processes. In this study, we consider the intercensal periods between the 1971 and 2019 census, and thus are able to take into account the period after 2011, when Italy was undergoing an acute demographic crisis. This approach provides us with recent insights into the relationship between the two phenomena. Unlike the previous study conducted on the subject (Reynaud and Miccoli, 2018), we add the last intercensal period, and apply the spatial model based on the assumption that one of the drivers of depopulation is the interdependence of neighbouring local units (Alamá-Sabater et al., 2021). We have chosen do so because previous studies have shown that when analysing demographic dynamics at a detailed territorial level, it is essential to take autocorrelation into account (Benassi et al., 2023; Matthews and Parker, 2013; Reynaud et al., 2018). The results of our previous paper may have been distorted by spatial autocorrelation.

The remainder of the article is organised as follows: Section 2 provides the theoretical background; Section 3 describes the research questions, data and methods used; Section 4 presents the results of the analysis, outlining first the descriptive results and then the results of the applied model; and, finally, Section 5 presents a discussion and the main conclusions of the study.

2 Theoretical background

Depopulation and population ageing are strongly connected (Díez Modino and Pardo Fanjul, 2020; Hospers and Reverda, 2014; Reynaud and Miccoli, 2018). The determinants that trigger depopulation processes are the same as those that cause population ageing, and the two phenomena influence each other. Low fertility and birth rates, together with emigration, cause both depopulation and ageing processes (Fihel et al., 2018; Hospers and Reverda, 2014). Indeed, a deficit of births over deaths implies that there are fewer babies, fewer younger people and more older people in the population (Kinsella and Phillips, 2005). The migration of young people (who are the most inclined to move and migrate) (Raymer et al., 2011) leads to a decrease in an important segment of the population: namely, young adults who are able to have children, and who are also more likely than older adults to contribute to the social and economic development of the society (Johnson and Winkler, 2015). On the other hand, ageing processes can cause further depopulation processes, because in contexts with older populations and fewer economic and social opportunities, the pressure on young people to emigrate to demographically and economically more dynamic areas becomes strong (Johnson and Lichter, 2019). These negative demographic processes – sharp declines in births and high levels of emigration, depopulation and ageing – can undermine the economic and social development of territories, resulting in a negative spiral of challenging demographic and social conditions.

Despite the close connection between depopulation and population ageing, there are no extensive studies in the scientific literature on the relationship between the two demographic processes in recent decades. Several studies have highlighted how depopulation processes have resulted in an ageing of the population (Lukic et al., 2012; Viñas, 2019), while other studies have discussed the consequences of both processes in Spain (Pinilla and Sáez, 2021); in several Eastern European countries (Daugirdas and Pociūtė-Sereikienė, 2018; Vaishar et al., 2020); and in Japan, which has the oldest population in the world (Coulmas, 2007; Doo-Chul and Hye-Jin, 2009; Matanle, 2014). Wiśniewski et al. (2021) conducted a descriptive analysis of depopulation processes in combination with population ageing processes in Polish regions. Díez Modino and Pardo Fanjul (2020) examined the relationship between ageing and depopulation, but by considering ageing as a driver of depopulation. For Italy, studies have been conducted on depopulation and its consequences, and especially on past dynamics (e.g., Golini et al., 2000; Sonnino, 1979). Several recent studies have examined the depopulation processes in specific Italian areas by considering demographic and geomorphological factors (Reynaud et al., 2020), while other studies have focused on the effects of depopulation on specific areas or rural parts of Italy (e.g., Fantechi et al., 2020; Quaranta et al., 2020; Rizzo, 2016).

As was mentioned above, some Italian territories began to experience depopulation processes over the course of the 1900s. During the demographic transition process in Italy, which was characterised by decreasing mortality levels and stable fertility levels, population growth was not supported by a significant process of economic and industrial development, especially in certain areas, including in areas in the South. The demographic surplus therefore contributed to high levels of out-migration, which was seen as the only opportunity many individuals had to improve their living conditions, regardless of whether they were male or female, educated or uneducated, young or old (Bonifazi, 2013). These out-migrations from the most disadvantaged territories were to other Italian territories, as well as to other countries (Livi Bacci, 2020; Sonnino and Nobile, 1988). However, in the initial phase of this period of out-migration, the negative migration balance (in-migration minus out-migration) at both the national and the sub-national levels was counterbalanced by strong positive natural growth (births minus deaths). When fertility and births also began to decline, the natural balance in the areas already characterised by strong emigration decreased, which led to depopulation processes. Internal migration played an important role, contributing to the growth of certain territories, especially of cities, and to the depopulation of smaller and more isolated municipalities (Morettini, 2006). Depopulation was particularly likely to occur in territories that did not offer many opportunities due to their geographical and morphological characteristics, such as in mountainous areas or in areas with poor connections to the city (Birindelli, 1977). However, the depopulation phenomena that took place in sub-national territories at the beginning of the 20th century were embedded in a context characterised by the growth of the resident population in Italy as a whole (Sonnino, 1979).

In the 1970s, new depopulation processes began that were driven by new demographic dynamics. Since then, the continuous declines in fertility and birth rates have led to a significant decrease in the natural balance, which has, in turn, had a considerable impact on population growth rates at both the national and the local levels. However, intense economic development, together with other socio-economic factors, have led to a reduction in emigration and to a subsequent increase of the inflow of immigrants from abroad (Bonifazi, 2013; Bonifazi et al., 2009). Particularly in the 1990s and 2000s, the positive and increasing migration balance helped to offset the negative natural balance, and thus contributed to a slowdown in the decline of growth rates, especially in areas in the North and the Centre. By contrast, in certain areas in the South, and particularly in the so-called inner areas, continuous outflows, low inflows from abroad and continuous declines in fertility have led to intense processes of population decline. During this period, the signing of the Schengen agreement and the substantial enlargement of the European Union that followed have profoundly changed, and are continuing to change, the system of international migration (Golini, 2005). Italy's entry into the Schengen area in 1997 may have facilitated the emigration of young people to more economically developed countries that were already destinations for Italian emigration, such as France and Germany. On the other hand, immigration flows were certainly facilitated by the Schengen agreement, as non-European people who were already present in one of the countries of the area could freely migrate to other countries of the area (Nikolić and Pevcin, 2022). Similarly, the entry of other European countries into the Schengen area, including Eastern European countries, has led to an increase in the number of European foreigners moving to Italy. However, migration flows to Italy have been decreasing for several years, and have not compensated for the imbalance between births and deaths, either nationally or in different local contexts. The economic differences between the various areas of the country – particularly between the North and the South, but also between cities and the countryside and between central and peripheral areas – are continuing to produce significant internal movements, albeit to a decreasing extent over time. These outflows from certain contexts have led to the abandonment, especially by younger people, of certain territories (Lasanta et al., 2017). Particularly in smaller areas, some sub-populations have either disappeared or shrunk significantly. Therefore, in recent years, depopulation has again become an important phenomenon in the Italian context, and is becoming increasingly widespread, as it is further accelerated by low fertility (Reynaud and Miccoli, 2016; Rizzo, 2016). Unlike the depopulation processes of the early 1900s, those that have taken place since the 1970s have occurred in a context characterised first by the slow growth of the resident population in Italy, then by a certain level of stability, and, finally, by a decrease in the population. In addition, current depopulation phenomena are combined with high levels of population ageing. In the 1970s and 1980s, emigration and the consequent depopulation process contributed to the intensification of the ageing process. However, in more recent decades, the high levels of ageing in some areas are contributing to further depopulation, which illustrates the vicious circle in which the two phenomena reinforce each other (Reynaud and Miccoli, 2018). The effects of the economic instability due to the economic crisis in 2008 are observable in the demographic dynamics, as they accelerated the process of population ageing in many areas of the country (De Rose and Strozza, 2015). While foreign immigration to European countries presents significant social challenges, it appears to be necessary to ensure the demographic sustainability and economic development of these countries. Increasing depopulation and ageing levels therefore present not just demographic, but also social and economic challenges related to the demand for more immigration and the integration of foreign populations (Lutz, 2019).

Given the dynamics of the depopulation and ageing processes in Italy, this paper aims to demonstrate the theoretical existence of an association between depopulation and ageing by analysing the Italian context, in which the two phenomena are clearly present. Through a descriptive and a spatial analysis conducted at the municipal level for the 1971–2019 period, this study aims to contribute to a strand of research that remains underexplored, and to add empirical evidence to the theoretical background on this topic.

3 Research design, data and methods

With the general aim of studying and investigating the phenomena of depopulation and ageing in Italian territories, this work seeks to answer two research questions. The first question is whether there is a relationship between the variation in the population in a given period and the level of population ageing at the end of the same period, and how this relationship changed over time (RQ1). As was stated in the previous section, the emigration of young people leads not only to population decline, also to population ageing. Younger people may decide to emigrate because they need to find work, or, more generally, because they want to pursue life projects elsewhere. As the younger population tend to move to cities for work, emigration often takes the form of rural–urban migration (Lasanta et al., 2017). Furthermore, the emigration of young people also means that there will be fewer births or babies in the areas they left behind in subsequent years, as young people usually raise their families where they are working, or their babies emigrate with them. A decrease in births and a decline in the number of young people in an area can contribute to a decline in population, and to a change in the age structure of the population. We hypothesise that negative growth rates are related to subsequent population ageing, and that this association has been especially pronounced in recent years (H1). The second research question is whether there is a relationship between the level of population ageing at the beginning of a given period and the variation in population in the subsequent period, and how this relationship changed over time (RQ2). A high proportion of older people in a population contributes to a natural decrease in the population, because the higher the number of older people there are, the higher the number of deaths there are. Furthermore, young people tend to emigrate from areas characterised by population ageing, because these areas are often less dynamic from an economic and a social point of view. Therefore, we hypothesise that a high level of population ageing at a certain date corresponds to a subsequent population decline, and that this trend has been particularly strong in recent years (H2).

The data used for the analysis come from population censuses, and refer to Italian municipalities. Because there have been several changes in the boundaries and in the number of municipalities over the years, we have decided to consider the situations of the municipalities as of the 2011 census, when there were 8092 municipalities. We have harmonised the data accordingly. Data from seven censuses conducted between 1971 and 2019 are used. The latest census, for 2019, is not a traditional decennial census, but is a permanent census that was conducted with a new methodology (Istat, 2014). Although the methodology used in the latest census is different from that employed in previous censuses, the population census data for all the census years in Italy have legal value, and are comparable.

We calculate the intercensal population growth for all the municipalities for five periods (1971–1981, 1981–1991, 1991–2001, 2001–2011, 2011–2019) using the following equation:

$$r_{i(t,t+n)} = \frac{\ln(P_{i(t+n)}/P_{i(t)})}{n}$$
$$i = 1, \ldots, 8092; \; t = 1971, 1981, 1991, 2001, 2011 \qquad (1)$$

where P is the total population, i is the ith municipality, t represents the census data, n represents the number of years between two censuses, and $t + n$ represents the next census data.

We consider a negative growth rate in the intercensal period to be a measure of the depopulation process. In municipal territories, some of which are very small in terms of both square kilometres and population, a negative growth rate over a period of 8–10 years can be denoted as depopulation, and as a sign of significant demographic distress. We then calculate the proportion of people aged 65+ years in the census years in order to have a measure of population ageing at the beginning and at the end of the five intercensal periods.

First, we exploit a descriptive analysis of the depopulation process in the Italian municipalities for the intercensal periods from 1971 to 2019 and a descriptive analysis of population ageing in the census years in order to detect trends along the territories and to highlight changes over time. We then calculate Pearson's correlation coefficients for evaluating the association between depopulation and population ageing. In particular, we calculate the coefficients between intercensal growth rates in every period and the level of population ageing at the end of that period, and between the level of ageing at the beginning of the period and the subsequent growth rates. This enables us to provide an initial answer to our research questions, and to check whether our hypotheses are correct.

We then calculate Moran's index to verify the spatial autocorrelation of growth rates and the proportion of people aged 65+ years in the municipalities. To calculate this measure, a neighbouring structure defining the contiguity between locations is assigned to our data. In our case, two municipalities are considered as neighbouring if they share one boundary point (queen contiguity). After detecting the presence of spatial autocorrelation – meaning that space has had an influence on population growth – we apply a model that is able to take into account the spatial autocorrelation

(Ma and Hofmann, 2019) in order to investigate whether depopulation over a certain period is associated with population ageing at the beginning of that period. Then, considering that space has had an influence on the level of population ageing as well, we investigate whether population ageing at the end of a certain period is associated with depopulation in that period. This effect can be induced by several factors, and violates the assumption of independence common to many regression models (Chi and Zhu, 2008). To consider this autocorrelation, we apply a spatial panel data model with fixed effects, where the spatial autocorrelation is induced through the adjacency structure of the areal units (Lee, 2013; Millo and Piras, 2012)[2]. This model is implemented in R programming language through the "splm" package (Millo and Piras, 2012). This approach makes it possible to consider the influence that space has on unobserved variables by controlling for the influence of neighbouring spatial units.

Let y_{it} be the observations of dependent variables in every ith municipality in every time $t = 1, \ldots, T$, while X is the design matrix including the explanatory variables with parameter coefficients β, and ε is the independent error component. Following Millo and Piras (2012), a fixed effect spatial lag model can be written in stacked form as:

$$y = \rho(I_T \otimes W_N)y + X\beta + \varepsilon \tag{2}$$

where ρ is the spatial autoregressive coefficient and W is a non-stochastic spatial weight matrix. We explore two different models. In the first model, the dependent variable is the proportion of people aged 65+ years relative to the 8092 municipalities at the end of every intercensal period $[P_{65+}(t + n)]$, and the explanatory variable is the rate of population growth during that period $[r(t, t + n)]$. This allows us to examine how the population change over a certain period, expressed by the intercensal population growth rate $[r(t, t + n)]$, is related to the level of ageing at the end of the same period, expressed by the proportion of the proportion of people aged 65+ years at time $t + n$ $[P_{65+}(t + n)]$, in order to answer the first research question: namely, whether the decline in population is associated with an acceleration of the ageing process. In the second model, the dependent variable is the intercensal population growth rate in each of the 8092 municipalities during every considered period $[r(t, t + n)]$ and the explanatory variable is the population ageing at the beginning of the period $[P_{65+}(t)]$. This enables us to investigate the relationship between depopulation and ageing (i.e., the subject of the second research question) in greater depth. Specifically, we are examining whether population growth in a certain period $[r(t, t + n)]$ is dependent on the level of ageing at the beginning of the considered period, expressed by the proportion of people aged 65+ years at time t $[P_{65+}(t)]$.

2 In the analysis phase, we tested the linear regression model and other spatial regression models (such as CAR) (Mingione et al., 2022). The outputs of these models allowed us to confirm the existence of a strong link between population ageing and depopulation. The results of the CAR model for each period confirmed the presence of spatial autocorrelation in each considered period.

4 Results

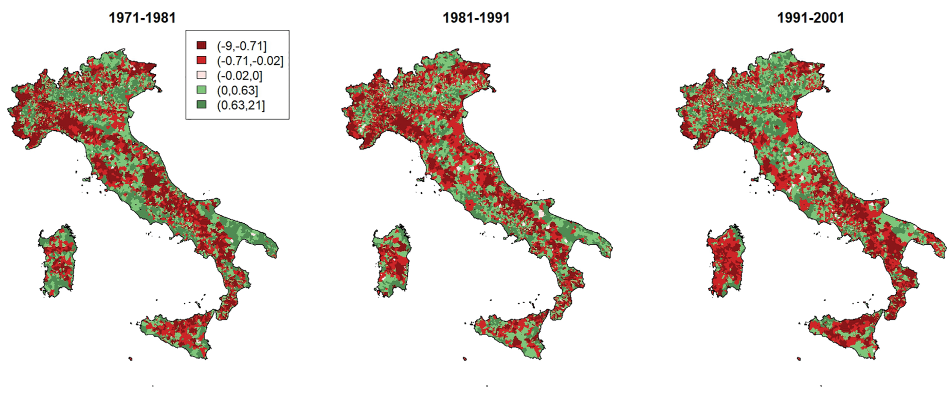
4.1 Descriptive results

The analysis of the growth rates in Italian municipalities for the first period (1971–1981) returned a pattern characterised by rather widespread depopulation processes throughout the country. Indeed, about 49% of Italian municipalities recorded a negative growth rate in this period, and thus experienced a process of depopulation. These municipalities were mostly located in rural and mountainous areas, and the decline was determined by significant emigration from these territories to large cities and, to some extent, abroad. Thus, it appears that even though the Italian population was growing at a rate of 0.6% in this period, depopulation was a rather widespread phenomenon at the municipal level (see Figure 1).

In the subsequent period from 1981 to 1991, the share of municipalities experiencing a decrease was very similar to that in the previous period, at about 48%. The situation was also rather similar to that in the previous decade (Figure 1). The decline at the municipal level can be linked to both the continuing emigration from rural areas (De Rubertis, 2019; Emanuel, 1997) and the movements that occurred from the major urban systems to the municipalities located around them (Dematteis, 1997).

In the 1991–2001 period, the proportion of municipalities with a negative growth rate dropped to 46%. This is the period in which internal migration flows were accompanied by immigrant flows from abroad, especially in the Centre–North. Thus, while some areas, particularly those in the North-East, experienced new

Figure 1:
Population growth rates (%) in the Italian municipalities for three periods: 1971–1981, 1981–1991 and 1991–2001



Source: Authors' calculation from ISTAT data.

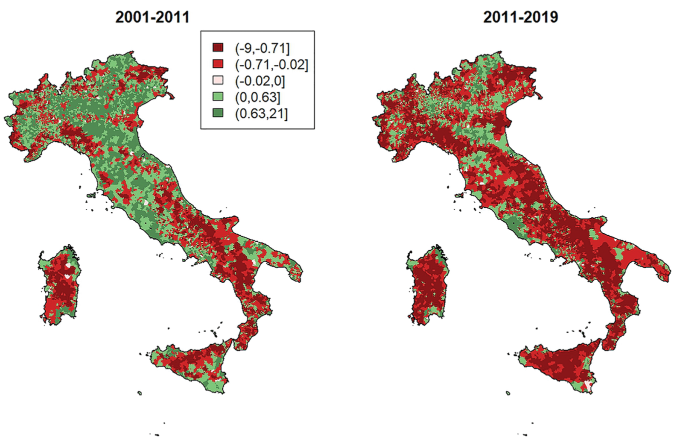
population growth, including in many previously shrinking municipalities, others continued to experience depopulation processes. For the first time, there was a barely noticeable dichotomy between the northern and the southern territories, with many municipalities experiencing negative rates (Figure 1). However, even in this decade, most of the municipalities with negative rates of increase were located in mountainous or inner areas.

In the following decade (2001–2011), the percentage of municipalities experiencing depopulation declined again to reach 40%. Immigration flows from abroad continued to be very strong until 2008, when, due to the economic crisis, the flows began to decrease. While foreigners were living all over Italy, most who were resident on a stable basis were living in the most productive areas of the country, and thus in the Centre–North. The effect of the depopulation phenomenon was strongest in the South of Italy, where the number of municipalities with a negative growth rate increased (Figure 2).

In the most recent period from 2011 to 2019, which was characterised by a decrease in migration dynamics, and in which, unlike in the past, there was no population growth, depopulation was once again a widespread phenomenon (see Figure 2). In this historical phase, the growth rate of the population resident in the country turned negative, and a new phase began in which depopulation at the municipal level occurred in a context characterised by population decline at the national level.

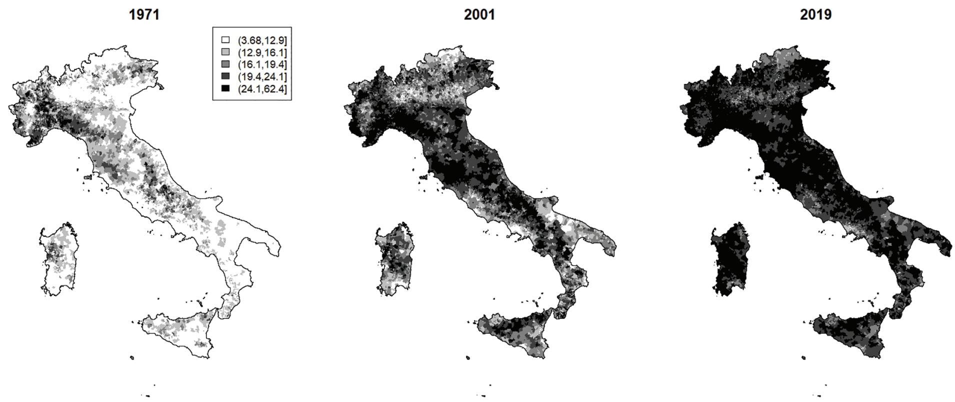
A descriptive analysis of the level of ageing in Italian municipalities in the census years returned a more linear profile (see Figure 3). The ageing process, which first

Figure 2:
Population growth rates (‰) in the Italian municipalities for the last two periods: 2001–2011 and 2011–2019



Source: Authors' calculation from ISTAT data.

Figure 3:
Proportion (%) of people aged 65+ years in the Italian municipalities: Census data from 1971, 2001 and 2019



Source: Authors' calculation from ISTAT data.

began in the territories of northern Italy and then spread throughout the country, had become a phenomenon that was affecting the population as a whole as well as municipal sub-populations. In addition to being widespread throughout the country, this phenomenon was accelerating in areas where it started later, such as in areas of southern Italy (Figure 3).

The Pearson's correlation coefficient between population growth and subsequent population ageing was negative in every period considered, and was always statistically significant. The correlation was higher in the 2011–2019 period than in previous periods (Table 1). Higher levels of population growth were associated with lower levels of population ageing, as we hypothesised. Thus, population decrease in a certain period was strongly related to the level of ageing at the end of the same period. Moreover, our finding of a stronger correlation in the last period confirmed an important change in the relationship between these two phenomena, which were not only more intense than in the past, but were also more interconnected (H1).

The opposite correlation between the proportion of people aged 65+ years at the beginning of a given period and the intercensal population growth rate in the following intercensal period was also negative and was always statistically significant (Table 1). A higher level of population ageing in a certain year corresponded to a more negative growth rate, and thus often to depopulation in the subsequent period. This relationship was more intense in both the 2001–2011 and the 2011–2019 periods, when migration flows started to decrease and population ageing was more widespread among all municipalities, and was very intense compared to past periods. Thus, not only was depopulation always associated with the level of population ageing, but in the last period, this relationship became stronger, in line with our

Table 1:
Pearson's correlation coefficient between the intercensal population growth rate in the period $(t, t+n)$ $[r(t, t+n)]$ and the proportion of people aged 65+ years at the beginning of a given period (t) $[P_{65+}(t)]$ and between the intercensal population growth rate in the period $(t, t+n)$ and the proportion of people aged 65+ years at the end of a given period $(t+n)$ $[P_{65+}(t+n)]$

$r(t, t+n)$	$\%P_{65+}(t)$	Signif.	$\%P_{65+}(t+n)$	Signif.
1971–1981	−0.50	***	−0.64	***
1981–1991	−0.52	***	−0.63	***
1991–2001	−0.46	***	−0.62	***
2001–2011	−0.54	***	−0.61	***
2011–2019	−0.54	***	−0.67	***

Notes: $^{***}p < 0.001$.

Observations: 8092 municipalities.

Source: Authors' calculation from ISTAT data.

hypothesis (H2). These findings indicate that recent depopulation processes have different characteristics and drivers than those in the past, which merits further explorative analysis.

These correlations show the existence of a link between the values of the growth rate and the ageing index in Italian municipalities.[3] While this relationship may be determined by other potentially common factors, it is important to emphasise that it appears to be statistically significant.

4.2 Model results

From the descriptive analysis of the depopulation process it emerged that this phenomenon had become more widespread among the municipalities in recent periods. By applying Moran's index to the growth rates in the five considered periods, we verified whether there was a spatial autocorrelation of the phenomenon in space. Moran's index for the intercensal population growth rates was always positive and statistically significant, showing a moderate spatial autocorrelation. The index was 0.10 for the first period (1971–1981) and 0.15 for the last period (2011–2019). This means that municipalities with high growth rates were close to other municipalities with high growth rates, while municipalities with low growth rates were close to municipalities with low growth rates. The same pattern applied to the proportion of people aged 65+ years: Moran's index was always positive and

[3] There can be many potential explanatory factors of depopulation and population ageing related to economic, social and demographic conditions. It is not possible to observe all of these factors together over such a long period of time, or at such a detailed territorial level.

statistically significant, and was increasing over time. The value of the index for the two measures indicates the importance of the space effect, and the need to take into account spatial autocorrelation in the model when analysing depopulation and population ageing at a detailed territorial level.

To investigate the relationship between depopulation and ageing more deeply, we decided to account for spatial autocorrelation by applying the spatial panel data model. As was previously mentioned, in the first step we used the proportion of people aged 65+ years at the end of the period [$P_{65+}(t + 10)$] as the dependent variable and the intercensal population growth rate in the period (t, $t + 10$) as the explanatory variable. In the second step, we used the variation in population in the intercensal period as the dependent variable and the proportion of people aged 65+ years at the beginning of the period as the explanatory variable. Although the models were very simple, they were essential for investigating the relationship between depopulation and the level of population ageing, while also taking into account non-visible spatial effects. We were aware that other factors could be associated with the evolution of the two phenomena, and might have an influence on the demographic determinants of the two phenomena. We wanted to observe to what extent, net of the spatial latent variable, a high level of ageing was associated with a lower subsequent level of growth, and to what extent the rate of population growth was associated with the subsequent level of ageing.

The model results (Table 2) demonstrated than an increase in growth rates in a certain period corresponded to a low level of population ageing at the end of the period. The coefficients were always negative and had a high level of significance. The proportion of people aged 65+ years in the considered periods always increased, on average, as the estimated coefficients were increasingly higher compared to the baseline period: from 1.750 in the 1981–1991 period up to 8.245 in the last considered period. The relationship between the rate of population growth and the percentage of older people was as expected: for the baseline period of 1971–1981, an increase of one in the rate of population growth corresponded, on average, to a 63% decrease in the old age index at the end of the period. This relationship was even stronger in the 1991–2001 period, as the differential coefficient for this period was −88.747. This means that depopulation in a period (i.e., a negative growth rate) was linked to a high level of population ageing at the end of the period. The association between the growth rate and the proportion of people aged 65+ years at the end of the period was lower, especially in the period between 2001 and 2011, when, as was already mentioned, migration flows from abroad were larger, and the foreign population had a strong impact on the change in the population size, although not as strong as on the age structure.

The results for the second model (in which the dependent variable was the population growth rate and the explanatory variable was population ageing at the beginning of the period) showed that the rate of population growth was, on average, increasingly negative. Specifically, the results demonstrated that a higher proportion of people aged 65+ years at the beginning of the period corresponded to a lower growth rate during the period: a one per cent increase in the proportion of people

Table 2:
Parameter estimates of the spatial panel data model wherein the proportion of people aged 65+ years at the end of the period is the dependent variable [$\%P_{65+}(t+n)$]

Name of variable	Variable	Estimate	Std. error	Signif.
The intercensal population growth rate	$r(t,\ t+n)$	−63.280	1.942	***
The intercensal periods	1981–1991	1.750	0.034	***
	1991–2001	4.776	0.034	***
	2001–2011	6.444	0.034	***
	2011–2019	8.245	0.037	***
The interaction between the intercensal population growth rate and the intercensal period	$r(t,\ t+n) \times$ (1981–1991)	−36.645	2.707	***
	$r(t,\ t+n) \times$ (1991–2001)	−88.747	2.912	***
	$r(t,\ t+n) \times$ (2001–2011)	−74.128	2.775	***
	$r(t,\ t+n) \times$ (2011–2019)	−57.303	3.193	***

Notes: '***' denotes statistical significance at <0.001.

Observations: 8092 municipalities.

Source: Authors' calculation from ISTAT data.

aged 65+ years in the population corresponded, on average, to a six per thousand decrease in the rate of population growth in the subsequent period. The coefficient of the proportion of people aged 65+ years in the population increased for the second period and the third period. Furthermore, the coefficient of the period between 2001 and 2011 was smaller than the previous one (between 2001 and 2011, migratory flows from abroad slowed down the ageing and depopulation processes), but the coefficient increased again in the last period (Table 3). This coefficient was highest in the last period, which shows that a high level of ageing influenced negative growth rates even more in this period than it did in past periods.

The spatial autoregressive coefficient ρ was significant in both models. This means that the demographic changes that occurred in the various periods were also affected by the spatial autocorrelation effect.

5 Discussion and conclusions

The end of the demographic transition has led to significant demographic changes in most European countries. In the second half of the 20th century, the natural balance, which had previously been the main driver of population trends, became negative for the first time in history not because of diseases, wars or other catastrophic events, but mainly as a result of individual fertility choices. Migration has therefore become the main driver of population growth in many European populations (van Nimwegen and Van der Erf, 2010). Moreover, when we look at sub-national areas, we can see that population growth did not occur everywhere, and that many areas of the continent

Table 3:
Parameter estimates of the spatial panel data model, wherein the population growth in period t, $t + n$ is the dependent variable $[r(t,\ t+n)]$

Name of variable	Variable	Estimate	Std. error	Signif.
The proportion of people aged 65+ years at time t	$\%P_{65+}(t)$	−0.00065	0.222	* * *
The intercensal periods	1981–1991	−0.00771	3.145	* * *
	1991–2001	−0.01333	3.253	* * *
	2001–2011	−0.01111	3.566	* * *
	2011–2019	−0.02268	4.036	* * *
The interaction between the proportion of people aged 65+ years at time t and the intercensal period	$\%P_{65+}(t) \times (1981–1991)$	−0.00056	0.198	* * *
	$\%P_{65+}(t) \times (1991–2001)$	−0.00090	0.197	* * *
	$\%P_{65+}(t) \times (2001–2011)$	−0.00086	0.199	* * *
	$\%P_{65+}(t) \times (2011–2019)$	−0.00101	0.210	* * *

Notes: '***' denotes statistical significance at <0.001.

Observations: 8092 municipalities.
Source: Authors' calculation from ISTAT data.

have been experiencing depopulation processes (Newsham and Rowe, 2022). At the same time, declining fertility and progressively increasing survival have led to high levels of ageing in these populations (Christensen et al., 2009). At the theoretical level, the relationship between depopulation and population ageing seems clear, as the two processes have very similar determinants: falling birth rates and directly or indirectly increasing life expectancy and the emigration of young people. As we observed in the introduction, a decline in births leads to a decrease in the population size and an acceleration of the ageing process; an increase in life expectancy implies an increase in the number of older people in the population, which means that the level of population ageing is higher but the chances of population growth are lower; and emigration by young people is one of main determinants of depopulation in many historical periods, but it can also intensify population ageing. Our aim was to verify the theoretical relationship between depopulation and population ageing by looking at a long period that also includes the most recent years.

The Italian population has been undergoing the most pronounced ageing process in Europe for decades. For the first time, Italy has seen the size of its population decline in the last 10 years, including at the national level. Furthermore, many areas of Italy have experienced depopulation in the past, including at the beginning of the 20th century, and have recently experienced it again. In the last decade (which we did not consider in the previous paper on depopulation and ageing), the depopulation process became more intense and widespread in many areas of the country. Therefore, Italy can be considered a relevant case for analysing the theoretical interplay between depopulation and ageing. There is also political interest in depopulated areas, which are often located in the inner regions of the country (Barca et al., 2014; Espon, 2017). In these areas, public services are provided to a small number of people, and therefore represent a significant cost for political actors (Pinilla and Sáez, 2021; Syssner, 2020). The lack of political interest in these areas can lead to problems, such as underserved populations and abandoned land (Syssner, 2020). Furthermore, in Italy, the abandonment of territories can mean the loss of important forms of cultural heritage, which are often associated with a strong sense of territorial identity (Dell'Ovo et al., 2022).

By using data on municipalities (the lowest administrative territorial level) and considering the importance of spatial autocorrelation in our models, it was possible to support such observations with results that were not biased by spatial autocorrelation. Indeed, taking spatial autocorrelation into account is crucial in analyses conducted at a detailed territorial level, and particularly when investigating depopulation, due to the political as well as the demographic implications of this process. When considering depopulated areas, analyses conducted at a more aggregated territorial level, such as at the level of provinces (NUTS 3) or regions (NUTS 2), are not effective because population trends can be determined by the larger population size. For example, it is likely that more people are living in the larger cities than in the other administrative units of the territory. On the other hand, Italian municipalities should be able to provide their citizens with basic services that reinforce the demographic dynamics, beyond the economic and social environment. Therefore, providing a picture at the municipal territorial level also means supporting a political response.

We showed that the depopulation processes that occurred in Italy during the 1971–2019 period decreased slightly at first and then increased consistently in terms of both the intensity of the growth rates and the number of municipalities involved. Thus, population ageing in municipalities went from being a phenomenon concentrated in some areas in the North to being a generalised phenomenon throughout Italy.

From the analyses we carried out, it appeared that the relationship between these two phenomena was statistically validated: i.e., the correlation coefficients between the population growth rate and the proportion of people aged 65+ years showed a significant and negative relationship. Thus, in the areas where the population increased, ageing decreased. This relationship could also be interpreted negatively: i.e., in the areas where depopulation took place, ageing increased. These findings confirmed our hypothesis that a decrease in the size of the population would be accompanied by an increase in the level of population ageing (H1). Population decline can be due to a negative natural balance (i.e., fewer births than deaths), a negative net migration balance (i.e., more out-migrations than in-migrations) or a combination of the two. When the natural balance has been negative over time, the age structure changes, with more people remaining in the population and the number of new-borns decreasing. When net migration is negative, the emigrants are predominantly young people who, by leaving, reinforce the ageing of the population in their place of origin, especially if the area already has an older population, as is the case for most Italian municipalities.

On the other hand, we found that in areas where the level of population ageing was higher, the level of depopulation was also higher, which confirmed our second hypothesis (H2). Areas where the proportion of older people in the population was high often had a higher number of deaths, as in a country like Italy, most deaths occur at older ages. In addition, in areas with a high proportion of elderly people in the population, proportionally fewer young people were having children. Furthermore, in areas with high levels of ageing that were also economically less competitive, young people tended to out-migrate to look for employment and for an environment that was more dynamic not just economically, but also culturally and socially. Our results confirmed the existence of an important connection in Italy between ageing and depopulation, which could, in certain areas, feed off each other. Our finding that this relationship existed did not take causality into account, but simply showed that the two phenomena were linked. Our work could be further developed by applying a spatial autoregressive model to attempt to prove that the influence of ageing on depopulation and the influence of depopulation on ageing were not independent of each other. While the determinants of the two phenomena were similar from a demographic point of view, many other economic and social aspects may have influenced the demographic determinants over time. Another potential development of our findings would be to consider the determinants of these processes.

Although the effects of demographic factors were taken into account in the theoretical background, they were not formally included in the model in this study. These effects can, of course, be investigated in future works that are more focused on understanding the various determinants of these processes. Despite these limitations, this paper provides a useful background for further in-depth analyses of the relationship between depopulation and ageing.

This paper has highlighted aspects that are useful to consider when investigating why demographic changes seem to lead to a vicious circle in which depopulation leads to accelerated ageing, and the ageing process, in turn, leads to further depopulation. These processes typically originate in areas that are in a demographically unsustainable condition, which can, in turn, lead to economic decline and environmental fragility (Collantes and Pinilla, 2004). As the populations living in these areas lose access to public and private services, the economic and social conditions in these places become less sustainable over time (Fernandes, 2019; Syssner, 2020).

Thus, the results of our study, which was conducted at a very detailed territorial level for the whole of Italy, can be useful to national and local policymakers who are seeking to implement policies aimed at counteracting the effects of depopulation and ageing, and at addressing the factors that cause the vicious circle triggered by these effects. Without political intervention, the current demographic dynamics in Italy will lead to economic and social sustainability problems across the country, with the number of abandoned areas increasing and population ageing occurring at a rapid rate in many territories.

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Parsimonious stochastic forecasting of international and internal migration on the NUTS-3 level – an outlook of regional depopulation trends in Germany

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Abstract

Substantiated knowledge of future demographic changes that is derived from sound statistical and mathematical methods is a crucial determinant of regional planning. Of the components of demographic developments, migration shapes regional demographics the most over the short term. However, despite its importance, existing approaches model future regional migration based on deterministic assumptions that do not sufficiently account for its highly probabilistic nature. In response to this shortcoming in the literature, our paper uses age- and gender-specific migration data for German NUTS-3 regions over the 1995–2019 period and compares the performance of a variety of forecasting models in backtests. Using the best-performing model specification and drawing on Monte Carlo simulations, we present a stochastic forecast of regional migration dynamics across German regions until 2040 and analyze their role in regional depopulation. The results provide evidence that well-known age-specific migration patterns across the urban-rural continuum of regions, such as the education-induced migration of young adults, are very likely to persist, and to continue to shape future regional (de)population dynamics.

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1 Introduction

Regional differences in demographic trends related to population size and structure are well documented across countries (see, for example, BiB, 2021; De Beer et al., 2010; OECD, 2018, among others). Having precise knowledge of the quality and the quantity of those developments is crucial for regional infrastructure planning, such as for estimating the supply of childcare and schools needed, or for labor market planning (Wilson, 2015a; Zhang and Bryant, 2020). Similarly, the future demand for healthcare due to population aging (Vanella et al., 2020b) or for housing depends on the future population size and structure (Gløersen et al., 2016; Vanella et al., 2020a). Therefore, both governments and enterprises have a strong interest in regional population forecasts that can provide them with a quantitative basis for decision-making (Wilson et al., 2021).

Notably, of the three components of demographic change – fertility, mortality and migration – migration shapes regional populations the most over the short term (Deschermeier, 2011), while fertility and mortality trends are more important over the long term (Vanella et al., 2020a). Migration dynamics can have substantial effects on a region's population, and particularly in smaller areas, where outflows can have a large impact on both the size and the structure of the population (Deschermeier, 2011; Zhang and Bryant, 2020).

The causes and the consequences of migration are multi-faceted, and have been studied using a wide range of approaches across disciplines.[1] However, a pivotal distinction can be made between its two different but nonetheless contiguous components: internal and international flows.[2]

Discussions of internal migration frequently address issues such as persistent net out-migration from economically weaker regions, particularly among younger, more educated and skilled sub-populations, which is likely to be driven by varying regional opportunities (Fratesi and Percoco, 2013; Sander, 2014). Regional heterogeneity in mobility, health services, shopping opportunities, housing, labor market opportunities and education (Zhang and Bryant, 2020), or in attractiveness (Skirbekk et al., 2007) based on factors such as architecture and landscape, may drive

[1] Given the scope of this paper, we do not provide a comprehensive cross-disciplinary review of approaches to (regional) migration. However, suitable starting points for corresponding investigations may be recent contributions across disciplinary boundaries, such as in King (2011) or Pisarevskaya et al. (2020), among others.

[2] In this paper, the term *flow* generally refers to any migratory movement of people. Normally, the flows are documented as directional data, i.e., as migrations from certain origin regions to certain target regions.

internal migration, and can ultimately lead to the emergence of regional demographic disparities in larger countries (Eberhardt et al., 2014). Importantly, when a significant share of the younger population leaves a region, an echo effect can occur: i.e., as the population of reproductive age decreases, birth numbers decline, which, in turn, further accelerates depopulation trends.

By contrast, a wide range of factors, from crises and macroeconomic conditions (Vanella and Deschermeier, 2018) to environmental change (Black et al., 2011), can heavily affect international migration flows. In host countries, international flows are likely to affect different regions to varying degrees (see, for example, Heider et al., 2020, for the case of German regions). Moreover, there is evidence that the two components are closely intertwined (see King and Skeldon, 2010 for a comprehensive discussion): i.e., high levels of international immigration lead to further internal migration flows. For instance, the correlation coefficient between annual international immigration to Germany for the years 1994 to 2018 and the one-year delayed out-migration of the German districts (i.e., migration over district borders in 1995–2019) is 94.8% (own computation based on GENESIS-Online, 2021; Statistische Ämter des Bundes und der Länder, 2021a).

Given the fundamental complexity of migration and its importance for regional demographic changes, and thus for regional planning in general, gaining a better understanding of future developments in regional migration is key to developing policies aimed at either counteracting regional depopulation and aging or mitigating the expected developments by, for example, adjusting infrastructure supply based on diminishing or changing regional demand (Iwanow and Gutting, 2020; Krüger, 2020). However, the existing approaches do not account for uncertainty in regional migration projections (e.g., Maretzke et al., 2021). By relying on deterministic assumptions, these projections are generally unable to quantify the probability that specific migration scenarios will occur, or the resulting migration flows. Given the importance of migration for regional population dynamics, these approaches clearly have significant shortcomings. At the same time, modeling migration is demanding, as it has a high degree of stochasticity; that is, migration tends to be volatile and sensitive to acute events (Vanella and Deschermeier, 2018). In the present paper, we evaluate potential approaches to incorporating stochasticity into small area migration forecasting, while simultaneously accounting for varying patterns and correlations across different age groups and regions. By incorporating both international and internal migration into a joint framework, we propose a novel, parsimonious stochastic forecasting approach.

The remainder of the paper is structured as follows. In the next section, we give a short overview of the state of research on migration projections with an emphasis on regional migration and discuss the features and limitations of existing (deterministic) approaches. In the third section, we introduce the data sources used and the properties of the best-performing model among a variety of models compared based on a backtest. Then, based on this model, we provide in the fourth section a stochastic forecast of age-specific future migration among German regions until 2040, indicating both the extent and the probabilities of migration-induced population declines. In the last section, we present our conclusions and a discussion of the results and the limitations of the study, while pointing out the need for more detailed data and further methodological advances.

2 (Regional) migration projections: An illustrative overview

Typically, population projections take into account three demographic components of population change: fertility, mortality and migration. Those projections draw on a variety of methodological procedures at both the national[3] and the regional level.[4] Notably, of the three major components, migration is the most challenging to forecast (UN DESA, 2022), largely due to data limitations caused by the under-detection of actual migrations in the reported data (Rogers et al., 2010), and to inconsistencies between different datasets and territorial changes, which can complicate the construction of consistent time series (Vanella and Deschermeier, 2018). Moreover, the sensitivity of migratory movements to political, social, economic and environmental trends and events implies that such movements are characterized by high stochasticity and inherently limited predictability. This is because the phenomena underlying migration may themselves be difficult to predict (Vanella and Deschermeier, 2018, 2020), and can appear rather abruptly, as demonstrated by the war-related refugee flows from Syria and Iraq between 2014 and 2016 (Vanella et al., 2022), or, more recently, the refugee flows from Afghanistan (Heidelberg Institute for International Conflict Research, 2022) and Ukraine (UNHCR, 2022).

Given the wide range of challenges associated with migration forecasting, there is no consensus on "best practices." Approaches differ regarding *what* and *how* to forecast; that is, regarding which target variables should be used, e.g., what modeling flows or rates should be employed and what degree of detail they should have. Moreover, there is no consensus on the overall modeling framework that should be used. The latter raises questions that are inevitably related to the incorporation of risk and uncertainty in the model, including questions ranging from what estimation strategy and what determinants should be used, to what cross- and autocorrelations should be considered, to what underlying assumptions about future migration should be included.

2.1 Flows, rates and the degree of detail: Target variables

Initially, migration forecasts depend primarily on the target variables to be modeled. While the approaches used by the statistical offices generally target gross or net

3 For a general overview, see Vanella et al. (2020a).

4 A recent comprehensive survey is given by Wilson et al. (2021).

migration flows, many authors, such as Bijak (2011) or Fuchs et al. (2021), have argued against forecasting migration flows. Fuchs et al. (2021) pointed to the "philosophical advantages" of forecasting migration rates instead of flows. Migration rates show relatively robust age patterns (Rogers and Castro, 1981), which implies that rates should be less volatile than flows. Migration rates are computed based on the population at risk of migrating. Consequently, forecasting rates rather than flows accounts for structural changes in the size and the age structure of the population, which can, in turn, significantly influence migration flows. Moreover, forecasts of migration flows using very small baseline populations, such as the oldest-old or the populations of sparsely populated regions, may lead to negative simulations for the end-of-period population. This combination may, in absolute values, result in net out-migration estimations that exceed the initial population base – which is, obviously, impossible (Fuchs et al., 2021). Thus, particularly, albeit not exclusively, in regional forecasting contexts, estimating rates appears to have advantages compared to estimating flows.

Indeed, regional migration rate forecasts have a long tradition (see, e.g., Rogers and Castro, 1981 or Rogers et al., 2010). However, one clear limitation of forecasting regional migration rates is that in-migration rates are difficult to define. Whereas out-migration rates from one region can be easily computed, at least in countries with adequate regional population and migration data, computing in-migration rates is not as straightforward, since the baseline population is not well-defined. Calculating migration rates based on the regions of origin of the migrants is not feasible in many contexts, and especially in the case of international migration from countries with less reliable statistical documentation. While computing rates based on the corresponding population of the target region for the purposes of projection is an alternative approach, it is philosophically questionable, as we do not use the population at risk in the denominator, but instead approximate the gravity of more populous regions in lieu of computing migration rates (Fuchs et al., 2021).

In addition to the question of whether to model flows or rates, the question of what degree of detail is appropriate can arise when deciding whether to incorporate the target variable disaggregated by categories such as age, gender or citizenship, as substantial differences in these categories have been documented. Raymer et al. (2011) estimated migrations by origin, destination, age and gender for European countries, and found age- and gender-specific patterns across countries. Similarly, Van Mol and de Valk (2016) demonstrated that the age and gender structure of migrants differs depending on both their citizenship and their destination country.

2.2 Consistency in forecasts of internal and international migration

On the regional level, migration comprises both international and internal flows. These flows affect and shape regions within a country quantitatively and qualitatively, and to different degrees (Fratesi and Percoco, 2013). In Germany, for example, distinct internal migration patterns have been observed in recent decades, as, following reunification, the number of people migrating from East Germany to West Germany greatly exceeded the number of people migrating in the opposite direction (see, as a recent example, Rosenbaum-Feldbrügge et al., 2022). While this demonstrates that both components should be included in projections, it also suggests that the target variables should be further distinguished for this category as well. The latter point is again supported by empirical evidence. For example, in the case of Germany, scholars have shown that out-migration from East Germany is selective in terms of age and gender (Kröhnert and Vollmer, 2012; Leibert, 2016).

However, relying on highly disaggregated target variables along all these dimensions faces two limitations in empirical applications. First, detailed regional migration data[5] are usually sparse (Rowe et al., 2019; Wilson et al., 2021). Second, even when these data are available, the dimensionality increases drastically, particularly for approaches that include region-to-region flows, which may even be disaggregated by gender, age and citizenship, as outlined above.

Migration projections that focus on the national level, such as those by UN DESA (2022), do not cover the regional perspective, and are, therefore, not necessarily compatible with regional projections for the same country. For the case of Germany, Maretzke et al. (2021) followed a hierarchical procedure that, first, assumed one of the variants suggested by Destatis (2019) for international migration between Germany and other countries, and, second, assumed internal migration rates in Germany based on a qualitative assessment and past data. While this approach has merit, it cannot capture changes in internal migration patterns after immigration shocks.[6] Moreover, due to its complex model structure, which is based on bi-directional internal migration, it is not feasible to sufficiently incorporate uncertainty into the projection, particularly given the high stochasticity in international migration (for more on that problem, see Section 2.4).

2.3 Modeling migration processes and determinants

Closely connected to questions of which target variables should be selected is the decision about which general modeling framework should be used, e.g., which migration determinants should be included. A large body of literature has emphasized the importance of including determinants in analyses of migration patterns. Among the potential drivers of migration that have been discussed in the literature are economic reasons (e.g., Bertoli et al., 2013; Grogger and Hanson, 2011; Mayda, 2010), the impact of education (e.g., Bernard and Bell, 2018; Lutz and KC, 2011;

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5 Bell et al. (2014) present a comprehensive overview of internal migration data for the 193 UN member states.

6 Even after internal and international migrations have been separated, there is still a variety of possible approaches to incorporating these flows. Interested readers may consult Rees et al. (2015), who discussed a variety of approaches to modeling international migration streams in subnational population projections.

Lutz, 2021), network effects (e.g., Beine et al., 2011; Pedersen et al., 2008), the institutional framework (e.g., Geis et al., 2013; Ortega and Peri, 2013), personal preferences (Mulliner et al., 2020; also *amenity migration*, e.g., Steinicke et al., 2012) and environmental causes (e.g., Beine and Parsons, 2015; Black et al., 2011; Cai et al., 2016).[7]

Notably, these scholars found that the observed migration patterns are usually explained by more than one of those drivers, or by interactions between them. For example, Leibert (2016) attributed the abovementioned internal migration in Germany, in which gender-selective out-migration plays a large role, to a combination of economic and context-specific institutional factors, including the labor market situation in East Germany after reunification combined with high levels of labor force participation among East German women. Heider et al. (2020) found that the locational choices of international migrants across German regions are strongly driven by network effects as well as by individual-level factors, such as educational considerations. Prenzel (2021), using German data, showed that regional population aging fueled by the selective out-migration of younger individuals may itself reinforce out-migration, and thus that polarization dynamics, in addition to the other discussed reasons, may be another explanatory factor in regional migration patterns.[8]

Just as a variety of migration determinants have been discussed across disciplines, a wide range of approaches have been used to forecast migration. While statistical offices (e.g., UN DESA, 2022) tend to rely on rather simple models for migration computations, more sophisticated alternatives have been applied in the literature. For instance, Kubis and Schneider (2020) used an econometric panel model that predicted immigration and emigration by EU citizens in Germany, and included labor market and freedom-of-movement variables as predictors. Lipps and Betz (2005) suggested forecasting cumulative net migration to Germany using an ARIMA model. Vanella and Deschermeier (2018) proposed ARIMA forecasting of principal components derived from age-, gender- and nationality-specific net migration to Germany. Moreover, migration forecasts between certain regions can also be performed based on directional models. Examples of studies that used this approach include Abel and Cohen (2019) and the sources cited therein. An example for forecasting bi-directional flows between Germany and Poland was provided by Bijak (2011).

Importantly, the methodological approach to migration forecasting may also vary depending on the extent to which cross-correlations between in-migration and out-migration, age and gender groups (which also model family migration indirectly), and different regions are included in the model.

[7] For further discussions, see, among others, Simpson (2022) or Van Hear et al. (2018). Interested readers may also refer to collections of interdisciplinary perspectives on migration, such as Brettell and Hollifield (2022).

[8] For a more detailed discussion of the drivers of migration between East and West Germany, see Rosenbaum-Feldbrügge et al. (2022).

Vanella and Deschermeier (2018), for example, covered these correlations on the national level by employing the abovementioned approach. From a regional perspective, simple (top-down) models do not sufficiently account for correlations in migration between regions. An illustrative example is that large inflows to a major city like Berlin will be highly correlated with migration flows to or from neighboring regions; in this case, Brandenburg. These correlations might be negative in the case of movements between Berlin and Brandenburg, or they may be positive if large inflows to Berlin are associated with large inflows to the neighboring regions because, for example, migrants are unable to find accommodation in Berlin due to a lack of available housing (Henger and Oberst, 2019a). At the same time, co-movement, such as family migration, will be observable in the data due to high positive correlations between corresponding age groups. This is a well-known phenomenon that has been investigated by Rogers and Castro (1981), and in later studies on the age schedule of migration.

2.4 Incorporating risk and uncertainty

Finally, migration projections, like demographic projections in general, differ in how they include risk and uncertainty. Migration projections are often categorized as either deterministic or stochastic approaches. While deterministic population projections were frequently employed in the past, as they were widely used by statistical agencies (Deschermeier, 2011; Vanella and Deschermeier, 2020), stochastic approaches have become increasingly popular in recent decades, at least on the national level.[9]

Deterministic approaches, which are often scenario-based (see, e.g., UN DESA, 2022), seek to identify several realistic outcomes. Some authors use rather naïve assumptions: i.e., that the most recent observations form the basis for the most probable future scenarios. For instance, the United Nations Population Division relies on such an assumption in its projections of international non-refugee migration in the medium scenario of its World Population Prospects (UN DESA, 2022). In cases in which the assumption that recent migration flows will continue in the future is not realistic, alternative values may be proposed, either for the near future (specifying a level) or for the medium to long term (specifying a full future trajectory). For instance, the national population projections for Germany proposed by Destatis (2019) assume that net migration will, in sum, converge to levels computed as the historical means over three varying periods. In this example, net migration to Germany is assumed to reach a level of between 111,000 and 300,000 in 2030.

Among the reasons why deterministic approaches have been popular are that they can be computed quickly, and they can be easily used to compare a range of different policy scenarios and the corresponding effects (Vanella et al., 2020a).

9 For a survey on Germany, see Vanella and Deschermeier (2020).

For example, Lomax et al. (2020) recently discussed a series of Brexit-dependent migration scenarios and presented corresponding deterministic projections for each scenario. Lutz et al. (2019), developed several demographic scenarios for the European Union in which they analyzed the impacts of fertility, mortality, migration, education and labor force participation. They showed that projections of how many people, stratified by skill level, will be living and working in the European Union in 2060 differed depending on which assumptions were applied. Similarly, Marois et al. (2020) compared six scenarios for the EU-28 that differed depending on which assumptions regarding immigration volumes, the educational selectivity of migrants, and labor force integration and participation were used, and analyzed the corresponding impacts on various dependency ratios. De Beer et al. (2010), taking a smaller-scale perspective, compared four policy scenarios based on different assumptions for reducing socioeconomic inequalities and moderating climate change across European regions, and assessed the impact of these policies on demographic developments such as (working-age) population growth and population aging.

However, despite being popular, deterministic approaches have major limitations, as they rely on scenario assumptions; that is, on fixing the relevant parameters at predefined values, and then making a straightforward calculation of the corresponding future developments. As these approaches are unable to quantify the probability that the respective scenarios will occur (Vanella et al., 2020a), they do not reflect future uncertainty, but instead only present a rather small number of realistic scenarios. While these scenarios may be informative, the statistical probability that they will actually take place is close to zero (Keilman et al., 2002). By contrast, stochastic (population) projections overcome these limitations, as they quantify the probability that future trajectories will occur by relying on statistical information and methods for both frequentist (e.g., Fuchs et al., 2018 or Vanella and Deschermeier, 2020) and Bayesian (e.g., Azose et al., 2016) frameworks.

Despite having these favorable properties, the stochastic modeling of (international) migration has previously been performed for only a few individual countries (Azose et al., 2016), such as Germany (Vanella and Deschermeier, 2018), or for migration between countries, such as between Germany and Poland (Bijak, 2011). However, as was noted above, the quantification of prediction intervals instead of point forecasts is preferable, since it allows researchers to assign probabilities to the outcomes of the respective future migration trajectories (Vanella and Deschermeier, 2018). Nonetheless, given its volatile nature, migration is particularly difficult to forecast, even when a stochastic framework is applied.[10]

Notably, in addition to stochastic approaches, there is also a series of approaches that combine both (scenario) assumptions and policy comparisons. For example, Lutz et al. (1998) suggested randomizing expert-based scenarios to derive stochastic

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10 Which additionally lowers the predictive value of selective (i.e., deterministic) scenarios, as the probability of an outcome is lower than it is for processes that are easier to predict, such as mortality improvements.

expert-based forecasts. Abel et al. (2016) incorporated future education pathways based upon the Sustainable Development Goals in a Bayesian framework. Marois et al. (2021) used a stochastic microsimulation model for China with pre-defined parameter values, e.g., for the total fertility rate, to project adjusted old-age dependency ratios that factored in both educational attainment and labor force participation. Similarly, Bijak (2011) and Azose et al. (2016), among others, have recently suggested using Bayesian approaches to combine the information derived from the data with qualitative knowledge or assumptions regarding future migration. The use of such approaches is conceivable if the necessary data are not available or are erroneous, or if we believe that the past data are unlikely to reflect future developments in migration.

2.5 Migration forecasts for German regions

For the reasons outlined above, the approaches to modeling regional migration are, in practice, quite heterogeneous. However, deterministic approaches are used even more frequently for regional projections than for projections on the national level. This is illustrated by looking at various recent population projections for German regions, some of which have already been addressed. For example, Maretzke et al. (2021) provided comprehensive population estimates for German NUTS-3 regions until 2040. They modeled internal migration using high dimensional region-to-region migration data from 2011–2017 and assuming constant mean outflow rates in the future, disaggregated by age and gender. Similarly, they modeled net international migration by applying a series of deterministic assumptions based on regional data from the observation period and assumptions about the overall levels of migration to Germany in the future. Reinhold and Thomsen (2015) provided population projection results for NUTS-3 regions of the German federal state of Lower Saxony using an average of different projection techniques. While they relied on several deterministic assumptions about regional migration dynamics, such as constant inward to outward migration ratios or zero net migration, they did not differentiate between internal and international migration. Breidenbach et al. (2018) provided much more fine-grained estimates, projecting the total population in Germany until 2050 using a 1×1-km grid. They did not take internal migration dynamics into account. Moreover, they assumed that net international migration to Germany will remain at constant levels, and will be distributed across regions proportionally to the total population. Regional projections using the subnational data of other countries often relied on deterministic modeling as well (e.g., Eurostat, 2021; Raymer et al., 2006; Wilson, 2015a).

By contrast, fewer regional migration projections have taken uncertainty into account. Ballas et al. (2005) estimated the internal migration probabilities for regions in Ireland over the 1991–2002 period by using Monte Carlo sampling from individual census records. However, they excluded international migration from their analysis due to a lack of data. Bryant and Zhang (2016) estimated regional emigration rates disaggregated by sex and age in New Zealand over the 2014–2038 time interval using a complex Bayesian approach. Similarly, Zhang and Bryant (2020) used a sophisticated Bayesian model to project migration between Icelandic regions.

Thus, even though migration dynamics play a crucial role in the demographic development – and, consequently, in the overall economic and social development – of regions, most regional projection approaches do not rely on a consistent (including both international and internal migration) and accurate (stochastic) modeling strategy. Investigating either international or internal migration, but not both, fails to account for the interdependencies or regionally differing effects of these two migration components. Furthermore, as Fuchs et al. (2021) demonstrated, in addition to relying on the sensitivity to the assumed parameter values, modeling migration deterministically implies a heavy dependence on a detailed approach for modeling in-migration and out-migration dynamics. This issue is of particular importance on the regional level, as Wilson and Bell (2004) showed for internal migration. In the same vein, Wilson et al. (2021) underlined the need for stochastic modeling of regional population changes in future research.

Therefore, given the state of the research and the respective implications and limitations of the prevailing deterministic methods outlined above, we propose in the upcoming section a comprehensive and parsimonious stochastic framework for forecasting migration on the regional level in Germany.

3 Data and methods

Based on the literature, we can identify a series of potentially relevant characteristics of a model for forecasting migration between German regions. However, the incorporation of these factors is constrained by data availability, which we discuss below. Moreover, *ex-ante*, there is ambiguity about which modeling approach performs the best. Therefore, the comparison of different specifications may be necessary.

Previous studies have evaluated a series of candidate models to find out which one performs the best. Reinhold and Thomsen (2015), using data for selected German regions, compared the accuracy of individual and model averaging forecasting techniques. Rayer (2008) compared the forecast error levels of different population forecasting techniques using data on U.S. counties. Wilson (2015b), building upon the findings of Rayer (2008) and others, compared the forecast accuracy of more than 200,000 simple to more complex averaged and composite model specifications for regions in Australia, England and Wales and New Zealand.

In line with these examples, and based on both the relevant factors discussed in the review above and the available data for German regions, we identified eight models to be tested and compared to each other:

- a prediction of gross migration flows using naïve status quo assumptions,
- a prediction of gross migration flows using observed mean and median values,
- a prediction of net migration flows using principal component analysis,

- a prediction of log-gross migration flows using principal component analysis,
- a prediction of gross migration rates using naïve status quo assumptions,
- a prediction of gross migration rates using observed mean and median values,
- a prediction of net migration rates using principal component analysis and
- a prediction of log-gross migration rates using principal component analysis.

Thus, our empirical strategy consisted of two major building blocks. *First*, we determined which of those eight competing models is most accurate by conducting a sequence of deterministic backtests (see, for instance, Vanella and Deschermeier, 2019). In doing so, we applied each model to each of the six available gender-age groups[11] by taking data for the years 1995–2014 as a baseline, while assuming no knowledge of the migration trends after that period. We then created in-sample forecasts for the years 2015–2019, and compared the corresponding *ex-post* errors. Interested readers can find details on the models that were tested, the measure of accuracy that was used (the symmetric mean absolute percentage error, see Chen et al., 2017), and the results for all other models in Appendix A. *Second*, the best-performing model was used to conduct a stochastic NUTS-3-level migration forecast until 2040. By applying this two-step procedure, we addressed the discussions outlined in the literature review about which target variables (net versus gross, flows versus rates) and empirical strategies should be used (from naïve models to principal components analysis), and how uncertainty should be incorporated.

3.1 Data: Sources and preparation

We used publicly available small-area data on migration from and to NUTS-3 regions in Germany (*Kreise/Districts*) for the 1995–2019 period from the German federal statistical office and the statistical offices of the federal states (Statistische Ämter des Bundes und der Länder, 2022). As there were various changes in administrative territories over the baseline period, we redistributed the past migration flows[12] to districts based on their boundaries as of December 31, 2019. For the data of districts in which the boundaries changed[13] over time, and for which obtaining consistent time series was therefore not feasible, we created pseudo-districts. Appendix B gives an overview of the territorial reforms since 1995, and of how we converted data with incompatible boundaries into consistent time series.

11 0–17; 18–24; 25–29; 30–49; 50–64; 65+ years.

12 In contrast to the general definition of migration flows as presented in Section 1, our model refers to the sum of either inflows or outflows during one-year periods from the perspective of a certain district. For instance, we consider each out-migration from Berlin as an outflow and each in-migration to Berlin as an inflow. Thus, our definition of flows is non-directional. For example, a person moving from Berlin to Wolfsburg in the year 2020 will appear as an outflow in the data for Berlin and as an inflow in the data for Wolfsburg.

13 For instance, after reunification, some districts in East Germany were dissolved and redistributed to three or four new districts.

Although it would have been preferable to do so, as we discussed above, the available data did not allow us to distinguish between internal and international flows or citizenships. Furthermore, in 15 of the 16 federal states, the district-level data did not distinguish migrants by gender before 2002. We obtained gender-differenced time series for those 15 federal states by performing a backcast of the rates for males among all migrants across all age groups and districts. For this purpose, we computed the age-specific shares of males among all migrants for 2002–2019, and then performed PCA on the resulting 4,596 time series (in- and out-migration, six age groups, 383 districts). The obtained PCs were backcasted until 1995, and were then retransformed to male shares for all age groups and districts, and multiplied by the total migration data to obtain gender-specific flows.[14]

3.2 Forecast model

The highest forecast accuracy was achieved by the PCA model for log-gross migration flows. Using this model for our forecast, we first performed PCA on the covariance matrix of annual age- (six groups), gender- (binary) and district-specific (396 districts and pseudo-districts) log-migration flow time series for 1995–2019, which corresponds to a 25 (years) × 9,504 (variables) matrix. PCA performed singular value decomposition on this matrix, thereby transforming the original and highly correlated data into linear combinations of the original variables that were uncorrelated, so-called principal components. This allowed us to efficiently cover cross-correlations between the original variables in our forecast (Vanella, 2018). More technical details on the PCA model used for the specific case in this paper are given in Appendix A.

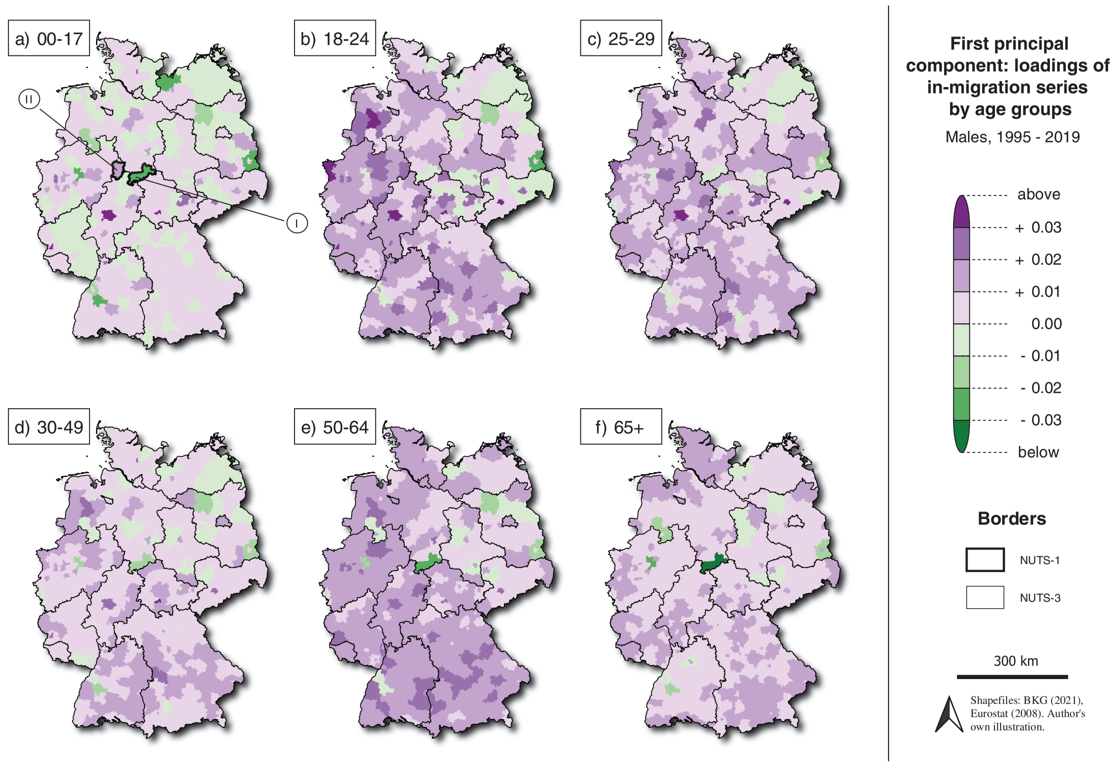
The inversed loadings (coefficients) of the district-, age- and gender-specific log-migration on Principal Component 1 (PC1)[15] are illustrated in Figures 1–4, whereby Figures 1 and 2 indicate loadings of age- and gender-specific in-migration and Figures 3 and 4 indicate loadings of age- and gender-specific out-migration. Darker colors are associated with higher correlations between PC1 and the respective log-migrations. Shades of green indicate negative loadings of the respective flows on PC1, while shades of purple indicate a positive connection.

For instance, the district of Göttingen (I) has a dark green color in Figure 1(a), which means that a decrease in PC1's inverse is, on average and *ceteris paribus* (c.p.), associated with relatively large *increases* in in-migration to Göttingen among males aged 0–17 years. Simultaneously, the dark purple of the district of Höxter (II) indicates that for the same age-gender stratum, an increase in PC1's inverse is, on average and c.p., associated with rather large *increases* in in-migration to Höxter. Moreover, the district of Göttingen (I) has a dark green color in Figure 4(f) as well.

[14] We purposely keep the description of the backcast method rather short. For interested readers, more details are offered in Appendix C.

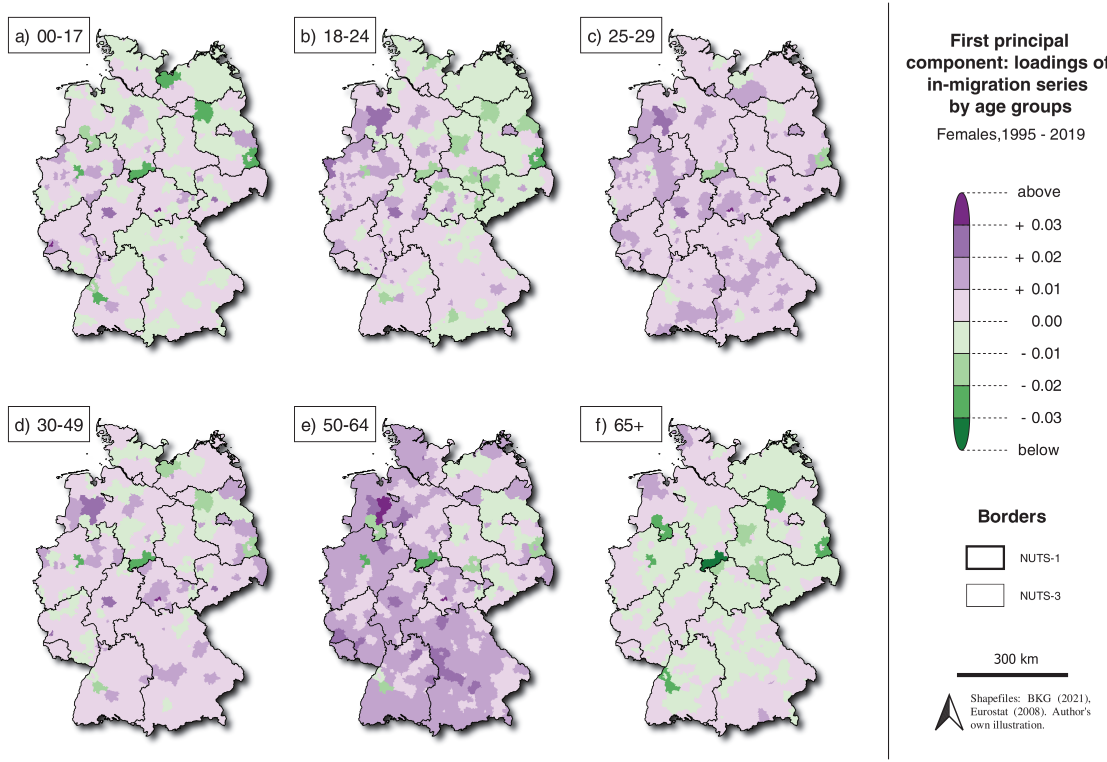
[15] For ease of interpretation, the sign of the PC1 time series (and, thereby, its loadings) was inverted in Figures 1–5, such that an increase in PC1 is associated with c.p. increases in migration.

Figure 1:
Loadings of the first principal component for log-inflows by males



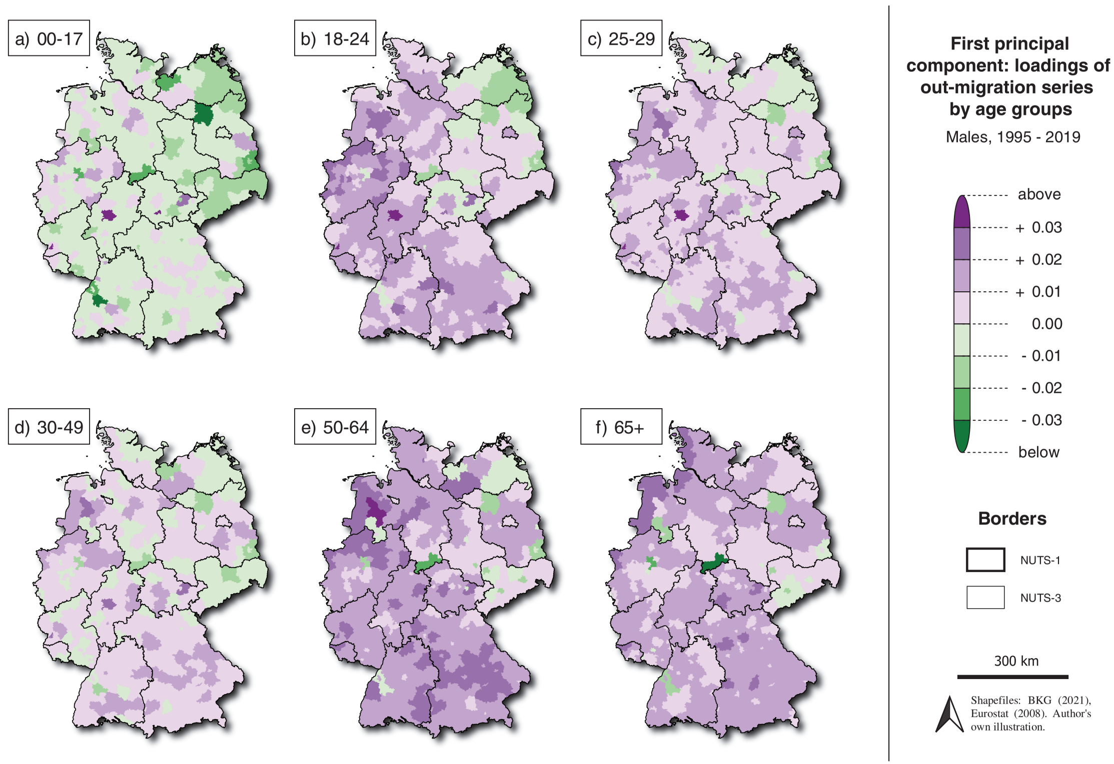
Source: Authors' computation and illustration.

Figure 2:
Loadings of the first principal component for log-inflows by females



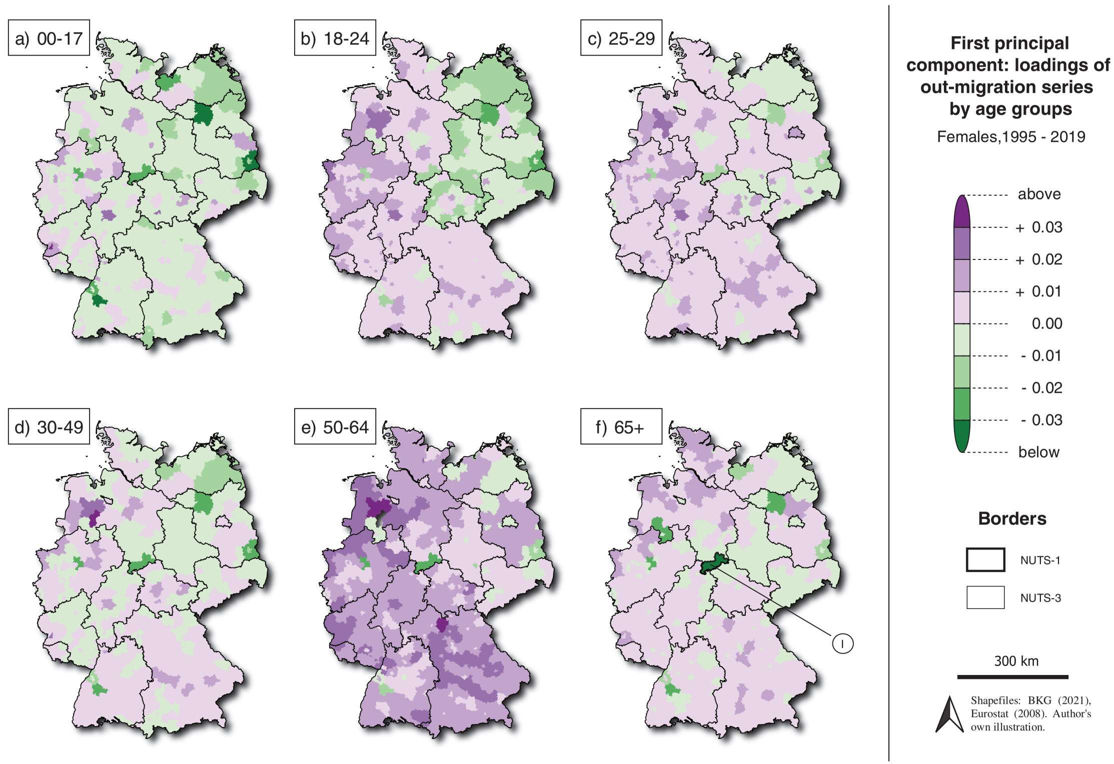
Source: Authors' computation and illustration.

Figure 3:
Loadings of the first principal component for log-outflows by males



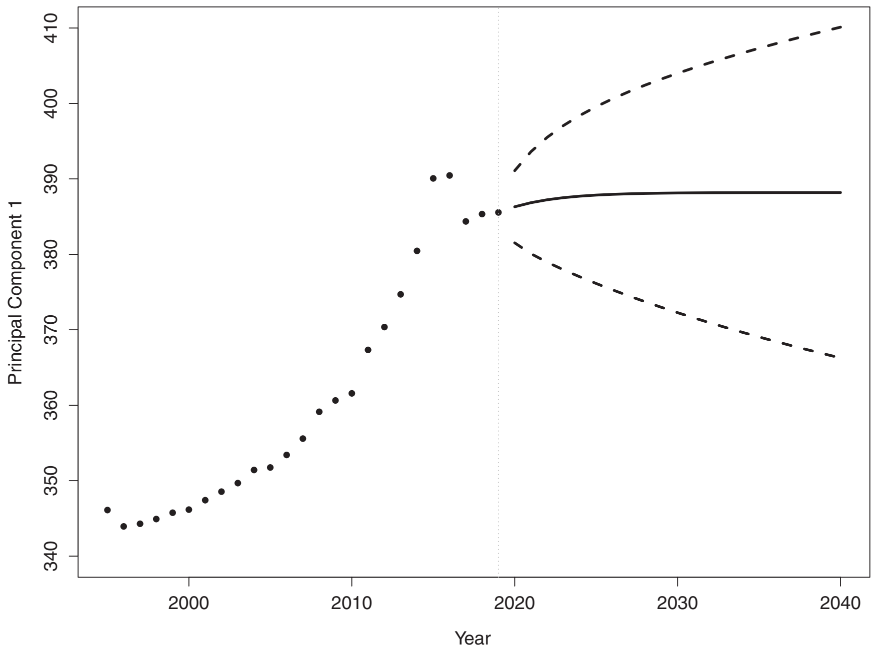
Source: Authors' computation and illustration.

Figure 4:
Loadings of the first principal component for log-outflows by females



Source: Authors' computation and illustration.

Figure 5:
Time series of Principal Component 1 (with inversed sign) with forecast



Source: Authors' computation and illustration.

This implies that a decrease in PC1's inverse is associated not only with increases in *in-migration* to Göttingen among young people, but also with increases in *out-migration* from Göttingen among females aged 65+ (c.p.). These selected examples demonstrate that trends in PC1 cover migration dynamics that occur simultaneously across districts, age groups and genders. Thus, as indicated by the literature review, we found that results relying on estimation by PCA accounted for the correlations and the interdependencies between regions and demographic groups reported in the historical data, such as the displacement of age groups due to overburdened local real estate markets.

Overall, PC1 explained more than 52% of the variance in the 9,504 variables throughout the 25-year period. Figure 5 illustrates its inversed course over time, alongside a forecast that was derived using an approach explained in Appendix A (see description of Model 4), including 95% prediction intervals (PIs) for illustrative purposes. Apart from the years 2015 and 2016, which were outliers due to the significant international refugee inflows and internal migration flows that occurred during that period (see Fuchs et al., 2021 and Vanella et al., 2022), PC1 followed a mostly monotonous course: migration was increasing steadily, then slowed down in the late 2000s, and accelerated again in the wake of the so-called Arab Spring in 2011 (Vanella and Deschermeier, 2018). After the large inflow of refugees ended in 2016, a deceleration of the curve can be observed.

Therefore, the long-term trend of PC1 can be emulated quite well by fitting an inverse logistic trend function to the time series. The model's inflection point (the year 2011) was chosen such that the fit maximized the model's likelihood. Then, the model coefficients were estimated by ordinary least squares (OLS). The model generating the prediction in Figure 5 is given in (1).

$$E[P_{1,y}|P_{1,2019}] \approx -345.675 - 45.998 \frac{\exp\left(\frac{y-2011}{2.856}\right)}{1+\exp\left(\frac{y-2011}{2.856}\right)} + r_{2019} \tag{1}$$

with

- $P_{1,y}$: value of PC1 in year y,
- y taking the values 2020, 2021, ..., 2040,
- $r_{2019} \approx 3.478$: the residual between the observation for PC1 in 2019 and the trend function's prediction for 2019.

After visual inspection of the residuals' time series and their autocorrelation function (ACF) and partial autocorrelation function (PACF) (see, e.g., Shumway and Stoffer, 2017), we concluded that they were appropriately modeled by a random walk process.

3.3 Stochastic forecast of regional migration flows until 2040

Having estimated in-sample regional migration using the best-performing specification, we attempted to forecast future regional migration among German regions until 2040. However, as was outlined above, uncertainty about future migration was a major concern. To account for this uncertainty, we set up a stochastic version of (1), which is given in (2).

$$P_{1,y} \approx -345.675 - 45.998 \frac{\exp\left(\frac{y-2011}{2.856}\right)}{1+\exp\left(\frac{y-2011}{2.856}\right)} + r_y, \tag{2}$$

with r_y being a random walk process that can be written as:

$$r_y = r_{y-1} + \varepsilon_y = r_{y-2} + \varepsilon_{y-1} + \varepsilon_y = \cdots, \tag{3}$$

with ε_y being a stochastic white noise process:

$$\varepsilon_y \sim \mathcal{NIID}(0,\, 0.149^2) \quad \forall\, y. \tag{4}$$

Table 1:
Explained share of variance by principal component

Principal component	Individual share of explained variance [as %]	Cumulative share of explained variance [as %]
1	52.4	52.4
2	25.7	78.1
3	4.9	83.0
4	3.9	86.9
5	2.1	89.0
6	1.8	90.7
7	1.1	91.8
8	1.0	92.8
9–9,504	<1.0	100.0

By drawing 1,000 times for each year over the forecast horizon from (4), plugged into (3), and thus also in (2), we computed 1,000 trajectories for PC1 until 2040. The remaining PCs jointly explained less than half of the variance in all log-migration time series (see Table 1 below). Since they did not show clear trending behavior, we assumed that those PCs followed random walk processes as in (3) and simulated 1,000 trajectories for each, which allowed us to consider the associated risk and to construct more realistic PIs, as suggested by Vanella and Deschermeier (2020). Using this approach, we obtained annual simulation matrices for all PCs that could be easily retransformed into annual simulation matrices of the log-migration, and by exponentiation, of migration flows, as given in (5):

$$\Gamma_y = \exp(\Pi_y \Lambda^{-1}), \tag{5}$$

with Π_y ($1{,}000 \times 9{,}504$) being the simulation matrix of the PCs for year y, Λ^{-1} being the inverse of the loadings matrix ($9{,}504^2$), and Γ_y being the simulation matrix of the migration flows for year y ($1{,}000 \times 9{,}504$). Based on the quantiles of the 1,000 simulated trajectories, we derived PIs for each district-, age-, gender- and direction-specific time series.

Subsequently, we aggregated each individual trajectory over the forecast horizon, resulting in cumulative migration flows until 2040:

$$\Gamma_{.} = \sum_{y=2020}^{2040} \Gamma_y. \tag{6}$$

Having obtained migration flows over the forecast horizon, we were able to derive measures of migration-associated depopulation for each district, age and gender. To this end, we subtracted, for each of the 1,000 trajectories, the forecasted outflows from the respective forecasted inflows. This yielded cumulative district-, age- and gender-specific net migration distributions through 2040. More formally, let $\gamma_{d,a,g,i,.,t}$ be the cumulative inflows to district d by individuals in age group a and of gender g in trajectory t for 2020–2040 and $\gamma_{d,a,g,o,.,t}$ be the corresponding outflow. Then, the net cumulative flow for the said district, age group, gender and trajectory is

$$\gamma_{d,a,g,n,.,t} = \gamma_{d,a,g,i,.,t} - \gamma_{d,a,g,o,.,t}. \tag{7}$$

Thus, $\gamma_{d,a,g,n,.,t}$ indicates whether a district faces an increase or a decrease in the corresponding demographic stratum because of migration flows over the forecast horizon – importantly, in absolute numbers.

However, German districts differ in population size, which alters the relevance of flows as absolute numbers. For example, a population decline of 10,000 is more severe in a district of 50,000 inhabitants than in a district of 1,000,000 inhabitants. To obtain a more realistic picture of the significance for each district of population decline due to negative net migration or population growth due to positive net migration, we computed the quotient of the cumulative net migration and the official population estimate as of December 31, 2019 ($B_{d,a,g,2019}$) for each stratum:

$$\frac{\gamma_{d,a,g,n,.,t}}{B_{d,a,g,2019}}. \tag{8}$$

Finally, we used our stochastic results to estimate the probability of migration-induced depopulation for each stratum. For instance, let $\Delta_{d,a,g,.}$ be a binary variable that takes the value of one if the cumulative net migration to d among individuals in age group a and of gender g during 2020–2040 is negative, and the value of zero otherwise:

$$\Delta_{d,a,g,t} := \mathbb{1}(\gamma_{d,a,g,n,.,t} < 0). \tag{9}$$

Then, the estimated probability of migration-induced depopulation based on our Monte Carlo simulation with 1,000 trajectories for the said district, age group and gender, is

$$\hat{P}(D) = \frac{\sum_{t=1}^{1,000} \Delta_{d,a,g,t}}{1,000}. \tag{10}$$

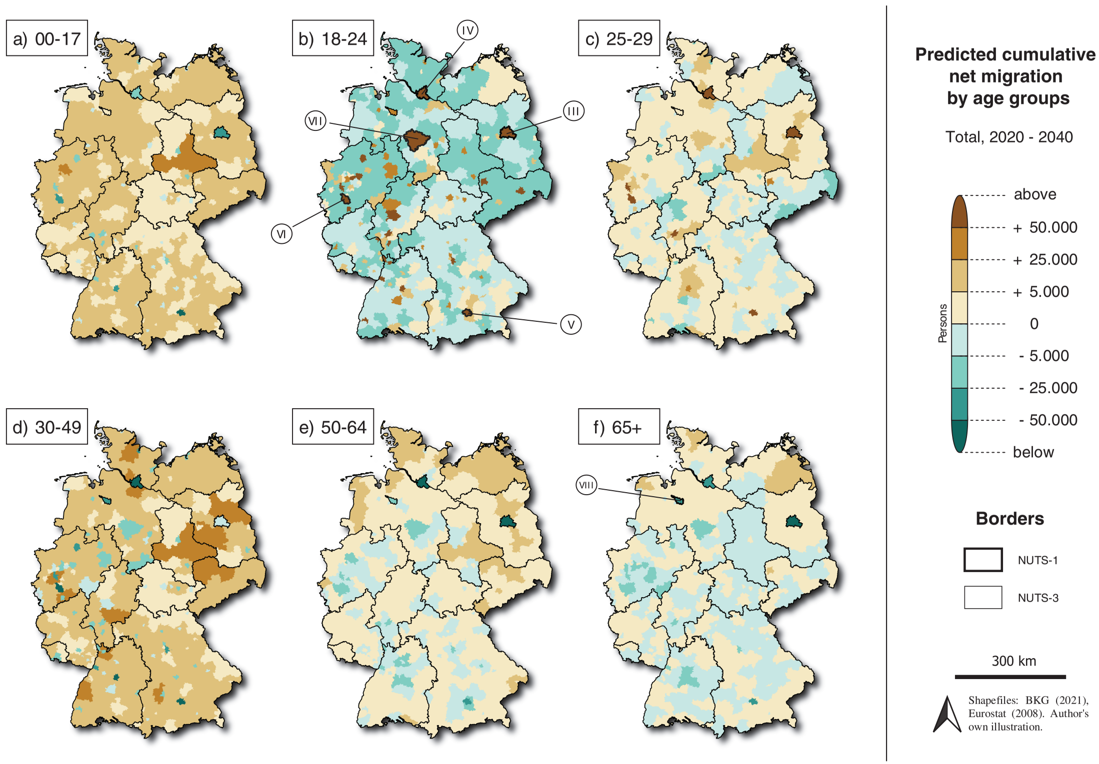
We will present the results generated from (6), (8) and (10) by district and age in Section 4. Gender-specific results can be found in Online Supplementary File 1 (available at https://doi.org/10.1553/p-5pn2-fmn8). We discuss the limitations of our approach in Section 5.

4 Results

4.1 Future migration flows among German regions

As the initial output of the model, given by (6), delivers migration flows, we visualize and compare the corresponding median of the forecasted flows in Figure 6. In this context, four distinct future migration patterns become visible.

Figure 6:
Median cumulative net migration in 2020–2040 by NUTS-3 region and age group



Source: Authors' computation and illustration.

First, there is strong evidence that for the 18–24 age group, migration-induced depopulation will occur in the majority of German regions by 2040, as indicated by the dark turquoise colors in Figure 6(b). Simultaneously, we observe scattered, brown-colored districts on the map representing major cities, which indicates that high levels of positive net migration to these cities among this age group will occur over the forecast horizon. For instance, Berlin (III), Hamburg (IV), München (V), Köln (VI) and Hannover region (VII) are easily distinguishable from their respective neighboring regions. These results are very much in line with the observed internal migration patterns in the recent past, which were characterized by educational migration by young adults from rural areas to nearby cities with universities and more occupational training opportunities (Siedentop et al., 2014 and the sources cited in the literature review).

Second, as illustrated by Figure 6(c), the forecast indicates that for the 25–29 age group, there will be positive net migration in most German regions, particularly in large cities, and only slight decreases in others. A key explanatory factor in this result is that overall positive net international migration is predicted for this age group due to both labor migration and, as implicitly included in the data, refugee migration (Vanella and Deschermeier, 2018; Vanella et al., 2022). The major cities and some of their surrounding areas will experience larger inflows since international migrants traditionally move to larger cities that are internationally known, and that frequently offer migrants a better network of co-patriates (Henger and Oberst, 2019b; Saa et al., 2020; Sharma and Das, 2018 and the sources cited in the literature review) who can facilitate their orientation after they arrive in the destination country (Gans and Ritzinger, 2014; Martén et al., 2019). However, by construction, Figure 6(c) displays internal movements as well. Here, migration patterns may be explained by the overall regional economic situation; that is, by labor market opportunities. Wage differentials between West Germany and East Germany have persisted since reunification (Smolny and Kirbach, 2011). Moreover, employment growth remains higher in West Germany, and this trend is expected to continue (Heining et al., 2021). For instance, the district of Göttingen shows positive net migration for the 18–24 age group (Figure 6(b)), but negative net migration for the 25–29 age group. This can be explained by Göttingen having a highly respected university that attracts students from other regions, but also a relatively small labor market that does not offer enough qualified jobs to keep graduates from leaving the city after they have finished their studies (Buch et al., 2011).[16]

Third, Figures 6(a) (0–17 years) and 6(d) (30–49 years) show quite different patterns of regional migration flows, apart from the overall positive net international

[16] Readers should, however, keep in mind that Figure 6 visualizes absolute net migration. Therefore, the color shades are naturally darker for larger districts. This somewhat explains the shades of the pseudo-district 150018285868991, which is merged from multiple rather rural districts in the federal state of Sachsen-Anhalt (see Appendix A for more details). Simultaneously, the 25–29 age group is the smallest of the six included age groups; thus, by construction, it tends to yield smaller absolute numbers.

migration. According to the median forecast, there will be negative net migration to major cities among the 30–49 age group. Figure 6(a) echoes these trends, as it shows migration among children, who typically migrate with their parents, most of whom are in the 30–49 age group. This echo in the migration age schedule has been investigated for decades, and was already observed by Rogers and Castro (1981), as was discussed above. The observed migration patterns can also be attributed to other factors identified in the literature, such as increased personal preferences for living in a quieter and more rural environment, and financial constraints that make it difficult to afford to live in a city (Günther, 2013). Young families are especially likely to search for housing on the outskirts of cities (Peter et al., 2022), as these areas tend to offer more safety and quiet and more affordable housing (Voigtländer and Sagner, 2020). Notably, as was discussed earlier, young families who leave cities often migrate to neighboring regions, as these areas typically offer good infrastructure and allow them to reach the city center relatively quickly (Peter et al., 2022). Moreover, the abovementioned gravity of major cities for internal and international migrants results in additional pressure on real estate markets, which can, in turn, lead to high levels of out-migration (e.g., Henger and Oberst, 2019a).

Fourth, Figures 6(e) and 6(f) illustrate that despite the large numbers of people in both groups, migration intensities generally decrease with age, as indicated by the lighter shades. A notable exception to these decreasing dynamics is the finding that deurbanization trends accelerate with increasing age, and will continue to do so in the future, according to the forecast. In Figures 6(e) and 6(f), the dark turquoise colors in Berlin, Hamburg, Bremen (VIII) and München indicate that levels of net out-migration among older people are high in these regions. Simultaneously, migration gains among older age groups are expected to occur in some areas surrounding these major cities, and in some northern regions of Germany, particularly those bordering the North Sea and the Baltic Sea. Recalling the literature review, this finding can be attributed to amenity migration. It is well known that retirement is associated with local migration peaks (Rogers and Castro, 1981), as significant numbers of individuals migrate to regions or countries they find more attractive (Vanella and Deschermeier, 2018). In our forecast, the seaside regions are expected to experience net inflows of older age groups in the future.

4.2 Migration flows along the urban-rural continuum

The analysis of migration flows across regions according to the median forecast has shown that in-migration and out-migration exhibit distinct age-specific patterns that can be linked to a series of explanatory factors discussed in the literature. Those factors often result in migration along the urban-rural-continuum, as was outlined. However, relying on district-level data may blur this finding, given that districts do not have a uniform residential structure; that is, each district may contain both rural and urban areas. To substantiate the finding that future migration will run along the

Table 2:
Median cumulative net migration 2020–2040 by age group and type of region [in thousands]

RegioStaR category	Age group 0–17	18–24	25–29	30–49	50–64	65+	Cumulative
71: metropolis in urban region	−198	+1,814	+999	−400	−236	−271	**+1,708**
72: regiopolis and large city in urban region	+58	+1,486	−36	−393	−52	−80	**+981**
73: medium-sized city, urban area in urban region	+888	−221	+202	+1,304	−69	−48	**+2,057**
74: small town area, village area in urban region	+369	−193	+63	+554	+57	+16	**+865**
75: central city in rural region	+106	+131	−32	+104	+39	+18	**+366**
76: medium-sized city, urban area in rural region	+520	−241	+40	+664	+170	+20	**+1,172**
77: small town area, village area in rural region	+373	−259	+54	+535	+187	+48	**+938**

Source: Authors' computation and illustration.

urban-rural continuum, we analyzed the forecasted migration figures with respect to the residential structure of a district.

An established classification for German regions is the *RegioStaR typology* by the Federal Ministry for Digital and Transport (BMVI). In a recent example, Heinsohn et al. (2022) suggested using the RegioStaR 7 specification to characterize regions in a study on regional COVID-19 infection dynamics in schools, as it provides a reasonable trade-off between enabling a sufficient differentiation of regions (seven) while still ensuring that the analysis is comprehensible. Since RegioStaR uses LAU nomenclature, Heinsohn et al. (2022) calculated the median category among all LAUs in each NUTS-3 region, with each LAU weighted by the corresponding populations on December 31, 2019. The resulting figure is used as the representative RegioStaR category of the NUTS-3 region (district). We borrowed their approach in the present paper. The RegioStaR typology is provided online by the BMVI (2021), alongside population estimates. Based on the outlined procedure, we derived net migration forecasts by age group and type of region. The median values in thousand individuals, cumulated over the forecast horizon, are given in Table 2. In the median, the model forecasted no overall migration-induced depopulation for any RegioStaR *category* due to positive international net migration. There was, however, support for the finding of age-specific regional depopulation due to age-specific migration patterns.

Heavily urban areas (71, 72) are expected to gain more than three million net migrants in the young adult age group (aged 18–24). Conversely, more rural areas to medium-sized cities (73, 74, 76, 77) are expected to face substantial declines in the population aged 18–24. This confirms the finding that internal migration from more rural to urban areas will occur among young people, most of whom are moving to pursue educational opportunities.

Simultaneously, these urban areas will face migration-induced declines among the 0–17 and 30–49 age groups. Again, more rural areas and medium-sized cities will experience the opposite trend: i.e., strong inflows of these age groups. This substantiates the finding that families are expected to migrate from heavily urban areas to smaller-sized cities or the countryside.

Similarly, cities are expected to lose population in the age groups close to or beyond retirement age, while more rural areas experience corresponding inflows. Again, this underlines the finding that amenity migration from urban areas to more rural regions will occur among people aged 50 and older.

4.3 Migration flows relative to district population size

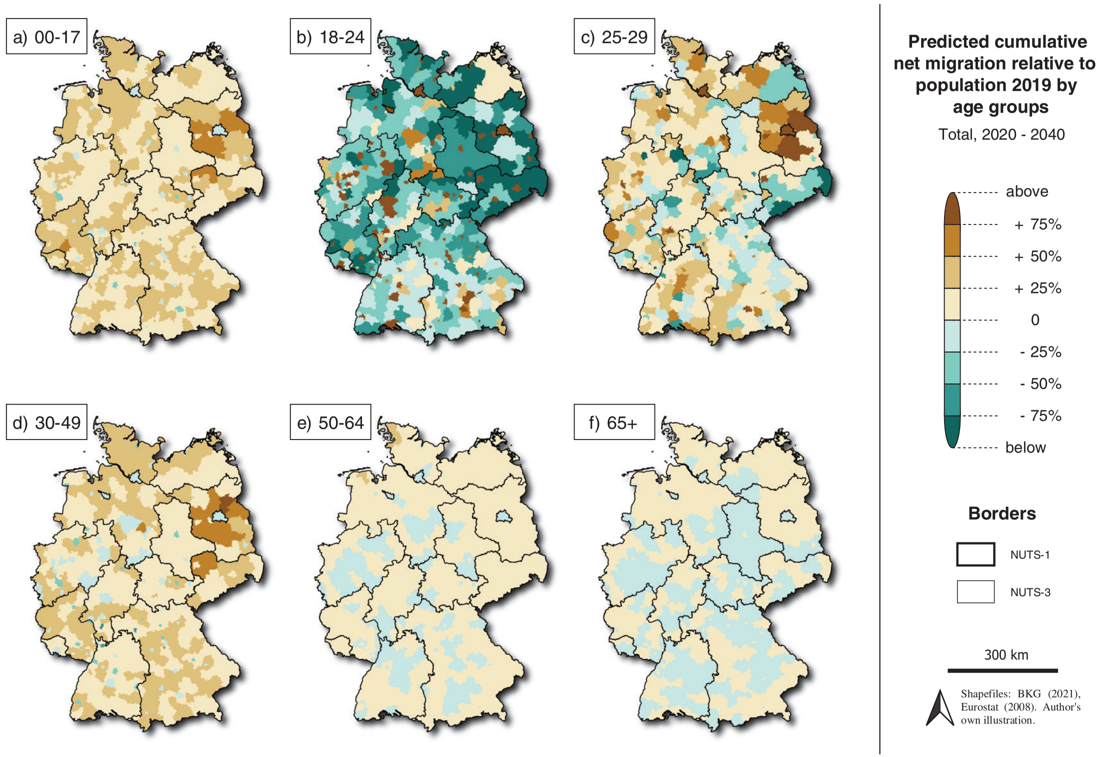
All of the results presented up to this point rely on levels. On the one hand, this allows us to compare the districts and to track migration patterns across region types. On the other hand, absolute numbers may not capture the district-specific significance of migration, as the population sizes of districts vary greatly. Therefore, we computed the cumulative net migration over the forecast horizon relative to the 2019 end-of-year population, as given in (8). However, readers should keep in mind that this is a synthetic measure that should not be confused with a rate or a share. Again, Figure 7 illustrates the median results.

The displayed patterns demonstrate that focusing on levels of migration flows can blur the significance of migration flows for particular regions. For instance, Berlin and its neighboring regions are disproportionally affected by family migration, as shown by these regions having darker color shades compared to other regions across Germany in Figures 7(a) and 7(d). Moreover, as Figure 7(b) illustrates, the out-migration by young adults from more rural areas to cities is, proportional to the number of persons in this age group, even more pronounced than the results in terms of levels suggest. Particularly in the eastern part of Germany, Berlin and other university cities appear to attract significant shares of individuals aged 18–24 who are migrating for educational reasons. However, our results also suggest that this trend is at least partially offset by remigration after the completion of education. Finally, Figures 7(e) and 7(f) demonstrate that migration patterns among people aged 50 and older are less intense proportional to the age group size than the observed net flows in Figures 6(e) and 6(f) indicate.

4.4 Probabilities of migration-induced regional depopulation

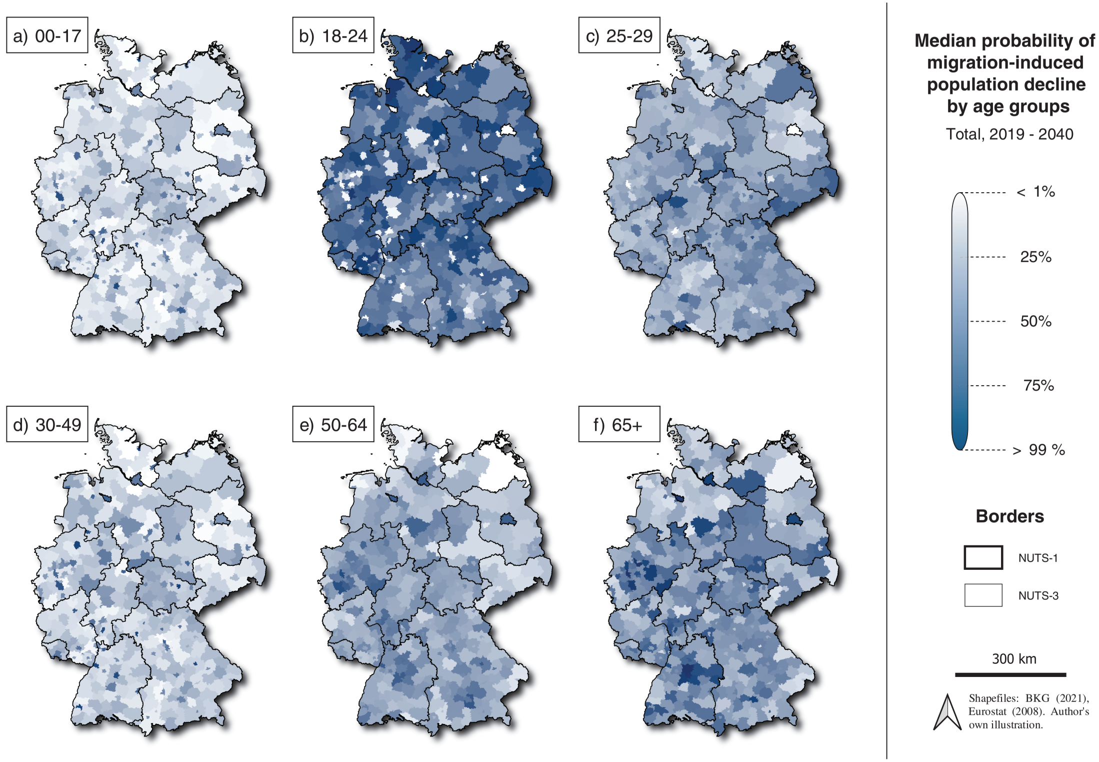
The results presented above have demonstrated that until 2040, distinct age-specific migration patterns are likely to shape population dynamics across German regions.

Figure 7:
Median cumulative net migration in 2020–2040 by NUTS-3 region and age group divided by the corresponding population on December 31, 2019



Source: Statistische Ämter des Bundes und der Länder (2021b); authors' computation and illustration.

Figure 8:
Probability of migration-induced depopulation between 2019 and 2040 by district and age group



Source: Authors' computation and illustration.

However, migration patterns, and thus our findings, are subject to substantial uncertainty. To account for this uncertainty in our forecast, we present the probability of migration-induced depopulation, as derived via (9) and (10) through our Monte Carlo simulation, in Figure 8. Again, we cumulated the results over the forecast horizon, and present total rather than gender-specific findings. The latter can be found in Online Supplementary File 1.

First, among children, migration-induced depopulation[17] is highly unlikely to occur over the forecast horizon in the vast majority of German districts. We observe that only some major cities face an increased probability of migration-driven decreases in the youngest age group. This finding is substantiated by the model results for the 30–49 age group, for whom the decline probabilities, as well as the forecasted median flows, closely mirror those of the youngest age group.

Second, in most German districts, the probability that the population aged 18–24 will shrink due to net out-migration is high. At the same time, we see that large cities, depicted by white dots surrounded by dark blue areas in Figure 8, have very low probabilities of losing population in this age group. Thus, the forecasted median migration flows indicate not only that substantial migration-induced declines of the population aged 18–24 will take place in rural areas in both absolute and proportional terms, but also that these declines are highly likely to actually occur.

Third, for the 25–29 age group, no clear patterns in terms of decline probabilities can be derived. It is likely that the composite, mutually offsetting effects of different migration flows, such as international migration, remigration after education or labor market-related migration, and the accompanying uncertainty, cause wide prediction intervals. Consequently, based upon the forecast presented in this paper, no clear statement regarding the probability of a migration-induced decline in the population aged 25–29, even in the regions exhibiting negative developments in the median forecast in Figures 6 and 7, can be made.

Fourth, median population changes due to migration among the population aged 50 and older will be quantitatively rather small, but are highly likely to take place in some districts. In other words, the model results shown in Figure 8 suggest that large cities are likely face a decline in the population close to or beyond retirement age due to net outflows of people in this age group.

5 Discussion and conclusion

This article presented a novel approach for joint stochastic forecasting of both international and internal migration on the NUTS-3 level in Germany. Relying on backtests, we found that a principal component-based approach to estimating log-migration flows gave the best prediction. This approach simultaneously computed future trajectories of in-migration and out-migration flows by age group and gender, while accounting for correlations among in-migration and out-migration

[17] Which does not rule out depopulation because of low fertility.

across districts, age groups and genders. Moreover, time trends in migration and autocorrelations were captured via time series analysis. Including stochasticity by using Monte Carlo simulation, we derived both the regional depopulation probabilities and the median net migration by age group and type of region for the 2020–2040 period. Thus, given the state of research in regional migration projections and forecasts, our modeling effort adds a novel approach to the existing literature.

Our findings provide evidence of strong heterogeneity in migration-induced regional depopulation patterns across German regions. This heterogeneity encompasses differences in both the quality and the quantity of migration by age group, gender and region. The results indicate that among parents (aged 30–49) and their children (aged 0–17), the probability of migrating and the migration flows are increased only for migration from large cities to the countryside. By contrast, the model results point to a high probability of migrating and large migration flows of young adults (aged 18–24) migrating from more rural regions to cities, presumably for reasons such as education. Similarly, the findings suggest that among people of early working ages (aged 25–29), the probability of migrating to economically stronger regions is high, which demonstrates the role labor market opportunities play in migration decisions. In contrast to the patterns observed among younger age groups, the results for people close to or beyond retirement age (aged 50 and older) indicate that they are more likely to migrate from urban areas and industrial centers, and that while these migration patterns are quantitatively less distinct, they are still highly probable.

Compared to the official German regional population projection performed by Maretzke et al. (2021), our median forecast has qualitative similarities but quantitative differences. The latter stem from significant differences in the predicted net international migration levels. Whereas Maretzke et al. (2021) assumed that net migration to Germany will converge to a level of 200,000 by 2026 and will remain at that level thereafter, our model predicts a cumulative net migration level of over eight million between 2020 and 2040, i.e., an annual average of 385,000 over that period. While this estimate is within the range of scenarios deemed realistic by Destatis (2019), it is close to their high migration assumption. Notably, an advantage of our approach is that it is fully stochastic and covers all scenarios described by Destatis (2019), while quantifying their individual probabilities. However, our structural results are remarkably similar to those of Maretzke et al. (2021). Whereas both studies predicted positive net international migration for all types of regions, they also predicted that cities and their neighboring regions will gain population in the younger age groups, whereas the rural areas will lose population in these age groups due to internal migration to urban centers. Thus, the migration-induced increases in rural areas are attributable to in-migration by the older age groups, leading to the aging of the overall regional population. Therefore, both studies predicted that the increase in the heterogeneity of regional age structures, particularly between urban and rural areas, will continue in the future.

Nonetheless, the approach presented in this paper is subject to several limitations. *First*, due to data availability, the analysis was restricted to six pre-defined age groups. This may be a drawback for future research, since the inclusion of our findings into annual population forecasts will likely require migration forecasts for one-year age groups. We did not impose assumptions on the age structure of the migrants to circumvent this limitation, but instead relied on the information available in the raw data. Fitting age schedules to the data, which is a common practice in migration modeling, would lead to smooth curves, and, when plugged into a forecast model, narrower prediction intervals that underestimate the future risk (Vanella and Deschermeier, 2020). Our model can, however, be seen as a building block that may feed into hierarchical migration forecasts. For instance, we could use auxiliary data, such as information on the age structure at a higher level of geographical aggregation, such as federal states, to construct forecasts of within-age group distributions of migrants, and multiply them by our age group-specific forecasts, which would result in one-year age group trajectories. Similarly, the availability of gender-specific migration data at this level of geographical disaggregation was restricted to the period from 2002 onward. Therefore, we needed to approximate the gender-specific time series before that point in time by predicting the gender shares through backcasting. Thus, having sufficiently detailed demographic input data would lead to more accurate age- and gender-specific migration forecasts.

Second, closely connected to the preceding limitation, the best-performing model in the backtests, which was used to perform the forecasting exercise, relied on migration flows. As was outlined in Section 2, several authors (Bijak, 2011; Fuchs et al., 2021) noted the advantages of using migration rates rather than flows. However, as was also discussed in Section 2, calculating in-migration rates at the regional level is not straightforward. Thus, the reliance on pseudo-in-migration rates, with their accompanying disadvantages, in the model comparison procedure likely explains the underperformance of the models using migration rates compared to those using flows.

Third, given the volatile nature of migration dynamics in general, migration data are associated with high levels of uncertainty. In particular, international refugee migration is hardly predictable, since it is sensitive to unforeseeable shocks (Vanella et al., 2022). For prediction purposes, it is important to have a sound estimation of future international flows, including of refugee migration, as these processes also shape internal migration. This is a point that should be addressed in future research.

Fourth, the forecast can only be as good as the input data. Thus, trends not included in the historical data also cannot be predicted over the long term by an adequate stochastic approach.[18] *Fifth*, closely connected to the preceding point, migration

[18] For example, the model is restricted to real estate market developments, as reflected in the past data. Regions, and especially cities, can only increase to the extent that the supply of housing and infrastructure (e.g., childcare, schools or mobility infrastructure) allows them to do so. Similarly, migration is only possible if the receiving region's real estate market offers the migrants room to live. A city that has received a large number of migrants in the past, but does not have living space available and is not building new housing projects, will not be able to generate further positive net migration in the future. However, this limitation appears to be mitigated by our model, as many of those trends – for instance, the trends for Berlin – are already included in the data for past periods, and are, therefore, implicitly included in the model.

is influenced by a variety of factors, which, for illustrative purposes, and while acknowledging the vast diversity among underlying reasons for migration decisions across individuals and households, may be identified as either *push* or *pull* factors, with the first being those that induce out-migration from some region, and the latter being those that draw in-migration to some region (Lee, 1966). Both push and pull factors can be of an economic,[19] a political,[20] a social[21] or an environmental nature.[22] A truly holistic approach would forecast migration based on the future development of those predictors. Importantly, the latter would need to be predicted themselves, which would be far from straightforward, and would greatly exceed the scope of this paper.

To conclude, our model addresses a significant shortcoming in the regional migration projection literature by comparing the performance of different modeling approaches and suggesting a stochastic strategy, thereby stimulating the improvement of the projection approaches commonly used by both researchers and statistical offices. In the bigger picture, by contributing to the accuracy of regional population projections in general, this paper also enhances the quality of the demographic base upon which decisions and actions in local and regional planning are taken.

Authors' contributions

Conceptualization: PV; Methodology: PV; Software: PV and TH; Validation: PD and TH; Formal Analysis: PV; Investigation: PV and TH; Resources: PV and TH; Data Curation: PV; Writing – Original Draft: PV and TH; Writing – Review & Editing: PV and TH; Visualization: TH and PV; Supervision: PV; Project Administration: PV.

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[19] For example, income (differences) or unemployment rates (Kubis and Schneider, 2020).

[20] Such as forced migration because of armed conflicts (Heidelberg Institute for International Conflict Research, 2022) or migration induced by restrictions to freedom of speech in the country of origin (EASO, 2016).

[21] Such as migration to a more family-friendly region after the birth of a child, as shown in the paper.

[22] For instance, nutritional problems caused by droughts and associated crop failures (UNHCR, 2020).

Data availability

The data used for the study or generated by the authors are available from the corresponding author upon reasonable request.

Supplementary material

Available online at https://doi.org/10.1553/p-5pn2-fmn8

Supplementary file 1. Forecast results by age group, gender and district.
Supplementary file 2. Annual migration flows for the years 1995–2019 by age, gender, direction and district.
Supplementary file 3. Annual (pseudo) migration rates through 1996–2019 by age, gender, direction and district.

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Appendix A. Model selection

Model 1: Gross migration flows, naïve model

As a baseline, we assumed a naïve model that holds migration flows constant to their last observed levels, i.e., for each district, age group and gender, the expected annual migration flows $M_{d,a,g,y}$ for the years 2015–2019 were assumed to equal the corresponding observation for 2014:

$$E[M_{d,a,g,y}] = M_{d,a,g,2014}, \quad y = 2015, 2016, \ldots, 2019. \tag{A.1}$$

Models 2A and 2B: Gross migration flows, observed mean and median values

As was discussed, several of the contemporaneous approaches in migration forecasting assume the convergence of migration flows to a prespecified level. Therefore, we tested two variants of models with target levels. *Model 2A* was inspired by the international migration assumption in Destatis (2019). Thus, we assumed that the migration flows for all strata will equal their respective historical means over the whole baseline period, i.e.,

$$E[M_{d,a,g,y}] = \bar{M}_{d,a,g}, \quad y = 2015, 2016, \ldots, 2019, \tag{A.2}$$

with $\bar{M}_{d,a,g}$ being the annual mean of migration to or from district d for age group a and gender g for 1995–2014. As a second variant, *Model 2B* imposed the expected median, since Vanella and Deschermeier (2020) suggested assuming that crisis-induced migration converges toward its long-term median rather than the mean, as the mean is more sensitive to extreme migration, which may, for example, be caused by extraordinary refugee flows. Then, the expected annual migration flow from or to some district by some age group of a certain gender is

$$E[M_{d,a,g,y}] = \tilde{M}_{d,a,g}, \quad y = 2015, 2016, \ldots, 2019, \tag{A.3}$$

with $\tilde{M}_{d,a,g}$ being the median migration flow from or to district d for age group a and gender g for 1995–2014.

Model 3: Net migration flows, principal component analysis

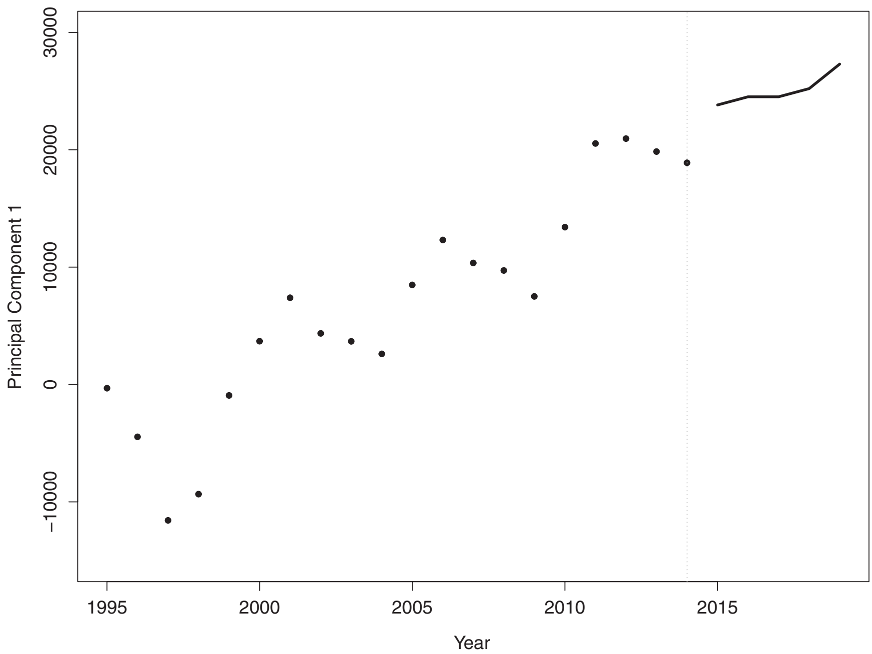
Model 3 is based on Vanella and Deschermeier (2018), applying PCA to the time series matrix of district-, age- and gender-specific net migration flows, a $20 \times 4{,}752$ matrix.[23] As was outlined, PCA transforms the original variables into linear combinations that are correlated to all original variables, yet are uncorrelated among themselves. For the case of net migration flows, for instance, the value of the jth PC in year y can be written as:

$$P_{j,y} = \sum_{d=1}^{396} \sum_{a=1}^{6} \sum_{g=1}^{2} \lambda_{j,d,a,g} N_{d,a,g,y}, \tag{A.4}$$

with $\lambda_{j,d,a,g}$ being called the *loading* (or coefficient) of net migration in district d, in age group a, and of gender g on PC j, and $N_{d,a,g,y}$ being the observed net migration in the said district of the said age group and gender in the said year.

[23] 20 years of observations (1995–2014) in the rows, 2 genders × 6 age groups (≤17; 18–24; 25–29; 30–49; 50–64; ≥65) × 396 (pseudo) districts in the columns.

Figure A.1:
Time series (with inversed sign) of Principal Component 1 of net migration model with forecast



Source: Authors' computation and illustration.

The loadings are computed by singular value decomposition.[24] Based on graphical analysis of the time series, the ACF, the PACF and maximum likelihood estimation, we fit a trend function with a linear and cosine trend to the time series of the first PC (which explained close to 55% of the variance in the 4,752 time series). The nuisance parameter was emulated by a random walk process:

$$E[P^3_{1,y}|P^3_{1,2014}] \approx 3,588 - 1,393(y - 1997) + 4,276\cos\left(\frac{(y-1997)\pi}{3}\right) + r^3_{2014},$$
$$y = 2015,\ 2016, \ldots,\ 2019, \qquad \text{(A.5)}$$

with r_{2014} being the residual between the value of the first PC and the predicted value by the trend function in 2014. The cosine had a periodicity of six years and was fit as suggested by Vanella et al. (2021) for forecasting weekly mortality rates. The past values are illustrated with the predictions for 2015–2019 in Figure A.1, again with an inversed sign as in the main text to facilitate interpretation.

24 See, e.g., Vanella (2018) for more details on applied PCA in demographic forecasting.

The remaining 4,751 PCs were assumed to be constant for 2015–2019, similarly to (A.1). The matrix of predicted PCs was then transformed back into predictions of net migrations for each district, age group and gender by inverting (A.4) over the set of PC predictions. In matrix notation, the predicted annual net migrations 2015–2019 are

$$\hat{N} = \hat{P} \times \Lambda^{-1}, \tag{A.6}$$

with $\hat{P}$ ($5 \times 4{,}752$) being the predicted PCs for 2015–2019 and Λ^{-1} being the inverted loading matrix ($4{,}752^2$).

Model 4: Log-gross migration flows, principal component analysis

For *Model 4*, the best-performing model used for the stochastic forecast in the main text, we pursued an estimation approach similar to that for Model 3. However, instead of using net migration flows, we applied PCA to a $20 \times 9{,}504$ matrix of the district-, age- and gender-specific migration log-inflows and log-outflows:

$$Q_{j,y} = \sum_{d=1}^{396} \sum_{a=1}^{6} \sum_{g=1}^{2} \sum_{z=1}^{2} \lambda_{j,d,a,g,z} L_{d,a,g,z,y}, \tag{A.7}$$

with $L_{d,a,g,z,y}$ being the log-migration in or from district d, among age group a, of gender g, and of type z (z = 1: inflows; z = 2: outflows) in year y.

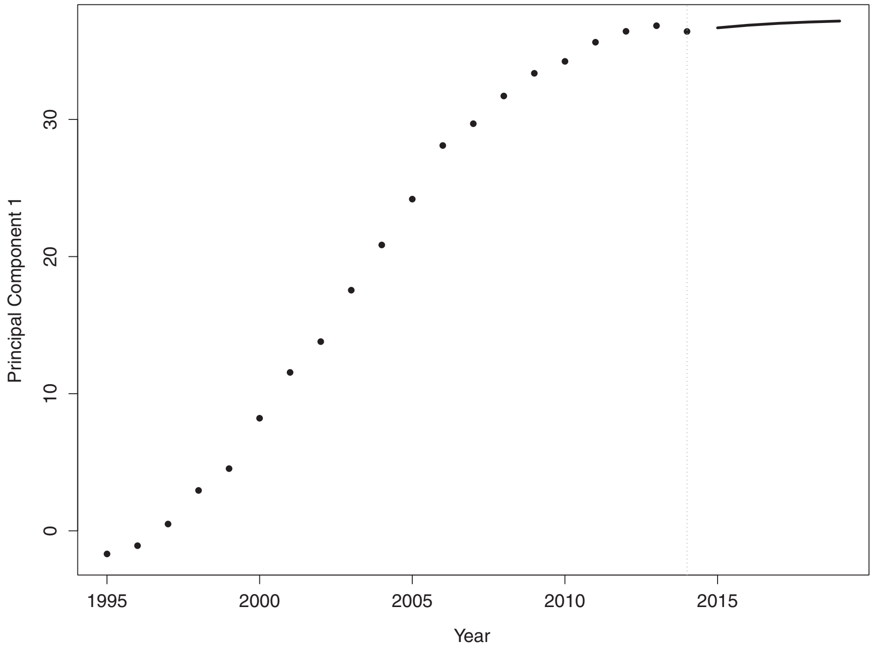
In doing so, we were able to cover trends of both in-migration and out-migration while simultaneously accounting for interdependencies between the two; a phenomenon that was also observed by, for example, Fuchs et al. (2021). By construction, migration flows cannot take negative values. Thus, we included the natural logarithms of migration flows in the PCA. Here again, the first PC (which covered almost 57% of the variance in the 9,504 variables) was predicted in detail by fitting a trend function (in this case, an inverse logistic trend) to the data and modeling the nuisance as a random walk. The resulting forecast function was:

$$E[P^4_{1,y} | P^4_{1,2014}] \approx 3.646 - 41,803 \frac{\exp\left(\frac{y-2003}{2.908}\right)}{1 + \exp\left(\frac{y-2003}{2.908}\right)} + r^4_{2014},$$
$$y = 2015,\ 2016, \ldots, 2019. \tag{A.8}$$

Figure A.2 shows the inversed course of the first PC with its prediction for 2015–2019.

The remaining 9,503 PCs were assumed constant, as they did not exhibit clear trending behavior. Thus, the prediction of the PC matrix can be easily performed in a similar fashion as given in (A.6).

Figure A.2:
Time series (with inversed sign) of Principal Component 1 of the log-migration model with forecast



Source: Authors' computation and illustration.

Model 5: Gross migration rates, naïve model

Many authors have suggested forecasting migration rates instead of migration flows, as was discussed in the literature review. Fuchs et al. (2021), for instance, showed for international migration in Germany that emigration rates are less volatile than emigration flows. Therefore, we tested models that were, in essence, similar to those already tested, but used migration rates instead of flows.

For instance, the out-migration rate of age group a of gender g from district d in year y is defined as the quotient of out-migration flows from that stratum divided by the end-of-year population estimate of the said stratum at the end of the previous year:

$$e_{d,a,g,y} := \frac{E_{d,a,g,y}}{B_{d,a,g,y-1}}. \tag{A.9}$$

Since it is not possible to derive immigration rates due to data restrictions (see Fuchs et al., 2021 and the discussion in Section 2), we defined the notion of *pseudo-in-migration rates*, which relates the inflow to some districts to the population of the target region instead of the origin region:

$$i_{d,a,g,y} := \frac{I_{d,a,g,y}}{B_{d,a,g,y-1}}. \tag{A.10}$$

Although this is a highly hypothetical measure, it allowed for a standardization of in-migration according to out-migration that enabled us to consider the previously discussed correlations between in-migration and out-migration flows in our statistical analysis. Moreover, we indirectly included a higher gravity of migration by larger districts, and thus implicitly accounted for spatial dependence. *Model 5* took a naïve prediction approach similar to that in Model 1, but with migration rates, which were held constant at their 2014 level:

$$E[m_{d,a,g,y}] = m_{d,a,g,2014}, \quad y = 2015, 2016, \ldots, 2019. \tag{A.11}$$

Models 6A and 6B: Gross migration rates, observed mean and median values

Like in Models 2A and 2B, in these models we tested two scenarios for the migration rates, with *Model 6A* assuming the long-term means and *Model 6B* taking the long-term medians as asymptotes. Accordingly, Model 6A assumed

$$E[m_{d,a,g,y}] = \bar{m}_{d,a,g}, \quad y = 2015, 2016, \ldots, 2019, \tag{A.12}$$

with $\bar{m}_{d,a,g}$ being the mean of the district-, age- and gender-specific migration rate over the 1996–2019 period.[25] Accordingly, Model 6B assumed

$$E[m_{d,a,g,y}] = \tilde{m}_{d,a,g}, \quad y = 2015, 2016, \ldots, 2019, \tag{A.13}$$

with $\tilde{m}_{d,a,g}$ being the median of the district-, age- and gender-specific migration rate over the 1996–2019 period.

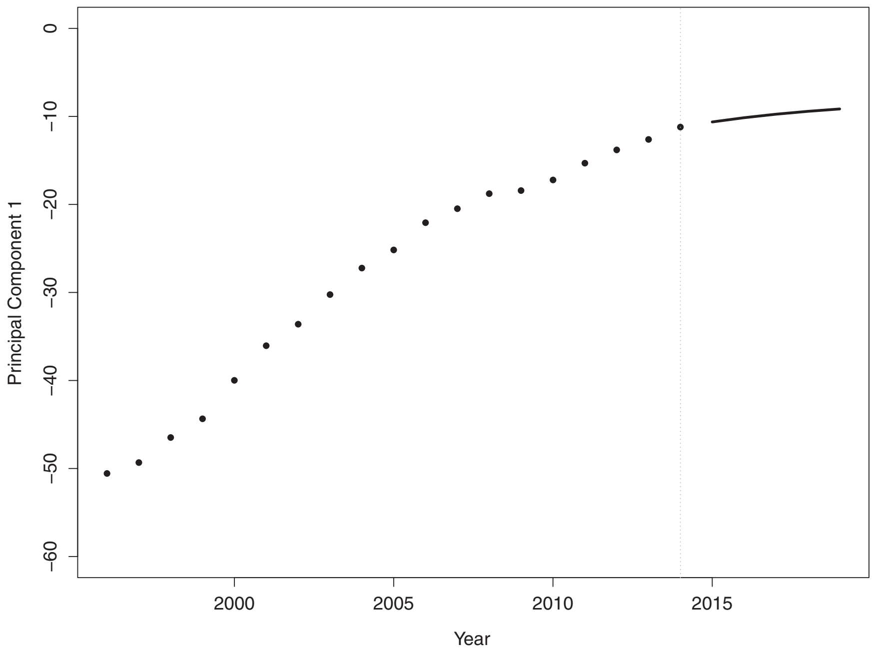
Model 7: Net migration rates, principal component analysis

Corresponding to Model 3, we performed PCA on pseudo net migration rates for all strata. We defined the pseudo net migration rate in district d for age group a, and gender g in year y as the difference between (A.10) and (A.9), given that migration projections based on net growth rates are the current standard in regional population projections in Germany (see Maretzke et al., 2021):

$$n_{d,a,g,y} := i_{d,a,g,y} - e_{d,a,g,y}. \tag{A.14}$$

[25] Note that there is no observation for 1995 because the population data are not available in the needed format before December 31, 1995.

Figure A.3:
Time series (with inversed sign) of Principal Component 1 of the log-migration rate model with forecast



Source: Authors' computation and illustration

However, in this case, PCA did not produce trending functions, and thus did not give insights useful for forecasting. As a result, the prediction of the PCs led to the same problem that arose when using the raw data: i.e., determining which target values should be pre-defined. Therefore, Model 7 was discarded.

Model 8: Log-gross migration rates, principal component analysis

Finally, we performed PCA on the compilation matrix of all log-pseudo in-migration and out-migration rate time series.[26] Like for the approaches explained earlier, a forecast model was fit to the time series of the first PC (which explained over 54% of the variance in the 9,504 variables over the 1996–2014 period). The past course and forecast are illustrated in Figure A.3.

26 Again, we ensured non-negativity among eventual simulations in this way.

The prediction was computed by the following forecast function:

$$E[P^8_{1,y}|P^8_{1,2014}] \approx 70.554 - 61.548 \frac{\exp\left(\frac{y-2000}{4.854}\right)}{1+\exp\left(\frac{y-2000}{4.854}\right)} + r^8_{2014},$$
$$y = 2015, 2016, \ldots, 2019. \tag{A.15}$$

The parameters are similar to the previously presented PC-based approaches. Here again, the remaining PCs do not exhibit clear trending behavior, and are therefore expected to remain constant at their 2014 levels over the forecast horizon.

Comparison of the forecast performance of the candidate models

Since units and dimensions of the predictions depend on the underlying model (net versus gross migration or flows versus rates), we applied a relative measure of forecast accuracy. Additionally, the dataset covered zero values of gross migration. To account for these specifics of the data, we compared the models via their *ex-post symmetric mean absolute percentage error* (SMAPE). Chen et al. (2017) defined the SMAPE as

$$SMAPE := \frac{1}{n} \sum_t \frac{2|e_t|}{|Y_t| + |F_t|}, \tag{A.16}$$

with Y_t being the observation for some variable Y at time t, F_t being its forecast based on some model for the same period, and e_t being the difference between Y_t and F_t. Using the SMAPE not only provides the desired properties, i.e., a relative measure that allows for zero values; it also avoids a high level of asymmetry among the forecast errors, which could appear for denominators close to zero (Chen et al., 2017).

Table A.1 gives a short presentation of the model approaches with their respective SMAPEs. The results of our backtests indicated a poor predictive performance of Model 3, which extrapolated past trends in net migration flows. PCA of pseudo net migration rates did not give additional insights compared to the rather simple models (1, 2A, 2B, 5, 6A, 6B) that were based on pre-stated assumptions about the development of migration. Notably, Models 2A, 2B, 6A and 6B performed significantly worse than the naïve Models 1 and 5, with the rate model having a slightly lower SMAPE than the flow model. According to our measure, the PC-based models that distinguished between in- and out-migration were superior, with Model 4 having the best forecast performance overall. Thus, Model 4 was used for the following forecast in the present study.

Table A.1:
Model summaries with forecast accuracies

Model	Input variables	Dimensions	Target variables	Method	SMAPE
1	Gross migration	396 Districts 6 Age groups 2 Genders In- and out-migration	Gross migration	Naïve prediction of all district-, age- and gender-specific migration flows	7.63%
2A	Gross migration	396 Districts 6 Age groups 2 Genders In- and out-migration	Gross migration	All district-, age- and gender-specific migration flows assumed to take their respective annual means from 1995–2019 in the forecast	14.23%
2B	Gross migration	396 Districts 6 Age groups 2 Genders In- and out-migration	Gross migration	All district-, age- and gender-specific migration flows assumed to take their respective annual medians from 1995–2019 in the forecast	15.16%
3	Net migration	396 Districts 6 Age groups 2 Genders Net migration	Principal components of net migration	PCA on covariance matrix of district-, age- and gender-specific net migration flow time series matrix Forecast function fit for first PC; naïve prediction of remaining PCs	44.88%
4	Log-gross migration	396 Districts 6 Age groups 2 Genders In- and out-migration	Principal components of log-gross migration	PCA on covariance matrix of logarithmized district-, age- and gender-specific gross migration flow time series matrix Forecast function fit for first PC; naïve prediction of remaining PCs	1.27%
5	Gross migration rates	396 Districts 6 Age groups 2 Genders Pseudo in-migration rates and out-migration rates	Gross migration rates	Naïve prediction of all district-, age- and gender-specific (pseudo) migration rates	7.4%

Continued

Table A.1: Continued

Model	Input variables	Dimensions	Target variables	Method	SMAPE
6A	Gross migration rates	396 Districts 6 Age groups 2 Genders Pseudo in-migration rates and out-migration rates	Gross migration rates	All district-, age-, and gender-specific (pseudo) migration rates assumed to take their respective annual means from 1995–2019 in the forecast	14.06%
6B	Gross migration rates	396 Districts 6 Age groups 2 Genders Pseudo in-migration rates and out-migration rates	Gross migration rates	All district-, age- and gender-specific (pseudo) migration rates assumed to take their respective annual medians from 1995–2019 in the forecast	14.73%
7	Pseudo net migration rates	396 Districts 6 Age groups 2 Genders Pseudo net migration rates	Principal components of pseudo-net migration rates	PCA on covariance matrix of district-, age- and gender-specific pseudo net migration rate time series matrix Naïve prediction of all PCs	Discarded due to lack of trends identified by PCA
8	Log-gross migration rates	396 Districts 6 Age groups 2 Genders Pseudo in-migration rates and out-migration rates	Principal components of log-gross migration rates	PCA on covariance matrix of logarithmized district-, age- and gender-specific pseudo migration rate time series matrix Forecast function fit for first PC; naïve prediction of remaining PCs	2.96%

Appendix B. Inclusion of territorial reforms and lack of data in Germany since 1995 in the model

Time	Change in raw data	Data preparation
1998	No data before 1998 available for Eisenach city (16056)	Computation of data before 1998 as differences between inter-district migration data for all Thüringen districts from totals for Thüringen
1998	Kreisreform Sachsen: • Merging of various districts • Renaming of statistical regions: ∘ Chemnitz: 141 → 145 ∘ Dresden: 142 → 146 ∘ Leipzig: 143 → 147	All old district definitions discarded; district definitions since 1998 available for whole period in the raw data
2007	Redefinitions of Sachsen-Anhalt districts: • Halle city: 15202 → 15002 • Magdeburg city: 15303 → 15003 • Altmarkkreis Salzwedel: 15370 → 15081 • Landkreis Stendal: 15363 → 15090	Old definitions changed to new ones before 2007
2007	Mergers of Sachsen-Anhalt districts: • Bördekreis (15355) and Ohrekreis (15362) → Landkreis Börde (15083) • Kreis Mansfelder Land (15260) and Kreis Sangerhausen (15266) → Landkreis Mansfeld-Südharz (15087) • Kreis Merseburg-Querfurt (15261) and Saalkreis (15265) → Saalekreis (15088)	Aggregation of data before 2007 to new definitions
2007	• Redefinition of Burgenlandkreis: 15256 → 15084 • Integration of Landkreis Weißenfels (15268) into 15084	Aggregation of 15256 and 15268 before 2007 into 15084
2007	Mergers and separations of Sachsen-Anhalt districts: • Merger of Landkreis Bitterfeld (15154) and Landkreis Köthen (15159) → Landkreis Anhalt-Bitterfeld (15082) • Merger of Landkreis Halberstadt (15357), Landkreis Quedlinburg (15364), and Landkreis Wernigerode (15369) → Landkreis Harz (15085) • Merger of Kreis Bernburg (15153) and Kreis Schönebeck (15367) → Salzlandkreis (15089) • Landkreis Anhalt-Zerbst (15151) divided into Dessau-Roßlau city (15001), Landkreis Anhalt-Bitterfeld (15082), Landkreis Jerichower Land (15086), and Landkreis Wittenberg (15091) • Landkreis Aschersleben-Staßfurt (15352) divided into Landkreis Harz (15085) and Salzlandkreis (15089)	No one-to-one distribution to new borders possible; thus, aggregation of all districts to pseudo-district 150018285868991

Continued

Appendix B. Continued

Time	Change in raw data	Data preparation
2008	Separate reporting of data of city of Hannover and Hannover region without Hannover city	Separate time series before 2008 cannot be constructed; thus, data since 2008 cumulated to total Hannover region, according to old definition
2009	Merger of Aachen city (05334002) and Kreis Aachen (05354) to Städteregion Aachen (05334)	Computation of data since 2009 to old definitions by subtracting 05334002 from 05334
2011	Mergers of Mecklenburg-Vorpommern districts: • Landkreis Bad Doberan (13051) and Landkreis Güstrow (13053) → Landkreis Rostock (13072) • Hansestadt Stralsund (13005), Landkreis Nordvorpommern (13057), and Landkreis Rügen (13061) → Landkreis Vorpommern-Rügen (13073) • Landkreis Ludwigslust (13054) and Landkreis Parchim (13060) → Landkreis Ludwigslist-Parchim (13076)	Aggregation of data before 2011 to new definitions
2011	• Redefinition of Landkreis Nordwestmecklenburg: 13058 → 13074 • Integration of Hansestadt Wismar (13006) into 13074	Aggregation of 13058 and 13074 before 2011 into 13074
2011	Mergers and separations of Mecklenburg-Vorpommern districts: • Hansestadt Greifswald (13001), partially Landkreis Demmin (13052), Landkreis Ostvorpommern (13059), and Landkreis Uecker-Randow (13062) → Landkreis Vorpommern-Greifswald (13075) • Neubrandenburg city (13002), partially Landkreis Demmin (13052), Landkreis Mecklenburg-Strelitz (13055), and Landkreis Müritz (13056) → Landkreis Mecklenburgische Seenplatte (13071)	No one-to-one distribution to new border possible; thus, aggregation of all districts to pseudo-district 1307175
2016	• Redefinition of Landkreis Göttingen: 03152 → 03159 • Integration of Landkreis Osterode am Harz (03156) into 03159	Aggregation of 03152 and 03156 before 2016 into 03159

Approaches to boundary change incorporation

The table above gives a comprehensive overview of the boundary changes underlying the dataset used for the empirical analysis. We applied a rather simple method that sought to obtain consistent time series throughout the period under consideration (1995–2019) by either relying on outdated boundaries or merging districts. We acknowledge that there is an established literature offering a variety of approaches to obtaining missing year-district (or another level of geographical disaggregation) observations, which strongly depends on the corresponding use case. Interested readers may start with examples such as Martin et al. (2002), Norman et al. (2003) or Logan et al. (2021).

Appendix C. Estimation of age- and sex-specific migration before 2002

As indicated in Section 3, for districts in 15 of the 16 federal states, age-specific but no gender-specific migration data are available in the pre-2002 data. To address this gap, we took annual age- and gender-specific data on district-level gross migration flows (Statistische Ämter des Bundes und der Länder, 2022) for 2002–2019. Based on these data, we constructed time series for migration flows by age group and gender for each district for in- and out-migration. To account for differences in the migration patterns between the genders and to retrieve the maximum of information from the data, we computed the annual shares of males among all migrants for each age-district stratum for 2002–2019:

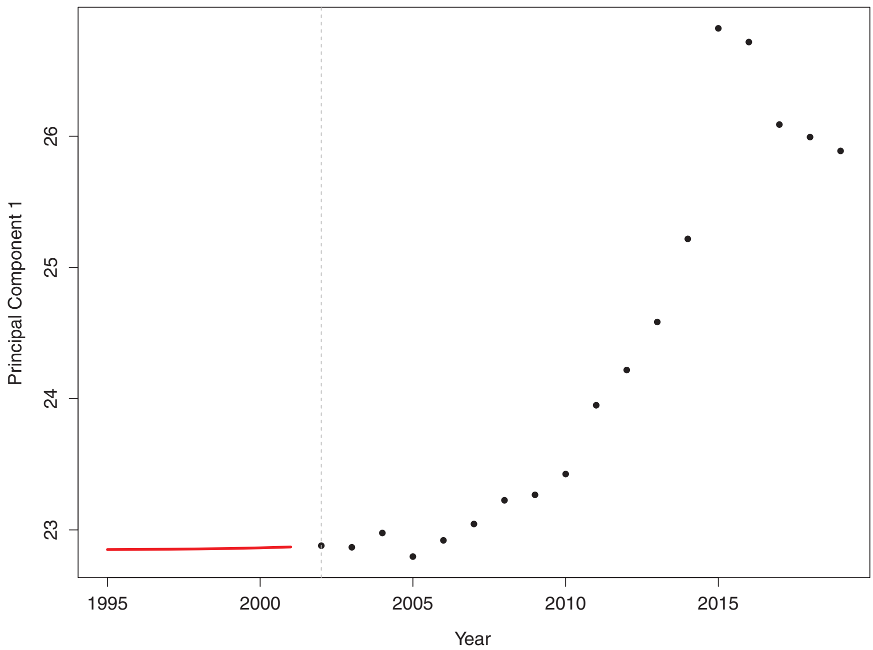
$$s_{d,a,z,y} := \frac{M_{d,a,m,z,y}}{M_{d,a,z,y}}, \tag{A.17}$$

With $M_{d,a,m,z,y}$ being the number of male migrations from or to district d in age group a for migration type z in year y, and $M_{d,a,z,y}$ being the corresponding total migration number for both genders.

The data were highly dimensional (4,596 time series), and the time series were highly correlated. Again, we applied PCA to deal with both problems. Figures C.1 and C.2 show the time series of the first two PCs. Those time series explained 55.7% of the total variance in the male share time series.

The red lines show the backcasts derived from time series models that were constructed as linear combinations of a mathematical trend function (exponential trend between 2002 and 2015 for the first principal component and the logistic trend between 2002 and 2010 for the second principal component) and a random walk model each. The remaining PCs did not show clear trending behavior, and were therefore assumed to be random walks. The backcasts of the PCs were then retransformed into backcasts of the male migration shares for each age group and district. We derived the shares of men and women among all migrants per age-district

Figure C.1:
Time series of Principal Component 1 of male shares in district migration with backcast

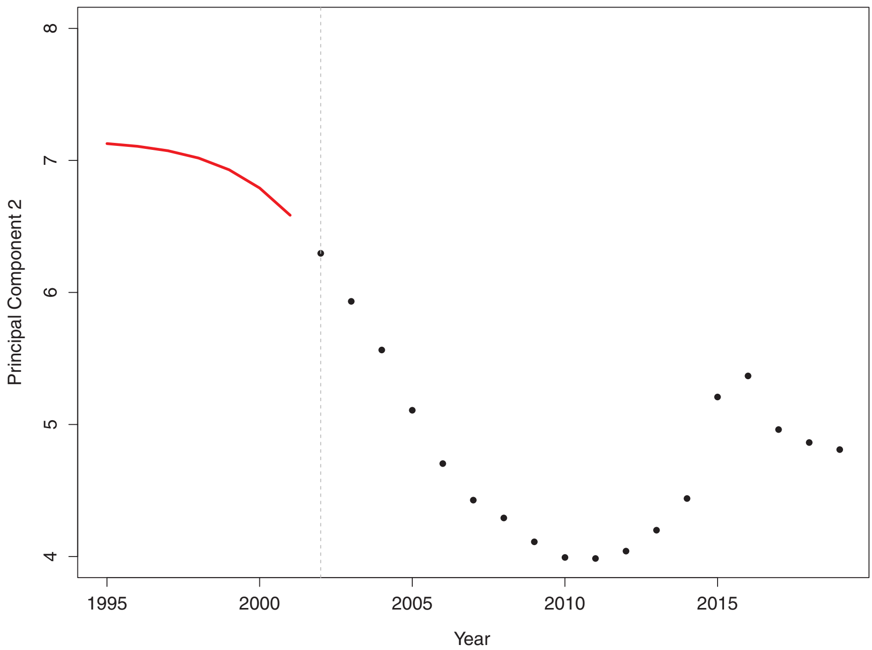


Source: Authors' computation and illustration.

stratum and year by multiplying the corresponding backcast of the male share, and its inverse, by the total migration for the given age-district stratum.

Supplementary Files S2 and S3 (available at https://doi.org/10.1553/p-5pn2-fmn8) offer the annual migration flows for the years 1995–2019 and the corresponding (pseudo) migration rates through 1996–2019, by age, gender, direction and district, respectively, in matrix form for further use. The data before 2002 are our backcast estimates as described above.

Figure C.2:
Time series of Principal Component 2 of male shares in district migration with backcast



Source: Authors' computation and illustration.

DATA & TRENDS

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Depopulation in Moldova: The main challenge in the context of extremely high emigration

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Abstract

In Moldova, there has been a long-term decline in the population, mainly due to high levels of emigration. The article presents an analysis of population dynamics in Moldova over the last three decades, and estimates the contributions of fertility, mortality and migration to this process. Using population censuses, data on the population with usual residence, vital statistics and data on Moldovan immigrants from the host countries' statistical institutes, we estimate population changes between 1991–2021, and present demographic projections up to 2040. The results show that migration outflows account for more than 90% of the depopulation trend, with high levels of premature mortality accelerating the natural decline. The fall in births is associated with a decrease in the reproductive-age population. The total fertility rate has been decreasing gradually, while the cohort fertility rates have not fallen below 1.75 live births per woman. Past migration and low fertility are projected to result in long-term population decline. Demographic ageing is expected to increase. While population decline cannot be stopped, its scale can be limited through reductions in emigration and mortality. This study on population decline in Moldova helps to complete the demographic picture of Europe in the 20th century and into the 21st century.

Keywords: depopulation; fertility; mortality; migration; demographic projection; Moldova

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1 Introduction

Over the past two decades, Moldova has been experiencing an ongoing decline in population due to massive levels of emigration and natural decrease. This trend has, in turn, led to a number of economic, social and political shifts that have undermined the country's development opportunities and its security (Tabac and Gagauz, 2020). Population decline is occurring in 17 of 48 European countries, most of which are located in Eastern and Southern Europe (Newsham and Rowe, 2022). In Eastern Europe, migration has become the key factor in the overall population dynamics of the region (Sobotka and Fürnkranz-Prskawetz, 2021). Scholars have observed that when population decline is driven by out-migration, natural decrease intensifies due to the deterioration of the age-sex structure, as most international migrants are young (Gagauz et al., 2021; Mihaiu, 2020). At the same time, scientists believe that depopulation is difficult to reverse, especially in the countries experiencing significant international migration and human capital losses (Lutz and Gailey, 2020).

Due to its geographic position bordering Romania to the west and Ukraine to the east, Moldova has been experiencing high levels of outward migration to both the west and the east (Poalelungi et al., 2017). Currently, more than one million Moldovan citizens are living abroad (about 26% of the population). Levels of labour and of youth emigration are particularly high in Moldova (Gagauz et al., 2021).

The demographic trends in Moldova are similar to those in Romania and Bulgaria, which are also facing depopulation over the long run, mainly as a result of high levels of emigration to more developed EU countries (Ghețău, 2014; Koyama, 2018; Pop et al., 2021). According to a 2019 Eurostat demographic projection, in the decades to come (up to 2050), Romania and Bulgaria will be the EU countries most affected by depopulation, with a population decrease of at least 20% (Eurostat, 2021). It is, however, worth mentioning that in recent years, the Romanian state has been introducing active policies aimed at encouraging Romanian emigrants to return, and at attracting workers from other countries, including Moldova (Goga, 2020).

This paper provides an overview of Moldova's population dynamics during the last three decades, and analyses the dimensions and the determinants of the country's population decline. The main contribution of this work is that it adds to the existing knowledge about population and demographic processes in Moldova, and thus helps to complete the demographic picture of Europe in the 20th century and into the 21st century, as Moldova has not been included in most comparative analyses related to Eastern Europe.

The paper is organised as follows: First, a brief description of Moldova's socio-economic and cultural context is provided. Second, the quality of the available population data is discussed, and the research methods used in the analysis are described. The main results section contains subsections that outline the population dynamics in Moldova over the last three decades, including the impact of migration, fertility and mortality on depopulation, as well as demographic projections for the 2019–2040 period. The paper ends with a discussion and a presentation of conclusions.

2 Moldova’s socio-economic and cultural context

Since Moldova proclaimed its independence in 1991, it has undergone a significant political, economic and cultural transformation. It has transitioned from having a highly centralised, planned economy to having an open, market-based economy; and from having an authoritarian government to being an open democracy. This three decade-long transition has been a complicated process involving gradual economic restructuring and slow growth, high levels of indebtedness and widespread losses of savings. Economic and social crises, domestic political instability and the country’s territorial disintegration due to the armed conflict in the Transnistrian region in 1992 have negatively impacted the country’s socio-economic and demographic development. While the situation improved during certain periods, Moldova has so far failed to make a significant economic breakthrough, and to secure the financial well-being of the country’s population. Due to the robbery of three large banks in Moldova in 2014, the country lost $1 billion (Varzari, 2020), which caused enormous damage to its economy. In 2020, Moldova’s GDP per capita was just 4551 US dollars, which places it among the poorest countries in Europe. Currently, almost every fourth person living in Moldova has an income below the poverty line, according the poverty headcount ratio based on the national poverty line (World Bank, 2022). Thus, labour migration and remittances have become essential resources for many Moldovan families. Among households in rural areas, remittances represent, on average, one-quarter of total income (Le Heron and Yol, 2019). The long-term effects of these developments are negative, as they are leading to population decline, a decrease in the working-age population, the loss of educated young people and a lack of skilled workers.

Moldova is a multi-ethnic country, with the largest share of the total population identifying as Moldovan/Romanian (80.6%). Slavic ethnic groups (Ukrainians, Russians and Bulgarians) make up 12.4% of the population, while Gagauz people (Turkic people) make up 4.5% of the population, and other ethnic groups account for 2.5% of the population. Over 90% of the country’s population identify as Orthodox (National Bureau of Statistics of the Republic of Moldova, 2017). In addition to Romanian, which is the state language, Russian is spoken throughout the country.

In terms of its political alignment, Moldova is balanced between the European Union and Russia. In 2014, the EU–Moldova Association Agreement was signed, granting Moldovan citizens the right to visa-free travel in the Schengen area. At the same time, Russia influences Moldova in the political and economic domains. Moldovan society is separated into those who support European integration and those who favour strengthening relations with Russia.

3 Data and methods

Similar to other countries with high levels of outward migration, Moldova has faced difficulties in fully accounting for emigration in its official statistics. Thus, for a long period of time, Moldova's demographic data did not paint an accurate picture of the country's demographic trends (Penina et al., 2015).

The data from the last Union census in 1989 were used as a benchmark for population calculations in Moldova's first decade of independence. As the territorial mobility of the population has increased considerably since the 1990s, accounting for migration has become problematic. Since 1998, Moldova has not provided the data for Transnistria to the National Bureau of Statistics (NBS) because it lost control over this region. At the same time, the country's lack of control over the borders in Transnistria has made recording migratory flows more difficult.

The data from the population census of 2004 were used only to calculate the total number of residents in the population, while the recalculations by age and sex for the period between the two censuses (1989 and 2004) were not made.

In the calculation of population numbers, a central problem was estimating the net migration level, which was done by using the special form of migrant registration as the data source. Moldovan citizens were included in the statistics as emigrants only if they deregistered from their place of permanent (official) residence, with these individuals being mentioned in the official statistics as cases of "documented" emigration. Citizens who went abroad to work for an extended period of time (12 months or more), but who retained their permanent residency in Moldova, were considered temporary emigrants or labour migrants. Thus, the total population of Moldova covered all citizens, including those who went abroad but were not removed from the register of permanent residents (*de jure population*). As all socio-economic and demographic indicators were calculated for the *de jure population*, these indicators were significantly distorted, with some being underestimated, and others being overestimated.

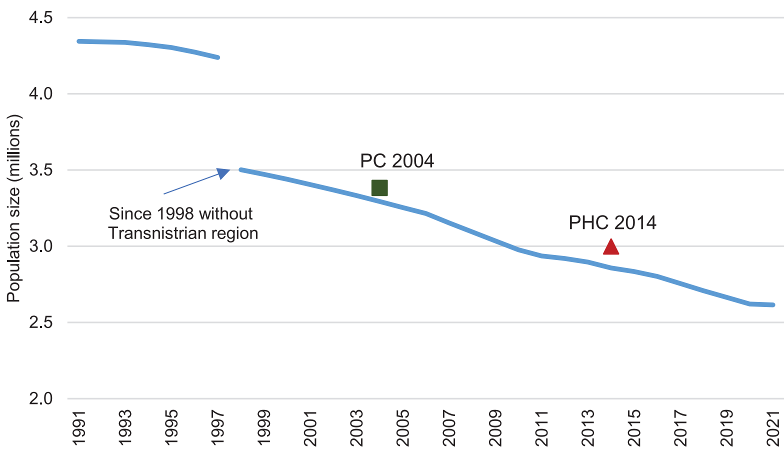
In 2015, Penina et al. (2015) recalculated the Moldovan population with *usual residence* for the years 1980–2015 by excluding Moldovan citizens who were long-term migrants (living abroad for 12 months or more). While the difference between the two data series (NBS and recalculated alternative data) was about 1% in the early 1990s, it had reached 18% by 1 January 2015. These data appear to be quite reliable, and the authors' comparison of their data with the data of two population censuses (2004 and 2014) shows that their data series were close to those of the population census (PC) of 2004 and the population and housing census of 2014 (PHC) (Figure 1). The NBS has been counting the population with usual residence since 2014 based on the population and housing census.

In this study, data on the population with usual residence for 2014–2021 from the NBS and data on the population exposed to risk for the 1991–2013 period (Penina et al., 2015) were used. All demographic indicators on fertility, mortality and migration were calculated for the population with usual residence.

The migration data were drawn from several data sources. The data on Moldovan immigrants came from statistical institutes of the host countries and from the NBS, which helped to ensure the accuracy of the findings. International migration was analysed using foreign data sources for the 1989–2013 period, and using data from the NBS for the 2014–2019 period. Long-term migration was analysed based on the

UN definition of residing more than 12 months abroad. For most EU countries, the US and Canada, the data refer to residence statistics.

Figure 1:
The average annual population with usual residence, 1991–2021



Source: for 1991–2013, estimates are based on Penina et al. (2015); for 2014–2021, estimates are based on data on the population with usual residence from the NBS; for PC 2004 and PHC 2014, estimates are based on census data.

The following databases were consulted: the OECD International Migration Database; Eurostat Population Statistics (statistics on migration); the Federal State Statistics Service of Russia; the State Statistics Service of Ukraine; the National Statistical Institutes of Italy, Portugal and Spain; and the National Bureau of Statistics of Moldova. Migration flows to and from Israel were estimated using data from the Israel Central Bureau of Statistics, as published by demographer Tolts (2020). All these data allowed us to determine the dynamics and the size of migration flows over the last 30 years, which, in turn, enabled us to estimate net migration, net migration rates and age-specific net migration rates.

The analysis of fertility covered the 1991–2021 period, and the data on the number of births by the mother's age from the NBS were used. The fertility investigation focused on two forms of demographic analysis: period and cohort fertility quantum trends. These were investigated using the following indicators: total fertility rate (TFR), age-specific fertility rates (ASFR), adjusted TFR, period mean age of women at first birth (MAFB), period and cohort median age, complete cohort fertility rates and age-specific cohort fertility rates.

The analysis of the impact of mortality on depopulation in Moldova focused on the evolution of age-specific rates, as we considered them effective tools for providing an overview of the mortality level, given that they were less exposed to errors induced by the structure and the number of the population. The data on the numbers of death by sex and age from the NBS were used.

Table 1:
Scenarios of changes in fertility, mortality and migration up to 2040

Years	TFR	Life expectancy at birth, female	Life expectancy at birth, male	The net rate of migration, ‰
		Scenario I – low		
2018	1.82	75.0	66.3	–1.30
2040	1.70	77.2	68.5	–1.00
		Scenario II – medium		
2018	1.82	75.0	66.3	–1.30
2040	1.90	79.4	71.8	–0.50
		Scenario III – high		
2018	1.82	75.0	66.3	–1.30
2040	2.10	81.6	74.0	0.00

Source: Gagauz et al. (2021).

The paper presents demographic projections for 2019–2040 for Moldova (without Transnistria) based on the data on the population with usual residence in 2018 (Table 1).

4 Main results

4.1 Population dynamics 1991–2021

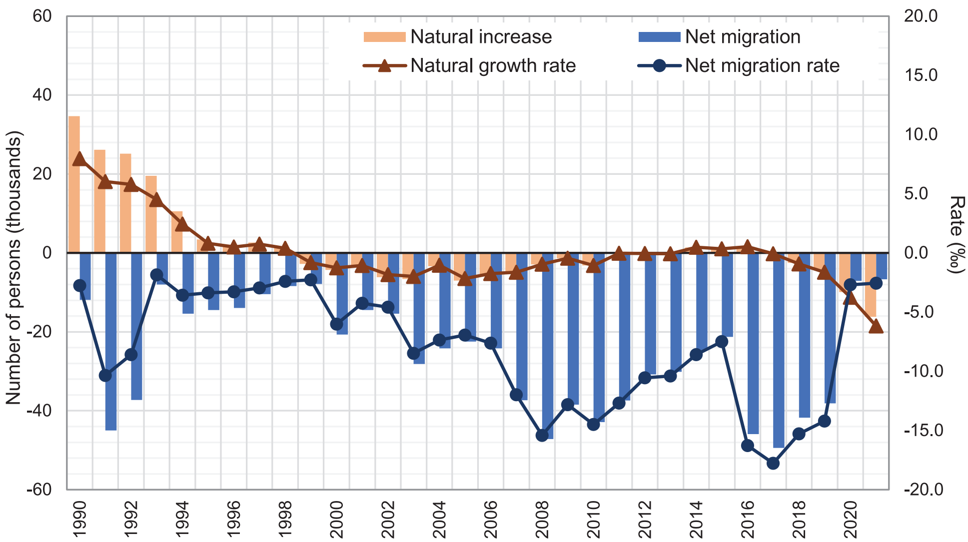
Depopulation has reached high levels in Moldova. In 1991, when Moldova became an independent state, the country's population, including the Transnistrian region, was 4364.1 thousand inhabitants (Table 2). Between 1991 and 1997, the population decreased by 46.6 thousand, mainly due to outward migration (136.2 thousand), which was only partially offset by natural growth (89.6 thousand). Since 1998, the population has been declining faster than in the previous period due to large-scale emigration and natural decline. In 1998, without the Transnistrian population of 665.7 thousand (Chivaciuc, 2014), the population was 3655.6 thousand. In the population census of 2004, the population was 3383.0 thousand, having fallen by 272.6 thousand, with a natural decrease of 25.5 thousand individuals accounting for 9.4% and the emigration of 247.1 thousand individuals accounting for 90.65% of the total decline. By the next census (population and housing, 2014), the decline in the population was significant, falling to 2869.2 thousand. Between 1998 and 2021, the total decrease in the population had reached over one million, with migration accounting for 92.0% of the decline. In 2021, during the COVID-19 pandemic, international migration decreased, and the share of the population decline that was attributable to migration shrank accordingly.

Table 2:
Population changes in Moldova during 1991–2021 and its components

Years	Population number (thou.)	Thousand people			%		
		Natural balance	Migration balance	Total balance	Natural balance	Migration balance	Total balance
1991	4364.1			–			
1997	4317.5	89.6	−136.2	−46.6	–	–	–
1998	3655.6	–	–	–	–	–	–
2004	3383.0	−25.5	−247.1	−272.6	9.4	90.6	100
2014	2869.2	−26.3	−487.5	−513.8	5.1	94.9	100
2020	2643.9	−15.1	−210.2	−225.3	6.7	93.9	100
2021	2615.2	−16.2	−6.7	−22.9	70.7	29.3	100
1998–2021		−83.1	−951.5	−1034.6	8.0	92.0	100

Note: Since 1998 without Transnistria region.
Source: Calculated for 1991–1997 based on NBS data; for 1998 based on data from Penina et al. (2015); for 2004 based on data from the population census; for 2014–2021 based on NBS data on the population with usual residence.

Figure 2:
Natural increase, net migration and their rates in 1991–2021



Note: Migration growth and the migration growth rate were estimated based on sources from the migrants' destination countries (1990–2013) and NBS data on international migration (2014–2019).
Source: Calculated based on host country data, NBS data and data from Penina et al. (2015).

The data on natural and migratory growth (Figure 2) show the oscillations of these indicators over the 1991–2021 period. In the first decade after independence, the prevalence of births over deaths was determined by the population structure, with young people accounting for a large share of the population, and older people making up a small share of the population. A negative natural increase was recorded for the first time in 1999. The natural decline of Moldova's population over the 1999–2010 period ranged from −0.8‰ to −2.2‰. Between 2011–2016, there was a positive natural increase, with insignificant values up to 0.5‰, thanks to the growth in the reproductive-age population, i.e., the generations born in the mid-1980s, and the number of births. Natural decrease began to rise in 2017, and increased sharply during the COVID-19 pandemic, to −3.8‰ in 2020 and to −6.3‰ in 2021.

Negative net migration can be observed over all three decades (Figure 2). The particularly high levels of net migration in 1991–1992 reflect the large flows of emigrants to Israel. For the period between 1993 and 2000, the indicator is low due to high levels of illegal migration (Mosneaga, 2013). Migration has been increasing since 2000–2003 due to the amnesties implemented in Southern Europe, and since 2007 as a result of family reunifications that followed these amnesties. Since 2014, a new wave of emigrants to Western European countries has been emerging. The net number of outward migrants was slightly more than 200 thousand in 2007–2011, and was 220 thousand in 2014–2019. The net migration rates for the two periods were between 12–15‰ and 9–18‰, respectively. In 2020 and 2021, during the COVID-19 pandemic, the net migration rate declined to 3–2.5‰.

4.2 Out-migration is the main cause of depopulation

The first migratory flows from Moldova began in the late 1980s, and consisted mainly of ethnic minorities, including Jews, Germans, Russians and Ukrainians, who were often encouraged to emigrate through the repatriation programs of the origin countries. Between 1989 and 1995, the number of ethnic migrants reached 176.4 thousand. The main destination countries were Israel, Russia, Ukraine, Germany and the USA.

While ethnic migration had largely ended by the mid-1990s, Moldovan citizens were starting to migrate in search of work and to earn money abroad. Due to restrictive migration policies in most EU countries, the largest flow of Moldovan workers during this period was to the Russian Federation and the Commonwealth of Independent States (CIS). Labor migration to the EU was significantly lower, and was mainly clandestine. Most illegal migrants from Moldova were in Southern European countries (Mosneaga, 2013).

Since 2000, migratory flows have changed their trajectories and characteristics. Labor migration to Europe has been increasing substantially, and the length of time Moldovans are staying in the host countries has been rising as well. At the same time, the first stocks of migrants have been emerging. The levels of migration to the EU have been increasing due to the amnesties offered to Moldovan citizens who were living illegally in countries like Italy, Spain and Portugal, and to the family reunifications that followed (Tabac and Gagauz, 2020). The number of emigrants in the 2000–2010 period exceeded 400 thousand, about 60% of whom emigrated to Italy or to Russia.

Our estimations based on data from the OECD international migration database, the Russian Federal State Statistics Service, the State Statistical Service of Ukraine and Israel Central Bureau of Statistics (Tolts, 2020) show that in Moldova over the study period, migration flows were segmented in two directions: towards the Russian Federation and towards Italy (Table 3).

These two countries hosted up to two-thirds of annual migration flows from Moldova in some years. Currently, these two countries host the most extensive stocks of Moldovan emigrants. Russia has become the main emigration destination for male workers, while women often migrate to Italy. During different periods, women who went to work in Italy accounted for 70–80% of the total number of Moldovan emigrants, while men who went to work in Russia accounted for about 70% of the total.

Although migration for temporary work was the most common form of migration in the first two decades of the study period, in the last decade, migration for settlement was increasing as well.

Table 3:
Long-term migration from Moldova and the main destinations of emigrants, in thousands

Country/Year	1989–1995	1996–2000	2001–2006	2007–2010	2011–2019
Russia	121,3	63	41,6	57,9	259,3
Israel	39,6	7,7	2,8	0,8	1,4
Italy	0,5	1,9	49,1	78,4	47,4
Ukraine	–	4,4	23,3	17,1	19,7
USA	8,5	5,8	13,4	7,3	21,1
Canada	0,6	1,2	3,8	5,7	8,3
Spain	–	0,8	10,9	7,9	7,9
Germany	5,8	9,8	7,1	2,9	34,5
Czech Republic	–	0,2	7,3	8,4	3,7
Portugal	–	–	10,9	7,1	3,7
Other countries	–	1,3	7,8	7,3	10,5
Total	176,4	96,1	178,0	201,0	417,4

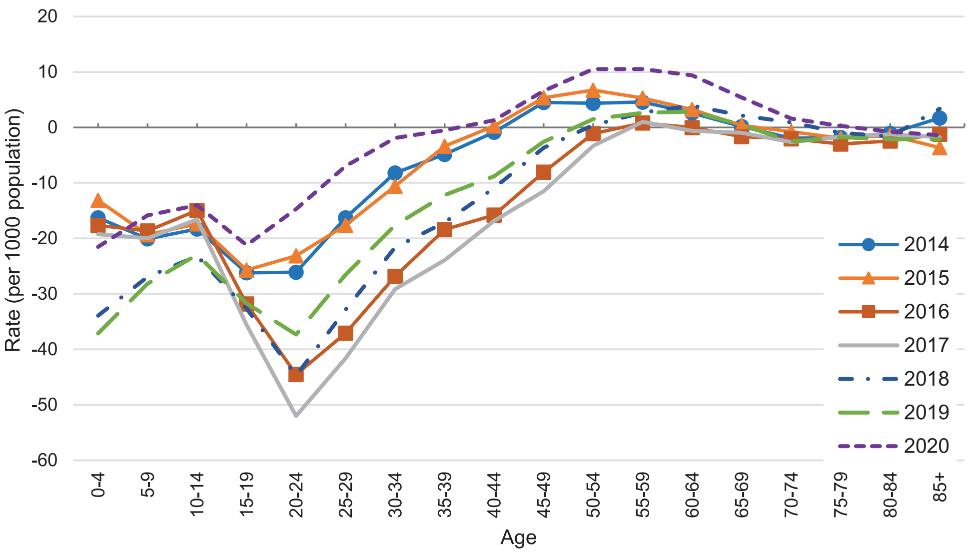
Source: Calculated based on data from the OECD international migration database, the Russian Federal State Statistics Service, the State Statistical Service of Ukraine and the Israel Central Bureau of Statistics (Tolts, 2020).

Recent trends in migration flows (over the last 10 years) point to a decrease in migration to Russia and Southern European countries, and an increase in migration to Western Europe, especially to countries such as Germany, France and the United Kingdom (Gagauz et al., 2021). Over the past decade, the ability of Moldovan citizens to acquire Romanian citizenship has played an essential role in the intensification of migration to other European countries (dual citizenship). Under art. 11 of the Romanian Citizenship Law no. 21 of 1 March 1991, all persons who had lived on Romanian territory since 1940 and their descendants up to the third generation have the right to acquire Romanian citizenship. Having access to Romanian citizenship has dramatically increased Moldovan citizens' opportunities to emigrate to other European countries, as it has facilitated legal migration for purposes of employment to all EU countries, and has granted them social protections and employment rights equal to those of European citizens. In particular, having access to Romanian citizenship has increased family migration to Germany, France and the United Kingdom.

High levels of long-term or permanent mass migration combined with low rates of return migration is a pattern specific to Moldova. The Moldovan migrant stocks calculated by the World Bank in *Bilateral Estimates of Migrant Stocks* in 2010, 2013 and 2017 show an upward trend. Globally, Moldovan migrant stocks were estimated at over 770 thousand in 2010; at about 860 thousand in 2013; and at 1025 thousand in 2017 (World Bank, 2017).

The recent trends show increasing migration among the population of reproductive and working ages. Levels of migration are especially high among young people aged

Figure 3:
Age-specific net migration rates in 2014–2020, per 1000 population



Source: Calculated based on NBS data.

15–34. The negative net migration in this age group has been estimated at 141.4 thousand, which represents just over 60% of the total net migration in the 2014–2020 period.

In 2014–2015, the group with the highest net outward migration rate was young people aged 15–24 years; with 25 out of 1000 people aged 15–24. In 2016–2017, the net outward migration rate of the 20–29 age group increased, to 37 and 52 out of 1000 people aged 20–24 and 25–29, respectively. In 2018–2019, the net outward migration rate was increasing not just among youth aged 20–29, but also among children aged less than 14. The net outward migration rate was highest in the 0–4 age group, with 34–37 per 1000 children aged 0–4. The restrictions related to the COVID-19 pandemic reduced the extremely high levels of migration: in 2020, a decrease in emigration at ages 15–34 and a positive increase in net migration at ages 40–70 was observed (Figure 3).

It may be assumed that a large share of the population of Moldova who are currently living abroad will not return to the country. It is difficult to estimate their number, but many emigrants of Moldovan origin and citizenship have lived in their destination country for 10, 20, and even 30 years. Many have retained their Moldovan citizenship even though they have also acquired the citizenship of their country of residence. More than one million Moldovan citizens have another citizenship as well (Tabac, 2019).

The number of people immigrating to Moldova is tiny. Thus, immigrants to Moldova neither offset the impact of the outflow of workers nor affect population growth in the country.

4.3 Impact of fertility on depopulation

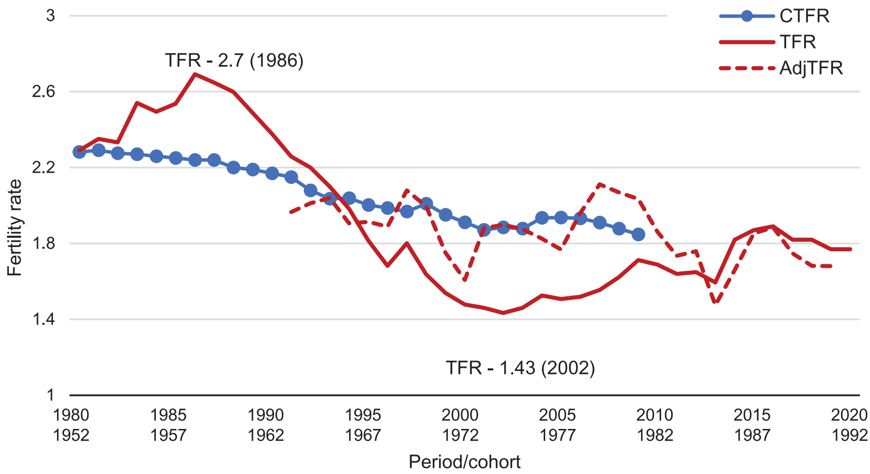
In 1991, Moldova had a relatively high total fertility rate compared to other countries, which ensured the replacement of generations (2.26 births per woman). However, in 1994, the TFR in Moldova dropped to less than two children per woman. In the following years, the TFR declined steadily, reaching a record low level of 1.43 live births per woman in 2002. Thereafter, however, fertility stabilised, and increased slowly as births that were postponed in the previous period were recuperated. In recent years, the TFR has, with some fluctuations, remained at a level of around 1.7 to 1.8 live births per woman. This level places Moldova among the countries with moderately low fertility, based on the benchmark proposed by Sobotka et al. (2019). Moreover, compared to other Eastern European countries, the TFR seems to be more favourable in Moldova, as it is significantly higher than the TFR in Belarus (1.45 in 2018) (National Statistical Committee of the Republic of Belarus, 2019) or in Russia (1.5 in 2019–2021) (Rosstat, 2022), even though these countries have had policies aimed at increasing fertility through financial incentives for more than a decade. At the same time, the TFR in Moldova is close to that of the neighbouring country of Romania, which has a TFR of 1.77 (Eurostat, 2019).

Period TFR in Moldova decreased continuously after 1991, which can be attributed in part to a compensatory decline after a period of significant fertility growth that was fostered by the pronatalist policies implemented in the Soviet Union in 1981, and in part to the impact of the worsening socio-economic situation in the country during the period following independence (Gagauz, 2018). The fertility postponement observed in Moldova starting in 1995 resulted in an increase in the mean age at first birth, which, in turn, led to a reduction in the TFR to 1.43 in 2002. However, the tempo- and parity-adjusted total fertility rate (adjTFRp) was higher in the 1995–2013 period (Figure 4). Despite these fluctuations, cohort fertility rates (CTFR) were decreasing gradually, but did not fall below 1.75 live births per woman, which is considered the threshold for "very low" fertility (Myrskylä et al., 2013; Zeman et al., 2018). The completed cohort fertility rate is 2.2 for women born in 1960, 1.94 for women born in 1970 and 1.88 for women born in 1980 (40 years old in 2020).

In Moldova, the early fertility model has persisted. While the mean age at first birth increased slightly from 21.9 in 1995 to 24.5 in 2020, it has remained significantly lower than in other Eastern European countries.

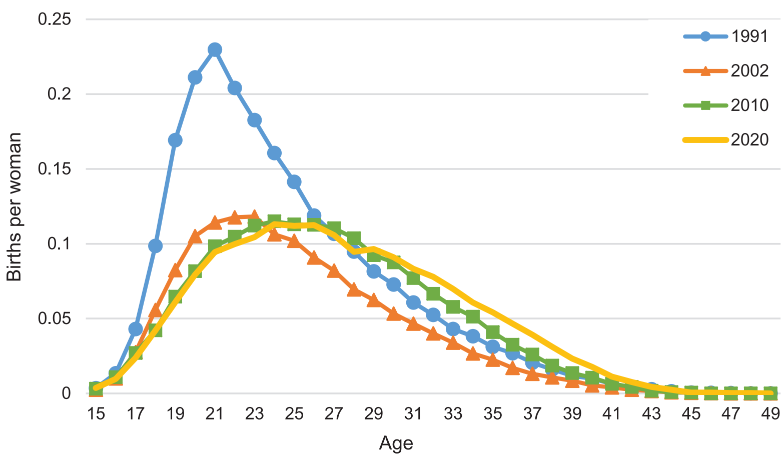
Over the past three decades, fertility rates have been rising faster among women between ages 25 and 40, whereas they have been decreasing among women in their early twenties. Thus, the mean age at childbirth has continued to rise. Delayed motherhood is a long-lasting trend that has changed the profile of the period age-specific fertility curve (Figure 5). The curve's shape lost its sharp top and shifted

Figure 4:
Total fertility rate (TFR) and tempo- and parity-adjusted total fertility rate (adjTFRp) during the 1980–2020 period, and completed cohort fertility rate (CTFR) of women born in 1952–1980



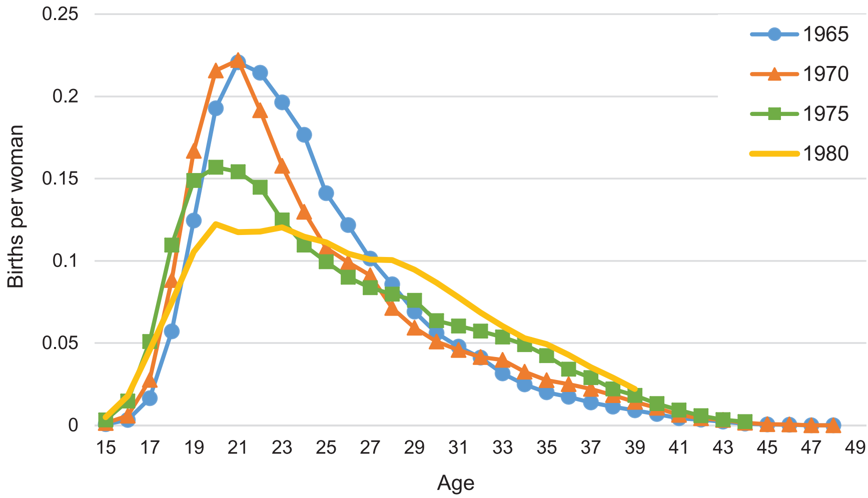
Note: Cohort fertility data displayed in the figure are shifted by 28 years, reflecting the mean age at childbearing in the 1960s–1980s. Since 1998 without Transnistria.
Source: Calculated based on NBS data.

Figure 5:
Period age-specific fertility rates, 1991, 2002, 2010, 2020



Source: Calculated based on NBS data.

Figure 6:
Cohort age-specific fertility rates of women born in 1965, 1970, 1975 and 1980



Source: Calculated based on NBS data.

to the right at older ages, and the period ASFR significantly increased at ages 25 and older. The median age at childbirth increased from 22.8 in 1991 to 26.3 in 2020. The cohort ASFR (Figure 6) underwent similar changes. Among women in the youngest cohort born in 1980 (40 years old in 2020), who were at their most active reproductive ages in the first decade of the 21st century, the ASFR reached its highest levels when they were between ages 20 and 25. The median age at childbirth was 22.9 for the cohort born in 1965 (CCFR-40), and was 24.9 for the cohort born in 1980 (CCFR-40).

In recent years, the number of births in Moldova has fallen significantly due to the drop in population numbers and the migration of the reproductive-age population. While the number of births in 2014 was 40.9 thousand, by 2020, it had declined to 30.7 thousand. The female population currently of reproductive age includes the relatively small generations born in the late 1990s and the early 2000s. Thus, the number of women of childbearing age (aged 15–49) in Moldova decreased from 714.4 thousand in 2014 to 608.4 thousand in 2020.

The COVID-19 pandemic had an insignificant impact on fertility. In 2021, the TFR (1.73) decreased by just 0.03 births per woman compared to 2020 (1.76). This may be because contraceptive usage fell by around 40% among couples with and without medium-term fertility intentions (Emery and Koops, 2021).

4.4 High mortality accelerates the natural decline of the population

Moldova is among the countries with high levels of mortality, in line with the pattern observed across the Eastern European region (Penina, 2021a; Vallin and Meslé, 2004). Male life expectancy in 2019 (66.6 years) was just one year higher than it was in 1965. Over the same period, female life expectancy increased by 5.0 years, reaching 75.0 years in 2019 (Penina et al., 2022). A high level of premature mortality, especially among men, results in a low level of life expectancy at birth (Pahomii, 2018), and a large gender gap (Penina, 2013).

In terms of life expectancy, Moldova lags behind the countries of Western Europe and the other former Soviet republics. A comparison of Moldova with Estonia and Sweden (Figure 7) shows a significant gap that has been increasing over time. In 1991, male life expectancy at birth in Moldova (64.4 years) was only 0.1 years lower than in Estonia (64.5 years), and was approximately 10 years lower than in Sweden (75 years). In 2021, male life expectancy at birth was 7.2 years lower in Moldova (65.2 years) than in Estonia (72.4 years), and was 16.2 years lower than in Sweden (81.4 years).

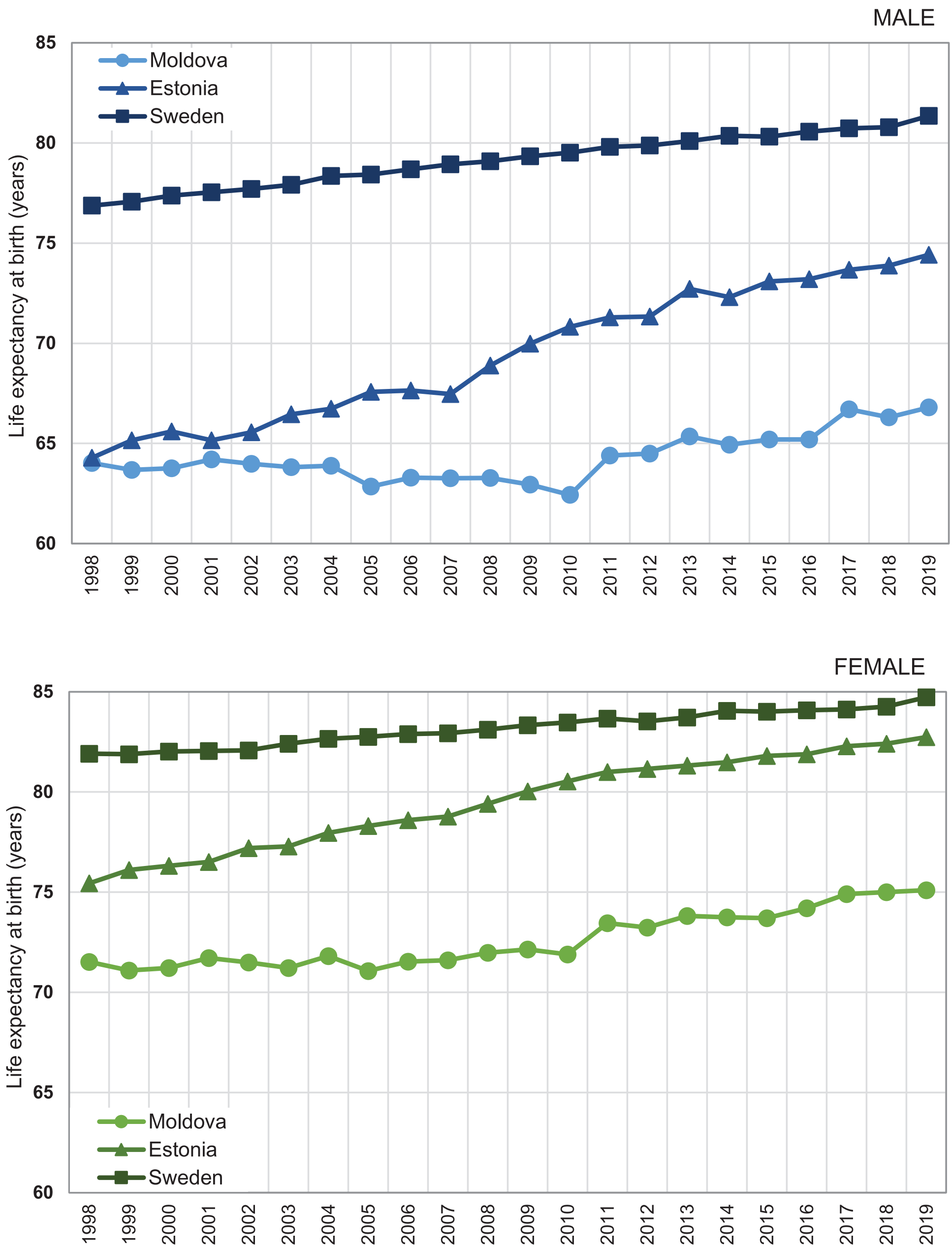
Among women in Moldova, mortality levels have been higher than in other European countries since the early 1990s, with Moldovan women having much lower life expectancy values than women in Estonia and Sweden. In 1991, female life expectancy at birth in Moldova (71.2 years) was 3.8 years lower than in Estonia (75 years) and 8.3 years lower than in Sweden (80.5 years). By 2021, the gap in life expectancy at birth between women in Moldova (73.1 years) and women in Estonia (81.3 years) had doubled to 8.2 years, while the gap between Moldovan women and women in Sweden (85 years) had increased to 11.9 years.

The COVID-19 pandemic led to a significant increase in mortality in both 2020 and 2021. Life expectancy at birth in Moldova dropped by 1.6 years for men and by 2 years for women in 2021 compared to 2019.

An analysis of the age-sex mortality patterns for 1991–2021 shows that the mortality profile did not change significantly over the past three decades (Figure 8). For both sexes, infant and child mortality rates declined the most (from ages one to 14 years among males, and from ages one to nine years among females). The reduction of infant mortality can have a large impact on the depopulation process, given that infant mortality represents the irreparable and immediate loss of population. Thus, reducing this indicator is of central importance (Anderson, 2002).

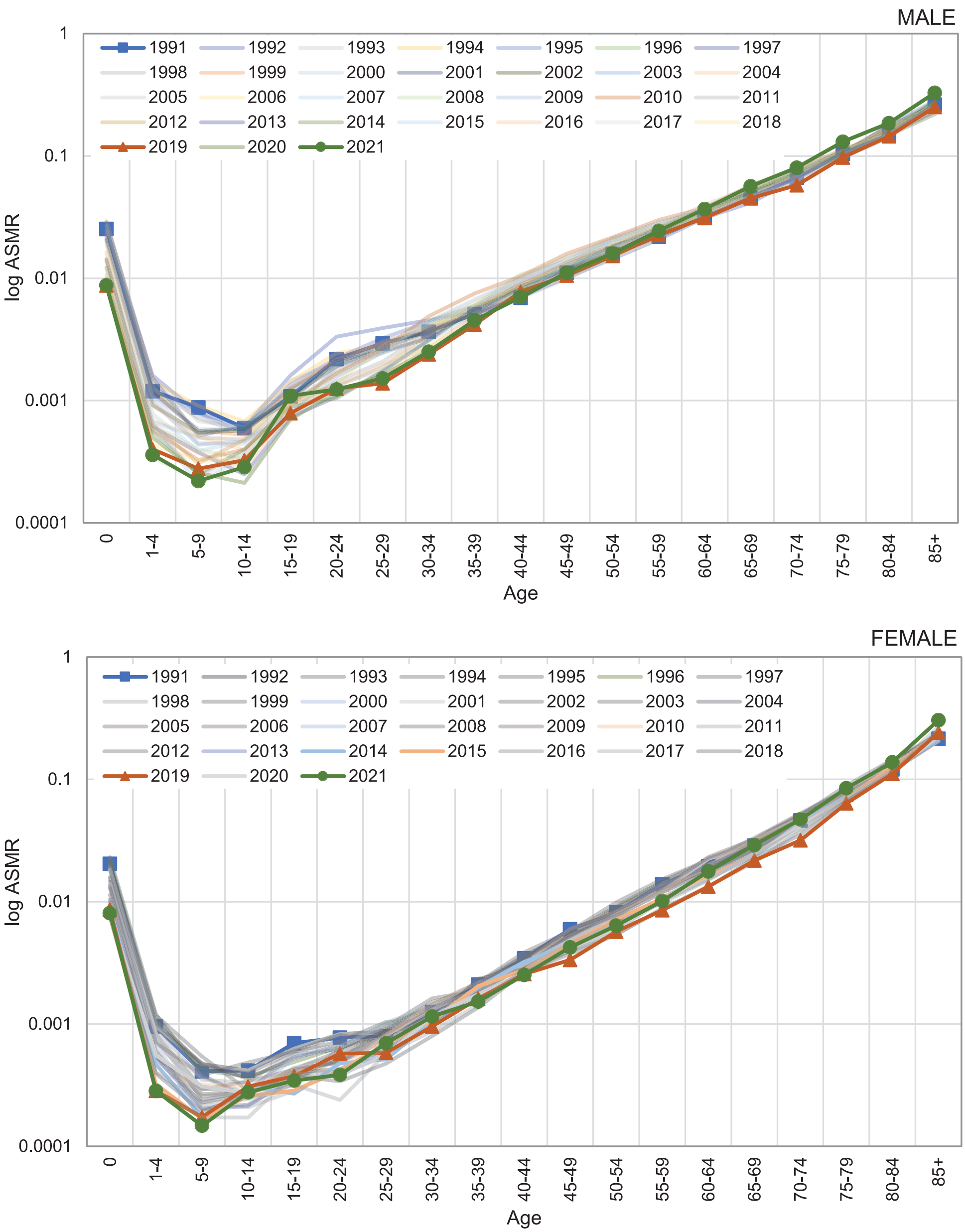
In the adult population, changes in mortality have been very modest, especially for men. A slight decrease in mortality was observed among males in the 15–39 age group, while mortality among men aged 40 and older remained at the same high level. Substantial reductions in mortality were found among women aged 40 and older, with the largest decrease being observed in the 45–64 age group. However, among the elderly population aged 65+, there was no significant decrease in mortality, especially among men. For women, the declining trend in mortality was continuous, and was especially pronounced in the 65–79 age group. A similar pattern, especially

Figure 7:
Life expectancy at birth by sex, Moldova, and some selected countries



Source: Calculated for Moldova based NBS data, and for Estonia and Sweden based on Human Mortality Database (1991–2019) and Eurostat (year 2020) data.

Figure 8:
Dynamics of the age-specific mortality rate (ASMR), by sex, 1991–2021



Source: Calculated based on NBS data.

in the age structure of mortality, has been detected across Eastern European and Balkan countries (Marinković and Radivojević, 2016).

During the COVID-19 pandemic, an increase in mortality was reported among males aged 65+ and among females aged 40+. The increase in mortality found among young males (aged 15–19) seems to be a statistical artefact due to small numbers, and does not represent a real increase in mortality in this age group. A recent study showed that the COVID-19 pandemic amplified premature mortality (Penina, 2021b).

In light of these findings, we can state that high mortality and its age and sex structure continue to be important elements of the process of depopulation. Low life expectancy and premature mortality lead to the loss of human lives, which, in turn, contributes to population decline.

4.5 Future trends

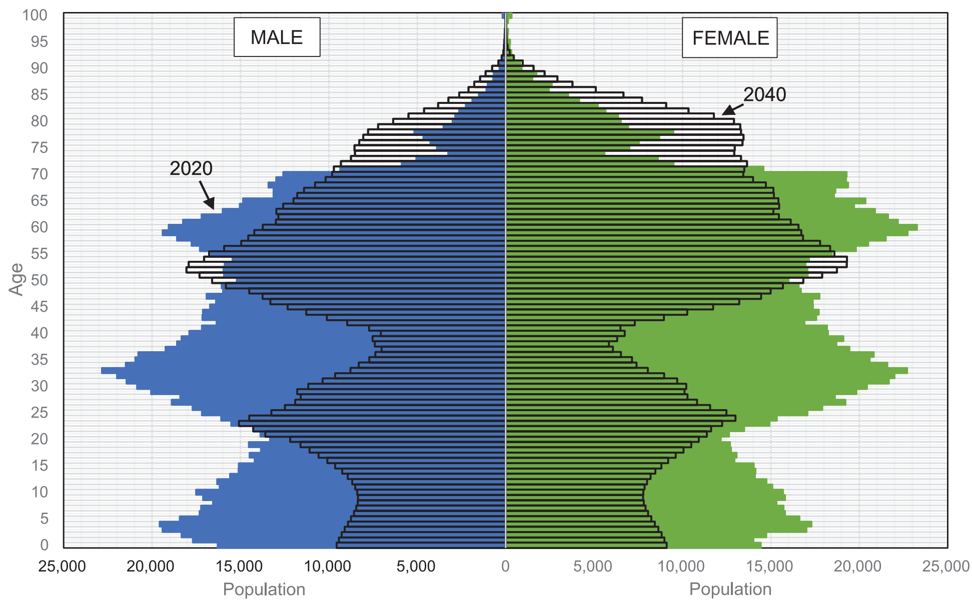
The demographic projections for 2019–2040 show (in an I-low most likely scenario) that in the coming decades, demographic decline will continue at a fast pace in Moldova, increasing annually from 1.6% to 2.3%; and the population will decrease by 34.5%, to 1754.6 thousand (Gagauz et al., 2021). This level of depopulation can be avoided only if fertility increases substantially, but mortality and emigration fall. According to the medium scenario, the population will decrease by 28.2% to 1924.9 thousand; while according to the high scenario, the population will decrease by 21.5% to 2094.5 thousand.

The age-sex pyramid (Figure 9) acquires an "hourglass" shape due to the high levels of migration among young people. The pyramid profile will "weaken" rapidly, gaining a "pinched waist" in the middle and a solid peak reflecting the presence of many old people. A significant shortage of young adults is projected due to the low birth numbers of people born in the late 1990s to early 2000s, many of whom are actively involved in migration. According to the I-low scenario, by 2040, when these cohorts reach ages 30–39, they will be the smallest group in the total population, with their share decreasing from 15.6% to 7.7%.

At the same time, it is projected that people aged 50 and older will make up about half of the total population of Moldova by 2040, while the European Union will not reach the same level of ageing until 2060 (Lutz et al., 2018). It therefore appears that the process of population ageing is occurring two decades earlier in Moldova than in the EU. In Moldova, the median age is expected to increase from 37.3 to 47.3 years between 2019 and 2040. The more significant reductions in mortality projected in the II-medium and III-high scenarios would cause demographic ageing to accelerate, and the median age to increase to 48.5 and 49.7 years, respectively.

Past migration trends and low fertility levels are projected to lead to a decrease in the number of women of reproductive age, and to a long-term decline in the number of births. The magnitude of demographic ageing will be determined by the age-sex structure of the population formed in the previous period, and by recent trends in

Figure 9:
Age-sex pyramid of Moldova in 2020 and 2040 (projection, medium scenario)



Source: Calculated based on NBS data.

the rates of return from abroad of migrants of pre-retirement age. It is projected that the share of young people aged 0–19 in the population will decrease from 23.9% in 2019 to 17.6% in 2040, while the share of older people aged 65+ in the population will increase from 14.2% to 24.4% over the same period.

5 Discussion

The results of our study suggest that in Moldova, low levels of fertility combined with high levels of mortality and outward migration are leading to an accelerated long-term demographic decline. The current population structure is developing in a negative direction due to fertility decline and increasing demographic ageing. The process of depopulation is expected to continue in the coming 20 years, with the speed of depopulation reaching unprecedented levels. It is, however, possible to limit the degree of depopulation that occurs. Reductions in population mortality could help to reduce the scale of depopulation. In the years after Moldova achieved its independence, the country failed to achieve a significant breakthrough in its efforts to reduce mortality and increase life expectancy. Thus, the gap in life expectancy between Moldova and other European countries remains large. High mortality, and especially premature mortality, leads to the loss of years of life, and is one of the factors in Moldova's population decline. Given that people who migrate tend to be young and healthy, while return migrants may be ill or in failing health, it is possible that migration has a negative impact on the dynamics of life expectancy, as it could result in a worsening of health indicators and an increase in mortality due to the relatively high number of elderly and seriously ill people in the population (Ullmann et al., 2011). It is obvious that life expectancy can be increased by significantly improving the population's standard of living and access to high-quality medical services.

Although Moldova's TFR is higher than the rates in other European countries, it is lower than the level needed to replace generations, and it has been decreasing steadily. The birth rate is hard to influence by politics, and the measures aimed at boosting fertility are costly. The emigration of large numbers of young people exhausts the reproductive potential of the country, given that, as was mentioned above, the number of women of reproductive age has been decreasing. Thus, the number of births has been decreasing, which fuels other dimensions of the depopulation process. As recent studies have shown, in countries that are experiencing intensive out-migration, the TFR must be significantly higher than 2.1 children to replace generations (Sobotka and Zeman, 2021).

Reducing the size of emigration flows could help to limit the scale of depopulation. However, there are a few signs that emigration will slow down in the coming years, despite a temporary decrease during the COVID-19 pandemic. As we showed, net migration rates are negative at young adult ages, and are positive at pre-retirement ages, albeit at a low level. These developments contribute to demographic ageing.

The imbalance in the age structure of Moldova, with older people making up a large share of the total population, will accelerate the processes of demographic ageing and depopulation. As other scholars have emphasised, the "depopulation trend contributed to subsequent levels of population ageing, but recent population ageing has also contributed to ongoing depopulation, creating a vicious circle" (Reynaud and Miccoli, 2018).

6 Conclusions

In this study, we examined the particularities of population reproduction and the determinants of depopulation in Moldova over the last three decades. All of the demographic indicators were calculated using population data based on usual residence. Our findings are broadly in line with those of previous studies, and our use of reliable statistical data, together with a validated analytical approach, suggests that the results are robust.

Modern approaches to population policies emphasise the need to shift the focus away from population size and towards the quality of human capital; i.e., levels of education and health. Based on forecasts of changes in the education levels of the population, it has been argued that education and labour market participation are the most important issues for countries with shrinking populations (Batog et al., 2019). Many international studies on Eastern European countries have recommended that the governments of these countries seek to achieve balanced population development in terms of age, gender, education and health, and to promote active longevity. But this advice may be hard to follow in the context of intensive international migration, the flows and directions of which are difficult to predict. Moreover, following these recommendations will require substantial investments. Given that Moldova is close to European economies that facilitate labour migration, and that migration networks are expanding, Moldova will continue to lose human capital. Free mobility of labour, as a part of the globalisation of the world economy, is becoming one of the most important trends in social development, and is fuelling the migration aspirations of the population. The pay gap between Moldova and the EU countries, rural poverty, the chronic lack of well-paid jobs, and increased opportunities to study and work abroad will evolve as push-pull factors of migration (Stratan et al., 2021). While policies aimed at encouraging migrants to return have been tried, they did not have a significant effect.

It has been suggested that the depopulation trend in countries like Moldova is impossible to stop. Some scientists have argued that emigration has far-reaching consequences, and that the countries with high levels of outward migration will, slowly but surely, see their public health and pension systems collapse, especially given that in the post-transitional countries, these systems are mainly based on the solidarity principle. Over the longer run, these countries may be unable to generate sufficient human capital to maintain economic growth, leading to economic collapse (Vuksanović Herceg et al., 2020).

Promoting a regional migration management approach based on European solidarity is crucial in this context. If policies for the recruitment of workers, and particularly well-educated workers from economically vulnerable backgrounds, are implemented, they will fuel high rates of migration, which may lead to imbalances at the regional level (Lutz and Gailey, 2020). Only if responsible actions to manage human capital are taken by the international community, by the governments of donor and recipient countries, and by international organisations concerned with population issues can the demographic development of countries in the European region be balanced.

Author contributions

The authors jointly contributed to the conception of the work, analysis and interpretation of the data. Specifically, OG contributed to the sections on fertility and future trends, TT contributed to the sections on migration, and IP contributed to the sections on mortality.

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