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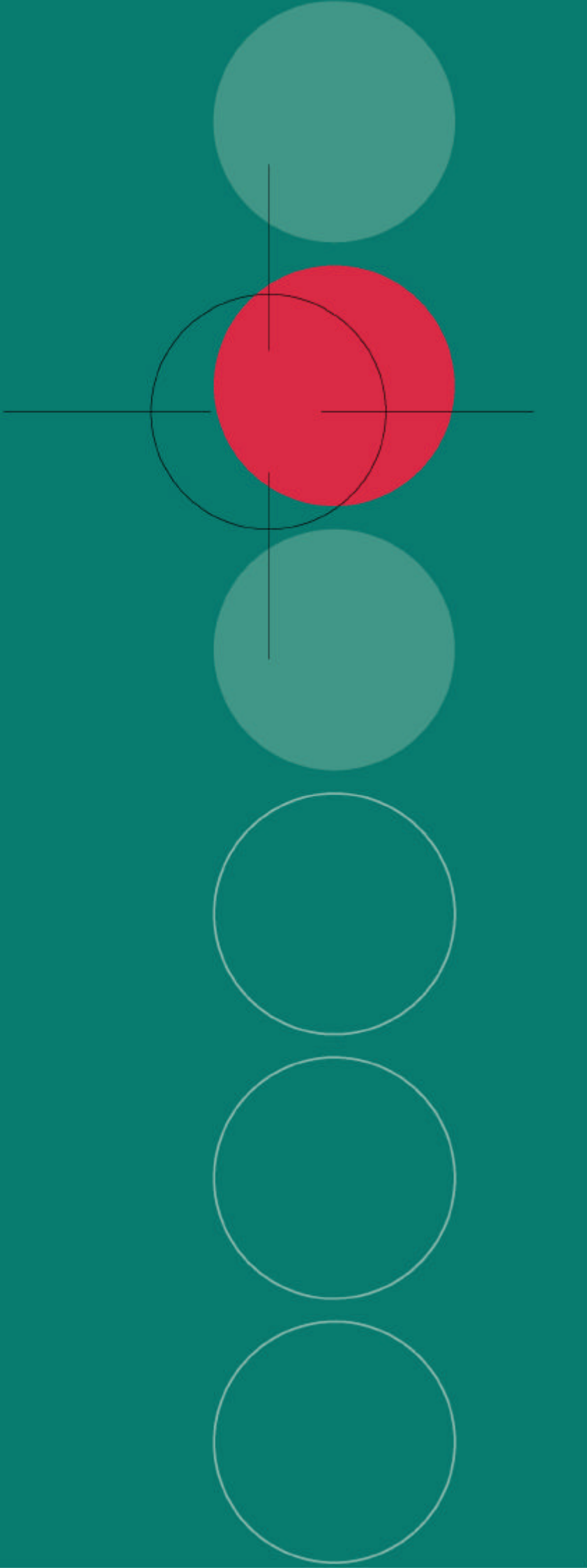
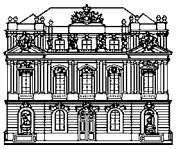
INSTITUTIONAL CHANGE IN THE PAYMENT SYSTEMS BY ELECTRONIC MONEY INNOVATIONS: IMPLICATIONS FOR MONETARY POLICY





INSTITUTIONAL CHANGE IN THE PAYMENT SYSTEMS BY ELECTRONIC MONEY INNOVATIONS: IMPLICATIONS FOR MONETARY POLICY

INSTITUTE OF TECHNOLOGY ASSESSMENT
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Summary

Electronic money innovations (such as card-based, mobile-phone-based or computer-based electronic money) are the most visible signs of far-reaching institutional change in economy-wide payment systems worldwide. Technological progress is increasingly intertwined with new products, new market entrants and new governance structures in payment systems. This research report focuses on the impact of these changes on monetary policy. A number of questions emerge in this context and are tackled in the report: How are the operation of alternative means of payment (e.g. payment services by non-banks such as mobile telecom operators) linked to central banks and how does that affect monetary policy? How does institutional change in payments system affect the stability and predictability of the demand for central bank money? Will the decrease of demand for money lead to a moneyless world? Is there a role for monetary policy in a world without central bank money?

In the introductory chapter, Stefan W. Schmitz and Geoffrey E. Wood outline the theoretical framework and the set of diverse but complementary methodological approaches which are applied in the research project. Furthermore, they provide an overview of institutional change in economy-wide payments systems. The analysis of data concerning retail and wholesale payment systems in the Euro area, the UK, and the US shows pronounced institutional variation. Policy initiatives and changing demand by banks and final customers are seen as the main drivers of institutional change. New payment instruments and payment service providers, the move to Real Time Gross Settlement (RTGS) and increasing electronification are the most visible indicators of this institutional change. Electronification and alternative means of payment are expected to lead to a steeper payment pyramid: the ratio of central bank (CB) money to total value of payments decreases. This development is giving rise to concerns about the future role of money in general and CB money in particular in economy-wide payments systems. Institutional change affects monetary policy by its impact on demand for CB money and on the efficacy of monetary policy implementation at a given demand for CB money. CBs have a large range of instruments at their discretion to react to and to influence institutional change in the payment system. They are heavily involved in the legal and political process shaping the broad legislative framework concerning payment instruments, and they have been transferred substantial regulatory power within the broad legislative framework. In addition, CBs can adapt the instruments of monetary policy implementation and their own payment system policies to cope with institutional change in the payment system.

Lawrence H. White applies an economic history approach and argues that in the United States as in Europe, payments-system innovations continue (as they have done for centuries) to promote the substitution of alternative payment media for direct use of base money. Though no revolution is evident, the real demand for central-bank-issued currency may shrink relative to transactions volume and to demand for broader monetary aggregates. In some respects, though no trend is evident in the United States, central-bank-issued deposit liabilities may be challenged as a medium for settling interbank flows. The central bank's power to influence nominal variables is not proportional to the size of its balance sheet. Shrinkage of the central bank's balance sheet will therefore *not* usher in a new era in which monetary policy has no effect, either for good or for ill.

Forrest H. Capie, Dimitrios P. Tsomocos and Geoffrey E. Wood set out the argument that money evolved to reduce transaction costs by economising on

information. They develop a formal model in which money exists by virtue of that property, and compare the costs of operating a fiat money system with the costs of operating a system of electronic barter. The key cost parameters are identified. They show that within this framework fiat money dominates – is cheaper than – electronic barter, unless inflation drives up the nominal interest rate. Secondly, increases in the number of commodities increase the costs of electronic barter faster than they do the costs of using fiat money; and finally that the lower bound to the cost of using fiat money is always below that of electronic barter. Thus fiat money is a superior transaction technology to electronic barter; transaction chains that use it have intrinsically lower information requirements. The resulting demand for fiat money by the non-bank public will in turn give rise to demand by the banking sector. Their joint demands will ensure both that central banks survive, and that they will retain control of a price level measured in the money they issue. Institutional change in the payments system will no doubt have quantitative implications for central bank operations, but it will not have qualitative implications for them.

Based on a critical assessment of the literature on electronic money and monetary policy, Stefan W. Schmitz demonstrates that many of the models on the effects of payment innovations on monetary policy assume an institutional structure of the monetary system that involves the separation of the unit of account from the generally accepted medium of exchange (GAME). His analysis shows that these models lack an analysis of the institutional structure of the payment systems, i.e. the mechanisms of price formation and that nominal prices in the unit of account presuppose the direct or indirect exchange of goods for the GAME, which embodies the unit of account in competitive markets. Until the world economy resembles the Arrow-Debreu model, transaction costs will remain positive and a GAME – which also fulfils the function of the uniform unit of account – will further reduce transaction costs relative to an economy without a GAME. The institutional structure is likely to involve redeemability of eMonies in the GAME and the respective uniform unit of account will prevail in the economy. The CB is likely to maintain its monopoly in the provision of the GAME and the unit of account at zero marginal costs. Nevertheless, the ongoing institutional change in the payments system – at the retail and the wholesale level – will necessitate adaptations of monetary statistics and of the instruments and the implementation of monetary policy, a challenge CBs have proved able to cope with quite successfully so far.

In his contribution on monetary policy in a world without central bank money, Stefan W. Schmitz argues that many papers attempting to discuss monetary policy without CB money turn out to assume that the CB maintains a monopoly in the provision of the GAME and the medium of final settlement on closer inspection of the implicit institutional structure of the monetary system presented. Unfortunately, they do not make the institutional structure explicit, i.e. the money market, the existence of a GAME and a medium of final settlement are rarely discussed in detail. The models are, thus, incomplete and inconsistent. The efficacy of monetary policy is discussed solely from the perspective of the monopoly provision of the GAME and the medium of final settlement by the CB, at zero marginal costs. It does not take into account the regulatory authority of CBs. In contrast, his paper provides a conceptualisation of monetary policy in a world without CB money based on a GAME that also serves as medium of final settlement. CBs can implement monetary policy by imposing reserve requirements in terms of the medium of final settlement and by paying or charging interest thereon. These instruments are independent of the monopoly of CBs in providing the GAME at zero costs at the margin. The smaller set of instruments and particularly the loss of control over the aggregate supply of the medium of final settlement impair the power of CBs to contain the volatility of the target rate. Politico-economic objections to this insti-

tutional framework also apply to the current practice of transferring regulatory powers and substantial discretion to CBs. Indeed, the current legal frameworks of the European Central Bank (ECB) and the Fed hardly need to be adapted. They already confer the necessary regulatory authority to CBs to conduct monetary policy based on the proposed instruments of implementation in a world without money.

In a case study of the effects of the Austrian eMoney scheme Quick on monetary policy Stefan W. Schmitz demonstrates how CBs can limit the detrimental impact of the diffusion of payments innovation on monetary policy implementation. Reporting requirements, redeemability requirements, and minimum reserve requirements are the main instruments that are applied in the case under consideration. While the details of the institutional structure of the scheme differ from schemes in other EU countries, the legal framework is largely defined by the EU eMoney directive 2000/46/EC and by the ECB's instruments of monetary policy implementation.

The results can be summarised in the following manner: First, by whatever mode of analysis used, it emerged that fiat CB money would not be wholly replaced by any form of electronic money currently envisaged. Most of the payment innovations are linked to CB money at some point. There is no evidence that they significantly reduce the ability of CBs to predict the demand for CB money in LVPS and the money market. Second, developments which have in the past, and may in the future, have improved or will improve the robustness or the efficiency of payments systems have not had and are not expected to have fundamentally damaging effects on the ability of central banks to control monetary conditions.

1 Institutional Change in the Payment System and its Impact on Monetary Policy – An Introduction

Stefan W. Schmitz and Geoffrey E. Wood

1.1 Introduction

The report presents the results of a research project on the interdependence between institutional change in the payments system and monetary policy. Monetary policy has been at the centre of economic research from the early stages of economic thought, but payment system research has attracted increased academic attention only in the past decade or so. This report's contribution consists of merging these two so far largely separated fields. It initiates research on the interdependence of institutional change in the payments system and monetary policy. (A neglected but instructive contribution to this field of study is the work of John Wheatley who emphasised the interrelation between payment systems and monetary policy at the beginning of the 19th century.[1])

Report initiates research on the interdependence of institutional change in the payments system and monetary policy

We are exploring the inevitable tension between the central bank's desire to control the monetary system – in order to ensure the effective implementation of monetary policy, the maintenance of financial stability, the smooth operation of the payment system and the collection of seigniorage –, which in general is thought to require commercial banks to hold some reserves of central bank money, and the desire of the commercial banks to economise on such reserves. The interaction of these forces drives institutional change in the payment system. What implications does institutional change in the payment system have for monetary policy? To answer this question, this report addresses two main subjects, the first of which is subdivided into three topics, the second into four. These divisions are as follows:

Tension between the central bank's desire to control the monetary system and the desire of the commercial banks to economise on such reserves.

1. **Institutional change in the payments system**
   a. Conceptualisation and empirical analysis of institutional change in the payment system
   b. Relevant forces shaping institutional change in whole-sale as well as retail and small value interbank payments systems (e.g. payment system policy; new technology enabling the emergence of new markets, new products, and new governance mechanisms; liberalisation, integration and consolidation of financial and product markets)
   c. Various central banks have moved to real time gross settlement (RTGS) inter-bank payment systems in recent years, against previous trends towards deferred net settlement systems (DNS).
2. **Implications for monetary policy**
   a. Implications of the alternative institutional structures of payment systems for the conduct and implementation of monetary policy

[1] For a discussion of Wheatley's contribution see Schmitz (2004).

b. Effects of institutional change in the payments system and the likely evolution of the demand for central bank money
c. Adaptation of the instruments of implementation of monetary policy by central banks
d. Alternative models of monetary policy implementation in a world without CB money

International research team

A team of researchers, from academia and central banks combined to analyse these topics from complementary perspectives – empirical economics (i.e. economic history), economic theory, and institutional economics – and in different institutional environments of monetary policy (i.e. the Euro-area, the UK and the USA).

Payment systems affect monetary policy through various channels. Their institutional structure has an impact on the functioning of the money market. That market's reliable and predictable functioning is a prerequisite for effective liquidity management and monetary policy implementation. Intraday liquidity provision (which has little monetary policy implication) can spill-over into the overnight market (possibly with monetary policy implications). Payments systems can also affect the stability and predictability of the demand for central bank money, which usually serves as the means of final settlement in the interbank market.

In order to assess, to what extent institutional change in the payment system affects monetary policy, a number of theoretical and empirical questions are addressed.

Theoretical and empirical questions

- *Method*: What are the appropriate methods to investigate institutional change in the payments system?
- *Main drivers of institutional change in payment systems*: What are the relevant forces shaping institutional change in whole-sale as well as retail and small value interbank payments systems (e.g. payment system policy; new technology enabling the emergence of new markets, new products, and new governance mechanisms; liberalisation, integration and consolidation of financial and product markets)?
- *Institutional change in payment systems*: What are the main institutional characteristics of payment systems? The institutional structures of payment systems show a great variety in different economic environments, for historic reasons[2] as much as for differences in the adoption of recent innovations. What are the major signs of institutional change in payment systems? A number of banks and non-banks, e.g. mobiles telecom operators, have entered the market for the provision of payment services in recent years with alternative means of payment. How are their operations linked with the CB and how does that affect monetary policy?
- *Institutional change in the payment system and monetary policy*: How does institutional change in the payments system affect the stability and predictability of the demand for central bank money? How does it impact on the quantity supplied and demanded as well as the quality of the means of final settlement? If effects are identified, can central banks adapt the instruments of implementation of monetary policy to cope with institutional change?
- *Central bank payment system policy*: Various central banks have moved to real time gross settlement (RTGS) and hybrid interbank payments systems in recent years, against previous trends towards deferred net settlement (DNS) systems. What are the implications of the alternative systems and their institutional features (i.e. availability of intraday credit in RTGS) for

[2] Humphrey et al. 1996.

the conduct and implementation of monetary policy? What are further instruments at the discretion of central banks to react to institutional change in the payment system?

- *The extreme case – a moneyless world*: Recent innovations in whole-sale as well as retail and small value interbank payment systems are widely expected to reduce the demand for money, and perhaps to increase the interest sensitivity of the demand for money. Is the collapse of the demand for money to zero simply the limit of such an evolution and should it, therefore, be modelled accordingly? Or would a "moneyless economy" reflect a different and incommensurable structure of the underlying economy? What are the appropriate methods to study such a fundamental institutional change? Is there a role for "monetary policy" in a world without central bank money?

The following pages attempt to lay the common foundations for the analyses presented in the main body of the report.

1.2 Method of Analysis

The definition of the "payment system" refers to the economy-wide payment system as the entire web of payment instruments in an economy. It consists of a number of individual payment systems, which are broadly categorised into two groups: whole-sale as well as retail and small value interbank payment systems. A payment system is defined as "… incorporating a particular set of payment instruments, technical standards for the transmission of payment messages and agreed means of settling claims among system members, including use of a nominated settlement institution." (CPSS 2003, 9).

Complementary methods of analysis

The analyses presented in this report utilise different but complementary approaches to investigate the impact of institutional change in the payment system on monetary policy: economic history (Lawrence H. White), general equilibrium analysis in Shubik's tradition of modelling monetary economies (Forrest H. Capie, Geoffrey E. Wood, Dimitrios P. Tsomocos) and institutional economics (Stefan W. Schmitz).

The report advocates diversity in the methods of analysis. The different approaches are employed to complement each other, as they allow the highlighting of different conceptualisations, main drivers as well as potential directions and impacts of institutional change.

1.3 Main Drivers of Institutional Change in the Payment Systems

Two groups of main drivers

The following sections will relate institutional change in the payment system to its main interdependent drivers, which are broadly categorised in two groups: policy initiatives[3] (e.g. Core Principles; SEPA, EU New Legal Framework; Revision of Federal Reserve Policy on Payments System Risk (PSR policy), Amendments to Money Transmitter Laws in many US states) and changing demand by banks (e.g. minimising opportunity costs of holding reserves) as well as final customers (i.e. increasing demand for cross-border payment services due to globalisation). New technologies are rarely drivers in their own right; more often they have an impact on institutional change by enabling the development of new products, new markets, and new governance structures.[4] This section provides a brief summary of the most important policy initiatives.

Johnson (1998) describes CB activities aimed at reducing settlement risk in the payment system by ensuring payment finality without explicit CB intervention. Measures taken include the containment of intraday exposure in DNS, collateralisation, loss-sharing agreements, the reduction of float, the implementation of RTGS operated by CBs (e.g. the ECB's TARGET system, the Fed's Fedwire, and the Bank of England's CHAPS) and the establishment of Lamfalussy standards for private DNS in 1990.

The BIS Core Principles

As an extension of the Lamfalussy Standards for DNS the Bank for International Settlements (BIS) initiated the Core Principles (CPSS 2001a) for systemically important payment systems[5] in 2001. The most important of the ten principles encourage payment systems to have a risk management procedure that clearly allocates responsibilities between operator and participants, to be able to complete settlement in the case of failure of the largest net debtor in DNS, to settle in CB money, to permit fair and open access and disclose the relevant criteria and to have effective governance mechanisms in place. In addition, the BIS assigns certain responsibilities to CBs in relation to the Core Principles. Central banks' own payment systems should comply with the Core Principles, they should disclose their payment system objectives and policies, and they should oversee the compliance with the Core Principles in systematically important payment systems. The Core Principles were adopted by the ECB Council in 2001 and incorporated into the oversight standards for retail payment systems in 2003.[6] They were also incorporated into Federal Reserve Policy on Payments System Risk (PSR policy) in 2004[7].

EU retail payment systems expected to undergo substantial change due to SEPA and ...

Retail payment systems in the European Union are expected to undergo substantial institutional change in the next decade or so, due to increasing demand for cross-border payments and ensuing policy initiatives. Despite the introduction of the common currency in 1999 and 2002 the intersections of national retail payment infrastructures in the Internal Market remained inefficient and much higher costs for cross-border payments than for domestic ones persisted.

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[3] Policy initiatives in the area of banking and financial markets have a direct and indirect impact on payment systems, too. Furthermore, privacy, consumer protection, and anti-money-laundering laws, to name but a few, also affect payment systems and can influence institutional change.

[4] McAndrews/Trundle 2001.

[5] CPSS (2001a) defines a system to be systemically important, if disruptions in the respective settlement process can have a sever impact on other financial system participants or lead to systemic implications.

[6] ECB 2003, 2004.

[7] Federal Reserve System Docket No. OP-1191.

In response, the European Council initiated the Single Euro Payment Area Initiative (SEPA) in 2001 to promote the creation of a euro area-wide integrated retail payment infrastructure by the end of 2010. Effective as of 1 July 2002 it requires charges for cross-border electronic payments in euro within the Internal Market up to € 12 500 (€ 50 000 after 2005) to be the same as for domestic payments in euro (Regulation (EC) No. 2560/2001). It contains a similar requirement (effective as of 1 July 2003) for cross-border credit-transfers in euro within the Internal Market. The Regulation promotes standardisation and straight through processing (STP) by the use of the International Bank Account Number (IBAN) and the Bank Identifier Code (BIC) to decrease the costs of cross-border credit-transfers. The European Payments Council (EPC) was set up by the banking industry to guide and implement the SEPA project. The milestones of the SEPA initiative were laid out in a White Paper in 2002. The operation of the first pan-European Automated Clearing House was envisaged for 2003. The EPC planned to introduce a pan-European credit transfer instrument (Credeuro) in 2003 and a pan-European direct debit instrument (PEDD) in 2005. Recommendations for consistent tariffs for card schemes should be implemented in 2006. Full migration of customers to the Single Euro Payment Area is intended by 2010. The ECB plays a catalyst role, but signalled to impose regulatory measures, if the progress towards a SEPA were backtracked by banks. The European Banking Association (EBA) operates the first Pan European Automated Clearing House (PEACH), called STEP 2, as infrastructure for retail payments covered by the Regulation.

The legal framework governing payments services in the EU is based on EU legislation and on national law. In order to remove legal barriers to an integrated European payments infrastructure and as part of the Commission's Financial Services Action Plan (FSAP), the European Commission proposed a New Legal Framework (NLF) for payments in the Internal Market to review and consolidate community legislation in 2003.[8] The basic principles of the NLF are that payment service providers should face prudential requirements proportionate to the risks involved and that a level playing field for all market participants as well as appropriate consumer protection should prevail across the EU. The ECB is intensively involved in the legislative and political process concerning the NLF (as it also was in the case of the eMoney Directive 2000/46/EC).[9]

… New Legal Framework

Implementation of the SEPA initiative and of the New Legal Framework is likely to remain a driver of institutional change in European payments systems beyond 2010, due to the expected consolidation and integration of national payments infrastructures in Europe.

In the US the fragmentation of the legal framework regarding payment services is substantial, too. Apart from Federal regulations such as the Electronic Fund Transfer Act (1978), Federal Reserve Regulation E and the Federal Reserve Policy on Payments System Risk, state abandoned property laws and money transmitter laws apply to some payment services and instruments. Understanding and complying with a large number of legal requirements is a substantial burden for payment service providers in the US.

US retail payment system subject to change due to regulation, too

[8] Communication from the Commission to the Council and the European Parliament concerning a New Legal Framework for Payments in the Internal Market (Consultative Document) COM (2003) 718.

[9] Payment System Policy Working Group 2004.

CBs strongly influence legal framework in EU and US

The main legal framework governing payment systems falls in the competence of legislatures. Nevertheless, central banks exert a high level of influence in drafting rules at the international level (e.g. Core Principles) and in shaping legislation by consulting governments and legislature (e.g. NLF, eMoney Directive 2000/46/EC). Furthermore, legal frameworks in the EU and US transfer substantial regulatory discretion concerning the regulation and oversight of payment systems to central banks (e.g. minimum reserve requirements, reporting requirements, ECB Minimum Standards, Regulation E).

1.4 Institutional Change in the Payment System

Central institutional characteristics of payment systems

The central institutional characteristics of payment systems concern the means of final settlement[10] in the payment system and its relation to the generally accepted medium of exchange in the economy as well as to characteristics of the clearing and settlement institution (CSI). The latter include conditions of access to its accounts, conditions of access to its credit facilities, and the nature of its clearing and settlement process (i.e. RTGS with or without intraday credit, DNS, hybrid systems). In addition, the surrounding institutional environment, in which the payment system operates, is of importance: the state of development of the interbank money market and the sophistication of participants' treasury management. But also some features of monetary policy implementation have repercussions on the institutional characteristics of the payment system. The reserve maintenance system is of particular relevance in this respect (i.e. the averaging of minimum reserve requirements, the averaging period, its relation to the interval of CBs' refinancing operations and the potential employment of minimum reserves for settlement purposes).

These characteristics can be interrelated in important ways. The relationship between the GAME and the means of final settlement as well as the relationship between the CSI and the issuer of GAME can influence credit and liquidity risk of the payment system. If the means of final settlement is not the GAME, potential demand for exchanging the means of final settlement into the GAME imposes a liquidity risk on the participants of the payment system, as the GAME is by definition the most liquid asset in the relevant market. If the CSI is not the issuer of the GAME, its opportunity costs of holding sufficient reserves are positive and it can – in principle – go bankrupt, thus imposing a credit and liquidity risk on participants. Although, there is no historical evidence of CSI bankruptcies we are aware of.

The role of the generally accepted medium of exchange (GAME) critical for CBs

For monetary policy implementation the involvement of the CB in issuing the GAME, and its role in the payment system are critical. If the CB acts as the CSI, the role of access to accounts[11] and credit at the CSI can give rise to risks for monetary policy implementation, due to potential spill-over of intraday credit to the overnight money market. If the CSI also performs supervisory functions with respect to the participating institutions, potential econo-

[10] Settlement finality refers to an unconditional and irrevocable payment (EU Final Settlement Directive 98/26/EC). For a discussion of the parameters influencing the choice of means of final settlement in the CLS system see Freixas et al. (2001).

[11] The Reserve Bank of Australia introduced exchange settlement accounts which provide access to CB settlement services for non-banks. Payment service providers, that are in a position to maintain liquid even during seasonal peaks as well as during periods of stress, are eligible. The only service the accounts permit, are settlement services related to a clearing process the account holder participates in.

mies of scope arise due to informational advantages. In historical examples of private CSI, the institution also acted as regulator and supervisor of the participating institutions.[12] If the CSI is also the issuer of the GAME, the lender of last resort function can be fulfilled at lower marginal costs. It is sometimes claimed that conflicts of interest may arise with monetary policy objectives of the issuer of the GAME, but this is not an inevitable problem.[13]

Institutional characteristics influence the operational characteristics of the payments market, such as its efficiency (as measured for example by the turnover ratio – how often do intraday reserves turnover in the payment system; size of the float – the value of funds processed at any time and thus neither at the discretion of the payer nor the payee; execution time – the time it takes to execute a payment order), stability, and reliability (stress resistance), the concentration of payment flows, the nature and intensity of competition among payment systems, structure and level of costs of access to the payment system and to intraday credit, and the degree of tiering in the payment system. The following subsections describe what we regard as the most important aspects of current institutional change in wholesale as well as retail and small value interbank payment systems:

1.4.1 Wholesale Payment Systems

According to the Committee on Payment and Settlement Systems (CPSS, 2003), liberalisation, globalisation, and consolidation have enormously increased the volumes handled in national wholesale (large value) payment systems and have thus increased awareness of potential threats to systemic stability. (As the CPSS consists of central bank delegates, it is less eager to stress the maintenance of seigniorage income as a driver of reform.) Consequently, the design of payment systems underwent considerable change. The spread of RTGS was intended to increase the safety of the large value interbank payment systems. These enabled the development of Continuous Linked Settlement (CLS), Delivery versus Payment (DVP – in security settlement) and Payment versus Payment (PVP – in foreign exchange settlement). Bilateral intraday payment obligations were harder to manage in DNS, as they remained largely invisible for most participants until end-of-day clearing. Bilateral intraday obligations result from the lag between sending payment messages and end-of-day settlement. Final settlement depends on the completion of all payment orders entered during the day. Thus, settlement cannot be considered final for a participant, even if the participant has no bilateral claim against the illiquid party.

Liberalisation, globalisation, and consolidation have enormously increased the volumes handled in national wholesale (large value) payment systems

Fry (1999) reports that unprotected DNS dominated in the large-value payment market internationally until the 1980s and that the associated risks were largely ignored. The Lamfalussy Report (BIS 1990) suggested "Core Principles" for cross-border DNS for the containment of risks, in particular that the system should be able to settle even in the case of failure of the largest net debtor. Nevertheless, participants in DNS had to comply with minimum levels of creditworthiness, which in turn had to be monitored by other participants or the system operator, which restricted the number of direct participants. The number of participants in RTGS vastly exceeds the number of direct participants DNS usually had. In 2001 the CPSS (2001a) adopted the Core Principles for systemically important payment systems, which encourage CSI to settle in CB money. All large value payment systems in the Euro area settle in

Real Time Gross Settlement Systems replace Deferred Net Settlement Systems

[12] See inter alia Selgin/White 1994, Holthausen/Monnet 2003.

[13] See Wood 2000.

CB money.[14] The wholesale money market is the only financial market in the EU which it is effectively integrated[15]. The establishment of the European large value payment system TARGET (Trans-European Automated Real-Time Gross Settlement Express Transfer) in 1999 laid the foundations for this integration and, thereby, for the ECB to implement monetary policy effectively across the Euro area.

Hybrids will replace Real Time Gross Settlement Systems

McAndrews/Trundle (2001) argues that the remaining risks and the associated costs even in protected DNS led to the adoption of RTGS in all EU and G10 countries in the 1990s. The higher costs of liquidity in RTGS also gave rise to hybrids. McAndrews/Trundle distinguishes two main types – Continuous Net Settlement (CNS) and queue-augmented RTGS. The former evolved from DNS. Participants hold some liquidity with the system operator and enter payment orders throughout the day. These orders are queued, i.e. not executed until an algorithm identifies those orders that can be netted without implying net positions of one of the participants that exceed its available liquidity balance. The algorithm operates frequently throughout the day and settlement occurs each time a group of payments complies with the relevant netting requirements. Technically the system remains a DNS, but net settlement occurs so frequently that many payments are effectively settled in real time. The settlement risks associated with the interdependency of settlement in DNS is reduced by reducing the length of the settlement period.

Queue-augmented RTGS are an important form of RTGS. Again payment orders are queued and an algorithm searches for offsetting orders on a bilateral or even multilateral basis. Once a pair or group of orders fulfils the relevant criteria, they are settled on a gross basis. Legally and technically the system is a gross settlement system, but economically only net positions are relevant. The gain in liquidity saving comes at the price of settlement deferral until a pair or group of payments complies with the relevant criteria. Usually offsetting occurs frequently during the day, so the deferrals are very short.

Centralised queuing mechanisms for CNS and queue-augmented RTGS all require sophisticated, reliable and cost efficient ICT infrastructure. This underlines the role of technological advances in enabling institutional change in the payment system. McAndrews/Trundle (2001) argues that the related investment and operational costs may outweigh the ensuing benefits in terms of liquidity savings. This implies that sophisticated centralised queuing mechanisms are less attractive for payment systems with inexpensive intraday credit and highly concentrated payment flows among a small number of participants, who can more easily coordinate their payment orders. Fry (1999) highlights that DNS with a small number of large participants might entail a moral hazard problem, which should be taken into account in the analysis of the costs of DNS. For participants face an incentive to underinvest in mutual monitoring of counterparty risk, as they rely on the LLR function of the CB to bail-out large participants, who are considered, perhaps erroneously, "too big to fail". The adoption of CNS and RTGS eliminates this moral hazard problem, as counterparty risk is reduced.

In both kinds of hybrid systems a RTGS is required in the background to settle the remaining payment orders not offset by the end of the day. In RTGS individual participants can reduce their working balances by delaying payments during the day. By entering payment orders after they have received sufficient funds, they can settle them from incoming payments and save liquidity costs. This incentive structure leads to delay of payments and the potential risk that

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[14] ECB 2004a.

[15] European Commission 2004.

not all payments can be completed during the day. Market participants can solve the problem by cooperation mechanisms. McAndrews/Trundle (2001) distinguishes ex ante mechanisms (e.g. participants set limits of net payments to individual counterparties; internal queues that release payments in response to incoming payments) and ex post mechanisms (e.g. rules of behaviour with ex post compliance monitoring). In addition, system operators can contribute to the solution of the coordination problem by centralised queuing mechanisms, as the probability of netting and offsetting matches increases with the number of payment orders entered at specific batches.

In RTGS intraday credit is usually provided explicitly by the clearing institution (often the CB), so that the clearing institution rather than other participants bears the associated risks. The centralisation of credit risk exposure and the better availability of information improve credit risk management in payment systems. On the other hand, the demand for settlement reserves or CB intraday credit increases, so that the payment systems become more reliant on CB money (either in the form of intraday credit or in the form of settlement reserves with the CB). McAndrews/Trundle (2001) argues that the evolution of hybrid systems constitutes a trade-off between CBs' desire for stability and market demands for efficiency.

High extent of tiering in large value payment systems

CPSS (2003) reports empirical findings of the extent of tiering in selected LVPS[16]: Out of the twenty-nine payment systems analysed, seventeen reported high degrees of tiering (i.e. less than 25% of domestically located banks were direct participants), six reported mixed degrees of tiering (i.e. 25%-75% of domestically located banks are direct participants), and six reported low degrees of tiering (i.e. more than 75% of all domestically located banks participate directly).[17] Only twenty-two payment systems provided figures concerning the degree of concentration in the value of payments handled. In seven of them the five largest participants accounted for more than 75% of the value of all payments.[18] Table A-12 shows that banks' reserves at the CB differ widely between the Euro area (5.7% of narrow money in 2002), the UK (0.3% of narrow money in 2002), and the US (1.7% of narrow money in 2002), which is largely due to different MRR and tiering. The latter becomes evident from the share of banks' deposits at other banks of narrow money, which ranges from only 2.9% in the US to 51.3% in the UK. Table A-13 lists the number of direct and indirect participants in 52 SVPS and LVPS in the Euro area, the UK, and the US in 2002. In some LVPS the share of direct participants is 100% (Fedwire US), while in CHAPS Sterling (UK) it is only 0.05%. In ECB's TARGET the ratio is 45%.

Options to cope with the internationalisation of payment flows

The Payments Risk Committee (PRC, 2003) investigated options to cope with the internationalisation of payment services and to reduce the costs of liquidity at the international level. It recommended the development of new intraday liquidity services involving intraday real-time repos, cross-boarder collateral pool facilities, and intraday collateral and currency swaps. It also asked central banks to accept securities, which are traded on foreign markets and denominated in foreign currencies, as collateral in intraday liquidity enhancing operations. Central banks could increase the efficiency of international large value payments by liberalising remote access to their domestic RTGS, central banks accounts, and intraday credit for foreign participants and the establishment of multicurrency facilities. The decision is likely to be based on trading off the

[16] Belgium, Canada, France, Germany, Hong Kong, Italy, Japan, Netherlands, Singapore, Sweden, Switzerland, United Kingdom, United States.

[17] CPSS 2003, 21, Table 1. Data refer to 2002 with a few exceptions.

[18] CPSS 2003, 21, Table 1. Data refer to 2002 with a few exceptions.

perceived benefits with respect to decreasing settlement risks and enhanced static efficiency due to central banks' involvement, against the perceived costs stemming from increased risks for monetary policy implementation (e.g. potential problems in controlling the supply of aggregate overnight reserves due to the provision of intraday credit foreign participants) and from public involvement (e.g. barriers to market entry and innovation as well as reduced dynamic efficiency in the market for international payment services).

1.4.2 Retail and Small Value Interbank Payment Systems

Efficiency and reliability of small value payment systems important for consumer confidence in financial stability

The efficiency and reliability of retail and small value interbank payment systems (SVPS) affect consumer confidence in the financial system as well as in the CB and currency in particular. Therefore central banks are regularly involved in payment system operation and/or oversight. However, their influence varies. Some have an operational capacity; others have merely an oversight function, and may act as catalysts for market developments.[19]

CPSS (2002) summarised recent trends in SVPS in the G-10 countries and in Australia:

- A shift from cash and paper-based instruments (i.e. paper cheques) to non-cash electronic payment methods (card-based – credit and debit cards – as well as account-based – direct debit and credit transfers)
- An increase of straight through processing (STP) due to enhanced interoperability of payment procedures based on common data protocols

Trends in small value payment systems

- The evolution of product innovation in the context of new payment methods (eMoney, mPayments) and in the area of access products (ATMs offer additional services, such as reloading prepaid mobile phone cards, internet banking)
- New entrants (e.g. market mobile phone companies, telecommunication operators, net-based scratch card companies) are often particularly innovative, and are more active in the area of new payment instruments (e.g. eMoney, Electronic Bill Presentment and Payment – EBPP), despite the fact that banks remain the main players in the payment system.

BCG (2003) expects the share of non-cash payments in Europe to increase from 42% in 2003 to 57% in 2010. In the US the share is expected to remain stable at 85%. That corresponds to an annual growth rate of 6% in Europe and 5.5% in the US. The composition of non-cash payments shifts towards electronic payments. The Federal Reserve System (2004a) estimates the annual growth rate of the number of non-cash payments to have accelerated from 3.1 percent (1979-2000) to 3.8 percent (2000-2003). In 2003 the number of electronic non-cash payments (55% of non-cash payments) exceeded that of checks (45% of non-cash payments) for the first time. The processing of paper checks decreased between 2000 and 2003 due to increased electronification of check payments at the point of sale and due to substitution of checks by electronic payment instruments.

Table A-4 in the data appendix presents evidence of the evolution of cashless payment instruments in the Euro area, the UK and the US from 1998 to 2002. The number of cheque transactions decreased in all three areas, while the number of transactions by all other cashless instruments (credit/debit cards, credit transfers and direct debit, eMoney) increased. The total number of transaction by electronic cashless instruments exceeds that of cheques substantially in all

[19] CPSS 2002.

Increasing share of cashless and electronic payments in Euro area, UK and US

three economies in 2002. The diffusion of debit/credit cards per inhabitant increased strongly during the period, as did the use of eMoney in the Euro area (table A-5). The use of credit transfers and direct debits grew substantially in the US and only slightly in the Euro area and the UK, where diffusion is much higher already. Table A-6 on the relative importance of cashless instruments by volume indicates, that the US mostly rely on cheques and credit/debit cards, while the Euro area uses largely account based instruments (credit transfers and direct debits). The data on relative importance based on value (table A-7) reveals that direct transfers play the most important role in all three economies in high value payments. The number of ATMs per 1 million inhabitants in much higher in the US than in the Euro area and the UK in 2002 (table A-9). The number of transactions in the UK and the US is about twice as high as in the Euro area. Table A-10 presents data on eMoney cards and terminals in the Euro area. In 2002 about 22 million eMoney cards were issued in the Euro area with an average loading of € 37. About 90000 terminals accepted these cards. In general, the distribution of cards with various functions (credit, debit, cash, eMoney, cheque guarantee) differs widely between the three economies (table A-11). The analysis of data concerning the retail payment systems in the Euro area, the UK, and the US shows pronounced institutional variation.

Pricing structure impacts on consumer demand

Humphrey et al. (1996) argue that the pricing of payment services has a strong impact on the direction of institutional change in payment systems by shaping changes in demand. This point is frequently stressed with regard to the (creeping) diffusion of alternative payment instruments (i.e. eMoney). Additional factors influencing the economy at large do often have an impact on the payment system as well (e.g. the introduction of the Euro).

Account-based (e.g. direct debits and credit transfers) and card-based payment processes differ in important ways: While account-based transactions are executed at the expense of the account-holder (either on a per-transaction-basis or in terms of total operating expenses of the account), card-based products involve a per-transaction-fee payable by the merchant.[20] Account-based transactions are often cleared and settled via a National Automated Clearing House (NACH).

The role of National Automated Clearing Houses (NACHs)

In all European countries (except Austria, Finland, and Russia) and in the US, NACHs operate in SVPS as DNS. NACHs are run in the background as an infrastructure not visible to the customer. In Europe central banks are actively involved in operating NACHs, many of which are owned and operated by central banks or by a company partly owned by a central bank (see table A-13). Card-based transactions are often cleared and settled via private, branded, networks. The visibility of these is a central strategic issue for the operating company. Clearing and settlement often take place on the books of a private CSI. The share of paper cheques has fallen continuously as electronification, straight through processing (STP), and interoperability of non-cash payments increase.[21] As a result the Bank for International Settlements (CPSS 2002) reports increases in security, decreases in operational risk, and reduced settlement lags.

The evolution of Pan European Automated Clearing Houses (PEACHs) and ...

Pan European Clearing Houses (PEACHs) evolved as an industry response to the increased pressure on prices for cross-border transactions resulting from the Single Euro Payment Area (SEPA) initiative. Due to stricter access criteria, more complex technological requirements, and a lower number of transactions, cross-border payments remain more expensive than domestic ones. Currently a large share of cross-border payments is processed via correspondent banking relationships. These are costly to administer and complicate risk as well as

[20] CPSS 2002.

[21] CPSS 2002 and BCG 2003.

treasury management. In order to cope with these disadvantages, European banks have developed alliances (such as the European Banking Association EBA) and joint ventures. Cross-border mergers and acquisitions have increased the cheaper variant, in-house cross-border payment services. In addition, money remittance offices provide cross-border money transfer services and spread geographically. Card-based transaction feature prominently in cross-border payments in tourism and distant selling (i.e. eCommerce).

… economies of scale and scope will …

Advances in information and telecommunication technology, the role of economies of scale and scope in payment systems, and political pressure may lead to a consolidation and concentration of the European SVPS market. Consolidation and concentration impact on efficiency and stability of the payment system in various ways. The BIS conjectures that competition enhances the innovative capacity and efficiency of market participants.[22] On the other hand, a fragmented market might leave potential economies of scale and scope partly unexploited, increase operational risk due to different procedural and technological standards, and amplify legal risks due to differences in legal arrangements or regulatory provisions concerning different market participants. Cooperation among market participants is necessary to some extent, as common technological standards and interoperability increase the efficiency of the financial system. "Co-opetition" (competitors cooperate in selected areas – e.g. development of common standards – but compete in input and output markets) poses challenges for competition policy; these problems are not unique to the payments market.

Both innovation and new market participants pose questions concerning the adequacy of the current legal and regulatory framework including CBs' settlement and access policies. The payment system traditionally rests largely on commercial banks. Despite institutional change in the payment system leading to the blurring of boundaries of traditional financial sectors, banks still dominate the wholesale payment system. A number of product innovations in retail payment systems increased the role of non-banks in small value transactions. Although the active participation of non-banks in handling payments has a long history in the US and Europe (e.g. postal giro), the increasing diffusion of current innovations such as smart cards and online debit cards raises a number of interesting questions; some are addressed in a study by the Federal Reserve Bank of Kansas City[23]. It presents evidence that non-banks engage in a large number of payment activities, but that they are hardly involved in settlement activities. As the latter are conducted mainly through the banking system, the potential dangers for systemic risk due to participation of non-banks in the payment system is thought to be limited.

… lead to the emergence of an integrated Euro area payments market

Cross-border economic activity increases as a result of European integration and so does demand for cross-border small value interbank payments. This will affect the structure of the European market. Major participants in the cross-border market (PEACHs) might also attract domestic payments. Large NACHs that expand into the cross-border market, on the other hand, might evolve into PEACHs. The emergence of an integrated cross-border payments market is likely to increase consolidation pressure on national markets. However, the market is still nationally fragmented and tendencies to delay integration are motivated by past investments in domestic payment system infrastructure, which are not yet fully depreciated. Consequently, switching from domestic to integrated small value interbank payment systems involves high investment under considerable uncertainty concerning future market structure. As a result of the

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[22] CPSS 2002.

[23] Bradford/Davies/Weiner 2003.

high fixed costs of direct participation, due to the more stringent technological requirements in PEACHs than in NACHs, banks with low cross-border volume might find it more efficient to participate indirectly via a larger domestic hub. That institution can be the respective CB or a domestic commercial bank. Most small value interbank payment systems in the EU are tiered to some extent; some are tiered to a large extent with the indirect participants by far outnumbering the direct ones. All systemically important payment systems in the EU settle in CB money.[24] But settlement in CB money occurs for the direct participants' clearing balances only. Although these include payment orders of indirect participants, the latter usually receive only commercial bank money after settlement.

Institutional change affects the choice between direct and indirect participation

Institutional change affects the choice between direct and indirect participation in interbank small value payment systems. The spreading collateral requirements and increasing technological sophistication increase costs of direct participation. Advances in ICT and increasing transaction volumes decrease the costs of operating and accessing payment systems at the margin for, both, direct and indirect participants. The impact on relative costs of direct and indirect participation remains ambiguous and the evidence so far is inconclusive.[25] In the cases of large nostro-banks and "quasi systems", small payment system participants settle on their books, which might rise to stability concerns in tiered systems. The Ferguson Report (Group of Ten 2001) defined "quasi systems" as financial institutions, which are not officially CSIs, that clear and settle large values relative to a well defined notion of entire payment flows across their own books. Especially in correspondent banking systems a small number of banks might emerge as nostro-banks. Many smaller banks hold accounts at these and settle across their books. Therefore, the extension of payment system oversight to these institutions might be called for.

Electronification as well as the emergence of institutional innovations (e.g. increased tiering), new payment methods (e.g. m-payments offered by mobile phone companies) offered also by non-banks, new markets (i.e. integrated European payments market – PEACHs, Continuous Linked Settlement – CLS) are expected to lead to increases in efficiency and to decreases of CB money needed to support a given value of payments in a relevant market. However spectacular recent innovations in payment systems are depicted, a world without CB money is not in sight. None withstanding, it is important for policy makers as well as for researchers to investigate the implications of such an evolution, even it is deemed unlikely at the moment.

1.5 Institutional Change in the Payment System and Monetary Policy

Institutional structure of payment systems affects monetary policy implementation by ...

The formulation, conduct and implementation of monetary policy take place in an institutional environment of which the economy-wide payment system forms an integral part. In principle, CBs implement monetary policy by manipulating the short-term interest rate, i.e. the overnight interest rate in the interbank market. Despite the small size of their repurchasing operations on interbank markets relative to total turnover, their impact is sufficient to steer the market. This is mainly due to their ability to issue the GAME at zero mar-

[24] ECB 2005.

[25] CPSS 2003.

ginal cost. But CBs have additional instruments at their discretion which increase their grip on the money market by imposing a structural liquidity deficit. They can influence demand for their own liabilities by minimum reserve requirements (MRR) and by legal restrictions concerning the issuance of banknotes, as well as by (in some countries) 'moral suasion'. The main instruments of monetary policy implementation are open market operations (OMO), minimum reserve requirements (MRR), and standing facilities (lending and deposit facility). Today CBs also routinely employ announcements of levels of their main operating target in monetary policy implementation. These instruments can be adapted to cope with institutional change in the payment system. But they also have an impact on the structure evolution of payment systems, and can, therefore, be employed by CBs to proactively shape institutional change in payment systems.[26]

The impact of the institutional characteristics of the payment system on monetary policy can be categorised along three dimensions.

... affecting demand for CB money, ...

First, institutional characteristics of the payment system affect the level of demand for CB money as well as its structure, predictability, velocity, and its sensitivity with respect to CBs' instruments (i.e. the interest elasticity of demand for CB money). Deutsche Bundesbank (1997) points out that the substitution of sight deposits for cash – due to decreasing costs of access to accounts by debit cards, electronic banking, and ATMs – might change the information content of monetary aggregates. The velocity of circulation of sight deposits is supposed to be higher than that of cash, so that the velocity of circulation of monetary aggregates might increase, too. On the other hand, improved payment instruments might enable individuals to separate transaction holding from store-of-value holdings more effectively. This might lead partly to a shift of funds from high velocity low-interest bearing deposits to low velocity higher-interest investments. The Bundesbank (1997) reports that the overall decline in the velocity of M3 experienced over the past decades was not slowed down by innovations in payment instruments. The interest rate sensitivity of monetary aggregates has increased, and this trend is expected to continue. It is mainly driven by the "asset acquisition behaviour" of investors. The Bundesbank conjectures that a gradual change in the velocity and composition of monetary aggregates will not undermine monetary targeting in principle, as the CB will be able to take trend velocity change it into account in setting the growth rate of monetary aggregates. In addition, new payment instruments (i.e. eMoney) are included in the definition of M1.

... operational efficiency, and ...

Second, the operational efficiency of the payment system is a precondition for the emergence of deep and liquid interbank markets. These, in turn, are prerequisites for the effective implementation of monetary policy, as a large and unstable float can lead to higher and more volatile reserves on the level of individual banks as well as at the aggregate level. That leads to more volatile intraday and overnight interest rates, and can make it harder for CBs to judge the liquidity stance of the system.[27] In addition, the estimation of autonomous factors in reserve demand will become harder for CBs; this estimation is a necessary precondition for determining the maximum operational volume of refinancing operations at given interest rates. In the short run, CBs can impose accounting standards (i.e. either the payer's or the payee's account has to be debited/credited before the transaction is completed) to deal with the float al-

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[26] Descriptions of the monetary policy instruments of the ECB and the Fed can be found in: ECB 2004b; Edwards 1997, Madigan/Nelson 2002, Federal Reserve System 2002 and 2004b.

[27] Fry et al. 1999.

beit at expense of distributional side effects. In the long run, more efficient procedures (e.g. electronification of procedures) will reduce the float. Efficient pricing of payment services in the interbank payment system with respect to the implicit credit entailed in float will increase incentives for banks to implement more sophisticated treasury management practices, procedures, and systems. Fry et al. (1999) point out that an efficient payment system, that is available and accessible throughout the monetary area, will enhance the effectiveness of the implementation of monetary policy in all financial centres throughout the monetary area by reducing transaction costs on the money market. Consequently, the fragmentation of the money market is prevented and the implementation of monetary policy can focus on a single and centralised money market. (A special case of the point Cagan made in his classic paper "Why do we use money in open market operations?".) The implementation of TARGET was motivated by this objective.

... stability of payment systems

Third, the payment system should not be a source of unforeseen and unpredictable shocks to the quantity and costs of liquidity with ensuing direct and indirect ramifications for monetary policy. CBs are the sole provider of liquidity to the market at zero marginal costs. In addition, they are not considered competitors by payment system participants, operate under a "public interest" prerogative[28], and are entrusted with the role of lender of last resort (LLR). This role is often nowadays accompanied by the responsibility for operation and/or oversight of payment systems and their participants. The failure of a large debtor in a DNS and the consequential liquidity shortage could motivate the CB – in its responsibility as LLR – to inject liquidity, which could spell over into the overnight market. The potential conflict of interest between these functions of CBs as monetary authority and LLR led to a discussion of their institutional separation.[29] At the same time, CBs often bear legal and/or statutory responsibilities for the stability of the financial system and the payment system[30], so that the market would expect them to act as LLR even in the absence of an official and explicit LLR mandate. The operation of LVPS and the oversight of other payment systems could imply an informational advantage for the CB that would greatly enhance its position to put in place effective policies to prevent liquidity problems of individual participants to threaten systemic stability (e.g. through the operation of RTGS systems), to detect potential liquidity problems of individual participants early, distinguish liquidity from solvency problems as well as to act as LLR efficiently and effectively.

In short, the institutional characteristics of payment systems affect the demand for CB money, the environment in which monetary policy is implemented, and the efficacy of different instruments of monetary policy implementation.

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[28] Arguments for the public interest motive go beyond the role of payment systems for monetary policy implementation. An efficient and stable payment system is a necessary part of the infrastructure for both an efficient economy of intra-temporal production and exchange as well as for a stable financial system of inter-temporal allocation. However, seigniorage provides a private interest motive for CBs' involvement in LVPS.

[29] See Goodhart/Schonmaker (1995) and Wood (2000) for a discussion.

[30] Article 105 (2) of the Treaty establishing the European Union and Article 3.1. of the ECB Statutes explicitly state that the promotion of the smooth operation of the payment system is a basic task of the ESCB. The Federal Reserve Act (1913), the Monetary Control Act (1980), and the Electronic Funds Transfer Act (1978, 1996) are the basis for the Fed's task to promote an efficient nationwide payment system.

1.6 Central Bank Payment System Policies

Instruments of payment system policy

In addition to participate in shaping and implementing government policy initiatives regarding payment systems policies, CBs have a number of instruments at their discretion to influence institutional change in payment systems. CBs' policies concerning payment systems can be distinguished according to the relevant addressees, which can be payment systems or their participants. The most important policy instruments available to CBs are: settlement policy, and access policy to CB accounts[31] as well as to intraday credit at the CB. In addition, CBs often resume an active role in payment system operation, regulation and oversight. CPSS (2002) provides an overview of relevant CB policies:

Settlement in CB money

First, many CBs encourage systemically important payment systems to settle in CB money in order to reduce systemic, credit and liquidity risk as well as to ensure service continuity (settlement policy).[32] In some cases the requirement to settle in CB money is restricted to the funding and defunding of end-of-day transactions, while settlement during the day is allowed to take place in alternative high-quality assets. Furthermore, the CB is often, for competitive reasons, preferred over competitors as the settlement institution. CBs often act as lender of last resort and participate in banking supervision. Continuous involvement in the payment system provides CBs with access to information valuable in fulfilling both roles successfully. Involvement can incur costs in addition to the resource costs of oversight, as CBs usually grant intraday credit when they act as settlement institutions. Thus, they have to bear certain risks, namely, credit risk and the risk of spill-over of intraday credit to overnight credit.

Restrictive access to CB accounts

Second, CBs' access policies to CB money (in the form of CB accounts) are the core instrument of their payment system policy with respect to payment system participants. Access is usually granted to institutions, whose role in the payment system is considered to be important enough for financial stability, so that the associated risks for CBs can be justified. These are usually resident banks. The drivers of institutional change in the payment system, in particular liberalisation and globalisation, have led to the blurring of boundaries between different financial sectors and to an increase in the demand for cross-border and multicurrency clearing and settlement services. Consequently, some CBs have broadened the range of financial and non-financial institutions, which are granted access to CB money, such as security firms, security settlement systems, foreign exchange settlement institutions, insurance companies. In many cases access to CB money and (limited) banking regulation is extended to non-banks that provide payment services. In order to facilitate cross-border, foreign exchange, and multicurrency settlement, some CBs adapted their policies to allow remote access to CB money, i.e. access for institutions that have no offices in the country under consideration.

Restrictive access to intraday credit

Third, CPSS (2002) reports that, in general, access to CB accounts also implies access to intraday credit at the CB and the underlying considerations are very similar. In order to limit their risk exposure, CBs require collateral or third-party guarantees, charge fees, and set limits, which provide further instruments to fine-tune CB policies with respect to institutions. Technological

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[31] Access to CB accounts influences the costs and the legal barriers non-bank entrants to the payments market face and, thus, affects efficiency, concentration, and stability of the payment system.

[32] "Core Principle VI: Assets used for settlement should preferably be a claim on the central bank; where other assets are used, they should carry little or no credit risk and little or no liquidity risk." (CPSS 2001a, 34).

standardisation (acceptance of international standards for message protocols) can reduce the costs of direct access to interbank payment systems and can have an impact on CBs' access policies.

Table A-16 provides an overview of access criteria to selected LVPS in the Euro area, the UK, and the US and documents wide variations between different systems. Neither CBs' settlement nor their access policies at large are by any means homogenous, according to CPSS (2002). CBs have a number of instruments from their tool-box of payment systems policies at hand to react to – but also to play a more proactive role in shaping – institutional change in the payment system.

A common framework of analysis

The chapters of the report build on a common framework, which consists of diverse but complementary methodological approaches. The analysis of data concerning retail and wholesale payment systems in the Euro area, the UK, and the US shows pronounced institutional variation. Policy initiatives and changing demand by banks and final customers are seen as the main drivers of institutional change. The latter leading to strong growth in the values and numbers of transactions in wholesale as well as retail and small value interbank payment systems. This in turn leads to calls for higher efficiency of payment systems, but also serves as motivation for many policy initiatives. New payment instruments and payment service providers, the move to RTGS and increasing electronification are the most visible signs of institutional change. Electronification and alternative means of payment are expected to lead to a steeper payment pyramid: the ratio of CB money to total value of payments decreases. This development gives rise to concerns about the future role of money in general and CB money in particular in the economy-wide payment system. Institutional change affects monetary policy by its impact on demand for CB money and on the efficacy of monetary policy implementation at a given demand for CB money. CBs have a large range of instruments at their discretion to react to and to influence institutional change in the payment system. They are heavily involved in the legal and political process shaping the broad legislative framework concerning payment instruments and they are transferred substantial regulatory power within the broad legislative framework. In addition, CBs can adapt the instruments of monetary policy implementation and their own payment system policies to cope with institutional change in the payment system.

1.7 The Chapters

In this section the chapters of the report are discussed in the order they appear in the report.

Historical analysis of relationship between payment systems and monetary policy for the US

Lawrence H. White's sterling point in **"Institutional Change in the US Payments System and its Implication for Monetary Policy (1945-2000)"** is that the central bank's monetary liabilities consist of paper currency (in the United States, Federal Reserve notes) and commercial bank deposit balances held at the central bank (which the banks use for interbank settlements). Payment system innovations have potential consequences for monetary policy, if they provide such close substitutes that they significantly reduce the scale or increase the price-elasticity of demand for central-bank-issued currency or central-bank-issued settlement deposits. His chapter analyses the structure of recent innovations that may provide close substitutes for paper currency and for central-bank settlement balances. He investigates the effects of these on the institu-

tional structure of the economy-wide payment system and the response of US monetary policy. He also compares the more recent developments with the diffusion of credit and debit cards and their impact on US monetary policy.

A model of institutional change in the payment system

Forrest H. Capie, Dimitrios P. Tsomocos and Geoffrey E. Wood **("Modelling Institutional Change in the Payment System and its Implications for Monetary Policy")** appraise one possible technological development, namely the evolution of electronic barter, and model both it and money as transactions technologies. Their method is in the tradition of Shubik's approach to modelling monetary institutions. By comparing the models, they appraise the future of fiat money. First is set out an outline of the technology that may replace money. This is followed by an informal description of the model used to appraise both this technology and fiat money as means of conducting exchanges. This is in turn followed by the development of a formal model, and the implications of the analysis for the survival (or otherwise) of fiat money. This leads to a discussion of economic policy, and then to a concluding overview.

Models of a world without money

In his paper "**eMoney and Monetary Policy: The Role of the Inter-eMoney-Institutions-Market for Settlement Media and the Unit of Account**" Stefan W. Schmitz presents a critical assessment of the literature on eMoney and monetary policy. After briefly summarizing his own previous results on eMoney, redeemability, the unit of account and monetary policy, he arranges the alternative models of eMoney and monetary policy in three categories. First come models which assume that central bank money will be replaced by another medium of exchange. Second is a review of models that argue that the residual demand for base money will remain positive, and third of those that propose payments systems with a publicly sanctioned unit of account, but without a generally accepted medium of exchange (GAME), in which net balances are either settled by privately issued fiat-type monies or the transfer of wealth. In the case of the last he discusses the implicit models of the market for media of settlement between eMoney-institutions and the role of the unit of account. Emphasized is the relationship between the function of money as the generally accepted medium of exchange (GAME) and its function as the unit of account, in doing so. His conclusion is that the alternative models of a world without money are inconsistent and incomplete, thus confirming his previous results on eMoney, redeemability, the unit of account and monetary policy by rejecting the alternatives.

Conceptualising a world without money

Stefan W. Schmitz **("Monetary Policy in a World without Central Bank Money")** sets out the prospects for monetary policy in such a world. The role of CB money as generally accepted medium of exchange (GAME) is a precondition for the implementation of monetary policy in the current institutional set-up. In the paper it is shown that conferring certain regulatory competencies (including the power to impose financial obligations on third parties) on CBs enables them to implement an equivalent to monetary policy in a world without CB money. The analysis is based on the conceptualisation of a payment system that does not settle in CB money; in which the demand for CB money is actually zero. As shown by an analysis of the legal foundations of the operations of the ECB and the Fed, CBs do in fact already possess the necessary regulatory powers to manipulate the demand for the generally accepted medium of exchange (GAME). Politico-economic objections to granting CBs the necessary regulatory competencies also apply to the institutional frameworks currently in place in the Euro area and the US.

In a case study of the effects of the Austrian eMoney scheme Quick on monetary policy **("Electronic Money in Austria: Legal Foundations, Brief History, and Monetary Policy Implications")** Stefan W. Schmitz demonstrates how CB can limit the detrimental impact of the diffusion of payments innovation on monetary policy implementation. Reporting requirements, redeemability requirements, and minimum reserve requirements are the main instruments that are applied in the case under consideration. While the details of the institutional structure of the scheme differ from schemes in other EU countries, the legal framework is largely defined by the EU eMoney directive 2000/46/EC and the ECB instruments of monetary policy implementation.

Case study: eMoney in Austria and monetary policy

An **appendix** providing data on transaction volume and value in major payment systems as well as on their institutional characteristics in the euro area, the UK, and the US is to be found at the end of the report. It was researched and compiled by Florian Saurwein.

Data appendix

1.8 Overview

It is hard to avoid ending such an introductory chapter with a plea for further research, and a recommendation to study the papers which follow. Both of these should be taken as read. A little more, however, is worth saying. In particular, by whatever mode of analysis was used it emerged that fiat CB money would not be wholly replaced by any form of electronic money currently envisaged. Second, it was also clear that developments which have in the past, and may in the future, improve the robustness or the efficiency of payments systems have not had fundamentally damaging effects on the ability of central banks to control monetary conditions.

CBs have sufficient instruments at hand to ensure the efficacy of monetary policy despite institutional change in the payment system

In sum, the tension between the central bank's goal and that of the commercial banks which was alluded to in the opening of this introduction has so far been creative rather than destructive, and shows signs of remaining so.

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[33] The project proposal was submitted and financial funds were allocated to the project before Stefan W. Schmitz joined OeNB.

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2 Payments System Innovations in the United States since 1945 and their Implications for Monetary Policy[1]

Lawrence H. White[2]

2.1 Payments System Innovations in the United States since 1945 and their Implications for Monetary Policy

2.1.1 The revolutions that haven't yet happened

Monetary policy rests on the demand for CB liabilities

Monetary policy works through its control over the monetary base, the volume of the central bank's monetary liabilities. (Central bankers typically prefer to think and talk about monetary policy working through changes in a targeted interest rate, but the central bank's balance sheet holds the key to understanding what the central bank can do to influence interest rates and other variables.) The central bank's monetary liabilities consist of paper currency (in the United States, Federal Reserve notes) and commercial bank deposit balances held at the central bank (used for interbank settlements).[3] Payment system innovations have potential consequences for the conduct of monetary policy if they provide such close substitutes that they significantly reduce the scale or increase the interest-elasticity of demand for central-bank-issued currency or central-bank-issued settlement deposits.

Recent innovations can affect the demand for CB liabilities

Recent innovations that may provide close substitutes for paper currency include such electronic money devices as card-based, mobile-phone-based, and personal-computer-based means for consumers to hold and transfer spendable balances. Innovations that may provide close substitutes for central-bank settlement balances include deposit-transfer systems that settle outside the central bank's books, such as PayPal, e-gold, and deposit transfers cleared and settled by private systems (private automated clearinghouses and ATM networks).

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[3] In the US, Federal Reserve liabilities of both types also serve to satisfy a commercial bank's statutory reserve requirements against demand deposits. By computerized "sweeping" of demand deposits into other liabilities without reserve requirements, US banks have reduced their statutory requirements so dramatically in the past 10 years that the requirements have effectively become non-binding (Anderson and Rasche 2001). Many banks now more than satisfy their requirements simply with the Federal Reserve notes they hold to meet customer check-cashing and automatic teller machine withdrawals.

In a 1996 interview (Bass 1996) banker Walter Wriston declared that digital currency carried on smart cards was "the revolution that's waiting in the woods" and a "technology … on the verge of exploding". The predicted explosion has yet to happen.

Some economists expect very serious negative consequences for CB

Monetary economists (Cronin and Dowd 2001; Friedman 1999) and central bankers (BIS 1996; King 1999) have envisioned serious consequences for – perhaps the complete disappearance of – monetary policy should privately issued electronic money completely displace central bank liabilities. The literature on e-money in this respect resembles the earlier literature on the "legal restrictions theory" of money demand (see Wallace [1983] and White [1987]), which envisioned the complete displacement of central bank liabilities by higher-yielding bonds in the absence of legal restrictions. Cronin and Dowd (2001, p. 227) foresee that

> the demand for central bank money will not only drastically fall, but also probably disappear altogether, over a foreseeable horizon. Prospective technological progress with electronic payments and settlements systems is likely to combine with ongoing institutional changes – such as shifts toward private-sector settlements systems – to eliminate the demand for central bank money.

One BIS (1996, p. 2) report posits that e-money innovations "have the potential to challenge the predominant role of cash for making small-value payments" by dint of their greater convenience, but worries that therefore "they also raise a number of policy issues for central banks because of the possible implications for central bank seigniorage revenues and monetary policy and because of central banks' general interest in payment systems." To date, the displacement of paper currency by e-money has been a non-event for US monetary policy makers.

At the 1999 Jackson Hole conference on "New Challenges for Monetary Policy," sponsored by the Federal Reserve Bank of Kansas City, the Bank of England's Deputy Governor Mervyn King (1999, p. 49) declared that, with enough computing power,

> There is no reason, in principle, why final settlements could not be carried out by the private sector without the need for clearing through the central bank. … [T]he key to a central bank's ability to implement monetary policy is that it remains, by law or regulation, the only entity which is allowed to corner the market for settlement balances … Without such a role in settlements, central banks, in their present form, would no longer exist, nor would money.

The Federal Reserve System's role in clearing and settlement has, if anything, grown since 1999. At the 2003 Jackson Hole conference, where the topic was "Monetary Policy and Uncertainty: Adapting to a Changing Economy," the changes and uncertainty posed by electronic money and private settlement were never mentioned as a concern.[4]

[4] The uncertainty that seemed of the greatest concern to the 2003 Jackson Hole policymakers was uncertainty about the size of the gap between actual output and "potential output".

2.1.2 Credit and debit cards

The diffusion of credit and debit cards constitutes the most visible sign of institutional change in the US payment system

Between 1945 and 2000, the proliferations of credit cards and later debit cards were the most visible developments in US retail payments. Credit cards systems grew to handle nearly one-fourth of US retail payments. The effects that these developments had on monetary policy, through their effects on the demand for central bank money, may give us some hint as what we might expect from payment innovations now in prospect.

History of US credit and debit cards

Sellers have extended credit to their customers for centuries. The growth of multi-outlet retail chains (most notably of gasoline stations and department stores) in the early twentieth century led to the formalization of standing credit authorizations and their representation by company "charge cards" that could be used for charging purchases at any of the company's outlets. Such single-company cards were supplemented by "travel and entertainment" cards beginning in 1950. The first of these was the Diners Club card, initially accepted by 14 restaurants in New York City. American Express, then a leading issuer of traveler's cheques, launched a more widely accepted T&E card in 1958. Unlike some retail chains, Diners Club and American Express expected the consumer to pay his charge balance in full at the end of each month.

Meanwhile various banks, the first of which may have been Franklin National Bank in New York in 1951, began issuing their own "universal" credit cards combining widespread acceptance with the opportunity to defer repayment beyond the end of the month. Because US laws at the time restricted each bank to operating in a single state or city, each bankcard was similarly limited at first, accepted only by the local retailers that the bank had signed up. Bank of America, then the largest bank in California with branches throughout the state, launched its BankAmericard in 1958. It took the card nationwide through licensing agreements with banks in other states beginning in 1966. An alliance of other California banks, seeking to build a network large enough to challenge the BankAmericard, formed a reciprocal bankcard-acceptance arrangement called the Interbank Card Association in 1966, and quickly began signing up banks in other states. The association adopted the "Master Charge" brand in 1969. Bank of America responded to the challenge by transferring ownership of its card brand to a similar association of issuing banks in 1970. The association licensed the card internationally, renaming it Visa in 1976. Master Charge became MasterCard in 1979.[5]

A third universal card, the Discover Card, was introduced by the nationwide Sears retail chain through a financial services subsidiary in 1985. American Express introduced its own universal credit card, the Optima Card, in 1987.

Credit card penetration became high in the 1970s and has continued to rise at an even pace, as measured by the share of US households having at least one credit card. According to the Federal Reserve System's Surveys of Consumer Finances (Yoo 1998, p. 21), the share stood at 64 percent in 1983, 70 percent in 1989, 72 percent in 1992, and 75 percent in 1995.

Some economists in the 1970s extrapolated from the growth of credit card use to the notion that credit cards would soon almost completely supplant cash and check payments, making the monetary aggregates irrelevant. Brunner and Meltzer (1990, p. 358 n. 1) later commented:

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[5] MasterCard International (n.d.), Visa USA (n.d.).

in the United States following the introduction of credit cards and a wider range of substitutes for money in the 1970s [a] common claim was that the demand for conventional money – currency and demand deposits – would go to zero and monetary velocity would approach infinity. Shortly after these predictions, monetary velocity declined.

Diffusion of credit cards not among major explanations for changes in M1 velocity

Cross-sectionally, as one would expect, credit card ownership is associated with smaller holdings of demand deposits (Duca and Whitesell 1995). But in time series the velocity of US$ M1, as Brunner and Meltzer indicated, declined after 1980 despite the continued growth in the use of credit cards (see Figure 2.1-1). The leading explanations for the post-1980 break in the path of M1 velocity are (1) the corresponding break in the path of nominal interest rates (Rasche 1993), caused by disinflationary Federal Reserve policy, and (2) the deregulation of interest rates on M1 deposits (Rotemberg 1993).[6] Given that the spread of credit cards was gradual and steady, there is no reason to link the use of credit cards to the sudden unsteadiness of M1 velocity and the corresponding challenge for monetary policy-makers.

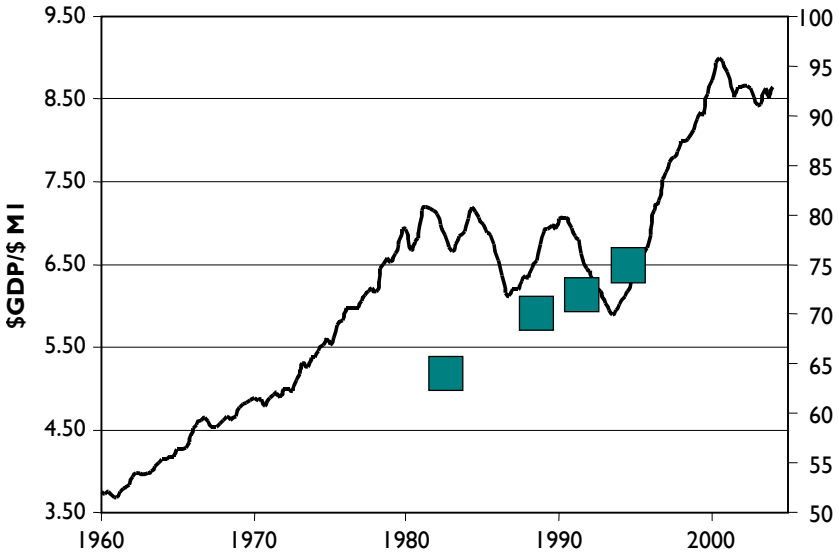

Figure 2.1-1: Velocity of US M1, 1960-2004, and Credit Card Use

[6] For discussion of the impact of the velocity trend break on monetary policy thinking, see Hafer and Wheelock (2001).

2.1.3 Electronic payments today in the USA

Wholesale wire transfer

Largest values of electronic payments are large value interbank payments

The largest flows of electronic payments in the United States are large-value ("wholesale") interbank payments over Fedwire and the National Settlement Service, both owned and operated by the Federal Reserve System, and over CHIPS, owned by an association of 54 commercial banks from 22 countries and operated by The Clearing House, an association of the US affiliates of 11 major banks.[7]

Fedwire and the National Settlement System are operated by the Fed and settle in CB money

Fedwire is a real-time gross settlement system (with intraday overdrafts) that transfers funds among commercial banks' reserve accounts at Federal Reserve Banks. Banks use Fedwire to transmit interbank loans of reserves ("federal funds") and, on behalf of customers, to transmit immediate final payment for securities and real estate transactions. The National Settlement System (NSS) is a mechanism for private-sector clearing networks (that handle paper checks, automated clearinghouse payments, ATM and debit cards, and credit cards) to settle end-of-day net obligations among participating banks by transferring funds among the banks' reserve accounts at Federal Reserve Banks.[8] According to the Federal Reserve, about 9500 institutions can send or receive funds over Fedwire. In the year 2000, daily Fedwire activity approached 430,000 payments with a total dollar value around $ 1.5 trillion. The mean payment was around $ 3.5 million, the median around $ 25,000.[9]

CHIPS is operated by banks …

CHIPS (Clearing House Interbank Payments System) handles a comparable daily volume of payments: 257,000 payments a day with a total dollar value around $ 1.4 trillion. Banks principally use CHIPS to transmit payment for foreign exchange transactions and cross-border payments. Rather than real-time gross settlement for each transaction, CHIPS uses what it calls "a combination of prefunding and bilateral or multi-lateral netting," with the netting continuously conducted during the day by its "patented balanced release algorithm". The netting reduces gross payment flows and thereby reduces participants' liquidity needs. The "prefunding" of settlement accounts (i.e. the pledging of liquid reserve balances, the equivalent of an escrow arrangement), in the amount of some $ 2.8 billion at start of each day (with provisions for intraday topping-up when necessary), allows CHIPS to provide real-time finality for payments up to the value of the paying bank's available liquid funds. CHIPS declares that "Payments are matched, netted and settled usually in a matter of seconds. Over 85% of payments are cleared before [noon]." Settlement of interbank net obligations takes place through transfers among the banks' reserve deposits held on the books of the Federal Reserve Bank of New York.[10] CHIPS advertises that it is less costly for its participants than Fedwire, but one industry observer (McGuire 2001, p. 4) has said that CHIPS "competes with Fedwire chiefly on the basis of service innovation and quality."

CHIPS introduced real-time finality only in 2001. Previously it had used end-of-day net settlement with a contingency plan for "unwinding" of payments in the event of end-of-day participant default. (The plan never had to be put into

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[7] The Clearing House, formerly known as the New York Clearing House Association, is jointly owned by The Bank of New York, ABN AMRO, Bank of America, Deutsche Bank, HSBC, Citigroup, Wells Fargo, Bank One, JP Morgan Chase, Wachovia and Fleet.

[8] http://www.federalreserve.gov/paymentsystems/fedwire/default.htm.

[9] http://www.federalreserve.gov/paymentsystems/coreprinciples/default.htm.

[10] See McGuire (2004, p. 1) and http://www.chips.org/about.php.

practice because no participant has ever defaulted.) The move to real-time finality might seem to have improved the competitive position of CHIPS as against Fedwire/NSS, but volume on CHIPS has not been growing any faster than volume on Fedwire/NSS.

… but also relies on CB money for final settlement

Even if CHIPS were to completely displace Fedwire and NSS, the implications for base money demand – and therefore for monetary policy – would seem to be minor. As noted, CHIPS makes final settlement using base money in the form of bank deposits at the Federal Reserve Bank of New York. CHIPS could in principle settle off the Fed's books (Selgin and White 2002, pp. 145-46), as all clearinghouses did before the advent of the Federal Reserve. If it were to settle by physical transfer of Federal Reserve Notes, the banks' demand for base money would merely be changing form, not size or elasticity. If it were to settle by transfer of claims on the clearinghouse association's own depository, that depository would need to own base money. (In pre-Fed days, the NYCHA normally held 100% gold reserves.) As long as base money remains central bank liabilities, the central bank retains a foothold sufficient for conducting monetary policy.

As long as settlement takes place in CB money, the efficacy of monetary policy in ensured

Retail electronic payments

Ongoing electronification of retail payments (i.e. paper checks, direct deposits and credit transfers)

Perhaps the most prominent recent development in retail payments systems in the United States has been the steady progress in switching from paper checks to electronic deposit transfers cleared through the automated clearinghouse system. The Federal Reserve (see Table 2.1-1 below) reports that the volume of paper checks peaked in 1999 and has declined each year since. The Fed processed 15.8 billion paper checks in 2003, a volume 4.7% smaller than in the previous year.[11] At the same time the Fed processed 5.6 billion commercial electronic payments in 2003 through its FedACH (Automated Clearing House) system, a volume 12.1% greater than in the previous year. These commercial FedACH payments exclude large-value wire transfers. At present the lion's share of ACH payments are pre-arranged "direct deposit" of payroll and "direct payment" of monthly bills, but a growth area is payments that the consumer individually authorizes via internet banking.

Table 2.1-1: Activity in Federal Reserve Priced Services, 2003, 2002, and 2001

	Millions of items			Percent change	
Service	2003	2002	2001	2002 to 2003	2001 to 2002
Commercial check	15,806	16,587	16,905	-4.7	-1.9
Funds transfer (Fedwire)	126	117	115	7.5	1.6
Commercial FedACH	5,588	4,986	4,448	12.1	12.1

Source: Federal Reserve System (2003, p. 118)

[11] The Federal Reserve System (2002b, p. 12) estimates that it clears 41% of the paper checks written in the US; total checks thus numbered close to 40 billion. The other clearing routes are "on-us," i.e. within-bank (29%), through private clearinghouses (18%), same-day settlement (6%), Treasury/postal money order (1%), and other (5%).

Table 2.1-2: Estimated Volume and Dollar Value of US Electronic Retail Payments, 2000

Payment instrument	Transaction volume (millions)	Dollar volume ($ millions)	Average payment value
Credit cards	15,048	$ 1,235,374	$ 82.10
Debit cards	8,278	$ 348,131	$ 42.05
Automated Clearing House*	5,622	$ 5,674,851	$ 1,009.40
Electronic Benefits Transfer	537	$ 13,744	$ 25.56
Total	29,487	$ 7,272,100	$ 246.62

** Table 2 ACH volume exceeds Table 1 ACH volume because Table 1 includes only payments routed through the Fed's ACH system. Table 2 includes privately cleared ACH payments.*

Source: Federal Reserve System (2002b, p. 58) and author's calculations based thereon. Credit cards are the sum of general-purpose and private-label cards. Debit cards are the sum of "offline" (signature-based, routed through Visa and MasterCard networks) and "online" (PIN-based, routed through ATM networks) cards. EBT here counts only consumer payments using funds in special government-benefit accounts (representing food aid, welfare, Social Security, Veterans' pensions); government transfers into the accounts are included under ACH.

Diffusion of electronic payment instruments already high

The Federal Reserve continues to study the status and evolution of the US payments system. The Fed's 2001 "Survey of Consumer Finances" found approximately 88 percent of U.S. families in that year using electronic funds transfer services in one or more of four forms: ATM cards, debit cards, direct deposit (into a consumer's bank account, typically of pay or government benefits), or direct payment (electronically deducted from a consumer's bank account). About 70 percent used ATMs, 67 percent direct deposit, 47 percent debit cards, 40 percent direct payments (FRB 2003, p. 73).

Emerging payment instruments might influence monetary policy

The Fed's 2000 "Electronic Payment Instruments Study," in addition to measuring the volume of these four established payment techniques, noted the following "emerging payment technologies" (Federal Reserve 2002b, p. 70):

- Electronic Bill Payment and Presentment
- Person-to-Person (P2P) payment
- Stored Value (prepaid) cards
- Internet Currencies.

Each of these emerging payment technologies merits some discussion comment as to its character and potential implications for monetary policy. In addition, we consider the mobile phone payment systems that are now in development.

The Fed study also mentions, as payment technologies in the test-marketing stage,

- internet platforms for debit/ATM cards
- an "ACH debit card"
- point-of-sale conversion of paper checks to electronic transactions
- internet platforms for debit/ATM cards, routing the payment through the Electronic Funds Transfer networks (i.e. through ATM clearing systems such as Star and NYCE). Like PayPal, but unlike internet bill payment via ACH (which typically takes two or more days to deliver the payment), the EFT networks transmit the payment near-instantly.[12]

[12] See Davis (2002).

- an "ACH debit card," which in contrast to an ordinary debit card "routes transactions through the ACH system rather than an EFT network."
- point-of-sale conversion of paper checks to electronic transactions which are then routed through the ACH system.

We will consider these technologies in connection with electronic bill payment and presentment, because all are devices for facilitating deposit transfer.

Electronic Bill Payment and Presentment (EBPP)

refers to "online services that enable customers to receive, review and execute payment of their bills over the Internet" by transfer of bank deposits. EBPP is a small but rapidly growing category of ACH payments. Previously the ACH system focused on pre-authorized recurring payments (e.g. payroll, monthly mortgage). EBPP allows consumers to make one-time payments using telephone or internet banking. As such, EBPP provides a close substitute for paper checks rather than for paper currency. The same applies to point-of-sale conversion of paper checks to electronic transactions which are then routed through the ACH system.

EBPP substitute for paper checks rather than for CB money

An internet platform for debit cards that would route the payment through the Electronic Funds Transfer networks (i.e. through ATM clearing systems such as Star and NYCE) rather than through ACH would provide yet another close substitute for paper checks rather than for paper currency. It potential advantage over internet bill payment via ACH, which typically takes two or more days to deliver the payment, is that the EFT networks transmit payment near-instantly.[13] Thus online EFT debit would combine the convenience of online payment from an existing bank account with the immediacy of PayPal.

The replacement of paper checks with EBPP (or online EFT debit) would reduce the use of central bank settlement balances only if ACH (or EFT) payments were more commonly cleared and settled outside the Fed's books than are check payments. In practice, the Fed is even more predominant in ACH than in check clearing. The Federal Reserve Banks clear about 69% of interbank paper checks, but more than 80% of commercial interbank ACH payments and 100% of government-to-recipient ACH payments (Electronic Payments Network 2002, p. 2).

EBPP cleared and settled mostly by Fed

The Fed's dominance of ACH processing has actually increased in the past decade. The ACH system was launched in 1974. The Depository Institutions Deregulation and Monetary Control Act of 1980 directed the Fed to price its payment services (both check and ACH processing) on a "market-competitive" and cost-recovering basis, with the intention that private-sector payment providers would no longer face subsidized competition. In 1994 the three existing private-sector ACH operators – American Clearing House, Visa, and the New York Automated Clearing House – formed a private exchange system, labelled PAX, allowing them to exchange transactions without going through the Fed and paying the Fed's inter-regional fees. Gowrisankaran and Stavins (2004, 262) estimate that in 1996 the FedACH system "handled approximately 75% of the roughly 3.3 billion on-others (between two different banks) commercial ACH transactions processed". In 2001 and 2002 the Federal Reserve Banks substantially reduced the prices of their ACH services, and announced plans for a third price cut, driving the American Clearing House and Visa out of the business (Electronic Payments Network 2002, p. 7),. Today the NYACH, renamed the Electronic Payments Network, is the only remaining private ACH

Fed increasingly dominates ACH processing

[13] See Davis (2002).

operator.[14] The EPN has publicly complained about the Fed's "unfair" and "anti-competitive" pricing policies, but Fed officials have argued that its reduced prices reflect its reduced unit costs for ACH transactions (Herd 2001; Roseman 2003).

Even private clearing systems settle in CB money

In any event the settlement for all private clearing systems (paper checks, ACH, EFT) takes place on the Fed's books through the National Settlement System. Even the complete displacement of Fed clearing by private clearing would therefore not affect the demand for base money (except to the extent that greater netting takes place before settlement) or the potency of monetary policy.

Person-to-Person (P2P) payment

"involves an electronically initiated transfer of value from one individual to another" to "send money to family members, settle debts with friends and pay for items purchased through online auctions." (Federal Reserve 2002b, p. 70). The Fed study does not name specific providers but clearly refers here to the PayPal service (purchased in October 2002 by the auction website eBay) and its less successful rivals (Citibank's c2it, which closed down in November 2003, and Yahoo! PayDirect). PayPal currently has about 40 million US-dollar-denominated accounts, and a total of slightly more than 45 million accounts world-wide. It does not report the US$ stock of funds in those accounts. The Wells Fargo Bank, the payment processor for PayPal, reported US$ 12 billion in Internet payments flow during 2003. PayPal's reported payment flow for the first quarter of 2004 was US$ 4.3 billion. Compared to the previous year's first quarter, PayPal's nominal revenue grew 68 per cent.[15]

P2P payments grow fast from low levels

PayPal combines a credit card and deposit transfer forwarding service with the functional equivalent of an online bank with instantaneous on-us settlement. If Smith has a positive PayPal account balance, he pays Jones by transferring part of that balance. If Smith's account balance is zero, he pays by charging a pre-registered credit card or making an ACH transfer from a pre-registered bank account. Jones receives a demandable debt claim on PayPal in the form of a PayPal account balance. A positive PayPal account balance can be withdrawn (transferred to an ordinary bank account) by check or ACH transfer. Though it has deposit-like liabilities, PayPal denies that it is a bank: when opening a new PayPal account, a customer must agree to the statement "that (i) PayPal is not a bank and the Service is a payment processing service rather than a banking service, and (ii) PayPal is not acting as a trustee, fiduciary or escrow with respect to your funds, but is acting only as an agent and custodian."[16]

PayPal relies on credit cards and the banking system as underlying infrastructure

The core of PayPal's business is not in fact best described as person-to-person payment, but rather as person-to-micromerchant payment, where a "micromerchant" is a seller whose business is too casual or too small to justify the cost of signing up with Visa or MasterCard (if they would even accept him). One journalist (Sisk 2004) notes that PayPal

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[14] Regional payments associations – e.g. Western Payments Alliance, South Western Automated Clearling House Association, Southern Payments Exchange – support and represent commercial banks in their ACH business but do not themselves process payments.

[15] http://www.epaynews.com/statistics/transactions.html; www.epaynews.com archive (04 May 2004 and 23 Apr 2004).

[16] http://www.paypal.com/cgi-bin/webscr?cmd=p/gen/ua/ua-outside.

> "... essentially invented the micromerchant category through a combination of prescience and luck: prescience in realizing early that its emphasis on person-to-person payments would not pay the rent, and luck that it was the early favorite by buyers and sellers on the Internet's iconographic success story, eBay."
>
> "We started as P-to-P, but that ended up never being a big part of our business, and now it's less than 5 percent," says PayPal's Todd Pearson, managing director for merchant services. "Those who followed in our footsteps mistakenly thought that P-to-P was the main thing."

PayPal "gained critical mass quickly on eBay" because it offered buyers the convenience and speed of online payment with immediate confirmation, and because it offered sellers easy sign-up and fees that are a "fraction of the cost of [accepting] credit cards" (Sisk 2004).

Funds in PayPal accounts are held as bank deposits or MMMF shares ...

Does the growth of PayPal have any implications for monetary policy? For each dollar of a customer's PayPal account balance, PayPal holds a matching deposit balance in Wells Fargo Bank, unless the customer elects to have PayPal to invest the funds in shares of a PayPal money-market mutual fund (MMMF). The movement of balances from other commercial bank deposits to PayPal balances of the first type does not alter the banking system's total stock of demand deposits, but merely redistributes it among banks. It poses no difficulty for US monetary policy. The movement of spendable balances into the PayPal MMMF shares poses no greater difficulty for monetary policy than the growth of other MMMFs has posed since the mid-1970s. MMMF shares are not counted in M1, so their increasing use as a means of payment (relative to M1 deposits) increases the ratio of spending to M1 (the velocity of M1). Because the growth of MMMFs has been gradual, and their transactions use limited, the growth in M1 velocity over the period has likewise been gradual (again see Figure 2.1-1). MMMF shares *are* counted in M2, so the Fed can track their volume and estimate its effect on M1 velocity. The amount of spending per dollar of PayPal fund shares may be greater than that of other MMMF shares: unlike the typical checkable money-market mutual fund, PayPal imposes no minimum size on out-payments. If this difference in spending is great, and PayPal were to become sizable among MMMFs, the Fed might want to track PayPal MMMF balances separately from other MMMF balances.

... and does not pose new challenges for monetary policy

PayPal a non-bank bank and checkable MMMF

Whether PayPal ought to be considered a bank for regulatory purposes is an entirely separate question. It might be noted that a "bank" is defined in US law as an intermediary that both takes deposits and makes loans. PayPal does not make loans. In the 1980s, when US banks established subsidiaries to gather deposits (but not to make loans) in locations where they were not allowed open full-fledged branch offices, such subsidiaries were known as "non-bank banks". PayPal might accordingly be called a combination of "non-bank bank" and checkable money-market mutual fund.[17]

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[17] In a 2001 interview (at http://www.efinanceinsider.com/email31501.html), PayPal's "co-founder and CEO" Peter Thiel said that PayPal had deliberately avoided becoming a bank in order to avoid bank regulation: "We're 90% a payments company, and maybe 10% bank-like. We are not regulated like a bank because we don't offer FDIC insurance, but correspondingly we also have much less of a regulatory load. We are pretty determined to stay on that side of the banking rules. We've spent a lot of time looking at whether we should become a bank – we even had the option to acquire a bank charter in the fall – but we decided to avoid that track because of the regulatory cost issues and the sense that the payment piece is most valuable to people."

Stored Value (prepaid) cards

have garnered academic attention in the past decade for their potential to reintroduce private currency. At least in the form of MasterCard's Mondex device, which permits card-to-card transfers, card balances have been seen as the 21st century version of the 19th century banknote: bearer claims that circulate without engaging any interbank clearing system. Such balances could be a very close substitute for central-bank-issued currency *if* issuing them were a profitable undertaking.

Stored value cards would be a close substitute for CB bank notes ...

The Fed study comments (Federal Reserve 2002b, p. 70) that stored-value cards are "best known for their gift card application, as a replacement for a gift certificate," but "also being used for payroll, incentives, insurance, refunds and other purposes." Gift-certificate cards spendable only at a single retail chain are, however, quite different from general-use cards like Visa Cash and MasterCard's Mondex.

Godschalk and Krueger (2000, p. 6) have argued persuasively that issuing digital bearer balances (e.g. to be carried on "smart" microchip-embedded cards) does not yet appear to be profitable. The firm DigiCash, a pioneer in encryption software for bearer e-money, went bankrupt in 1998; the firm CyberCash did likewise in 2001 (see also McCullagh 2001). German banks have given away millions of cards capable of carrying currency balances, only to find that the public has little use for them. Nor have other technical platforms like personal computers proven popular as electronic purses:

... if issued them were profitable

> No e-money issuer has a clear business case. There is a morning-after feeling for most e-purse roll-outs in Europe. Even in Germany with a free mass distribution of e-purses on chipcards by the banks (more than 50 million GeldKarten) the volume loaded is stagnating at a level of a negligible 0.01% of the total money supply M1. For software-based e-money products like ecash we see in spite of booming e-commerce worldwide only a few pilot projects (e. g. Deutsche Bank).

As Kevin P. Sheehan (1998, p. 4) has commented: "electronic-cash pilots have shown that the technology is effective, but they have also shown that, for the most part, consumer demand is lacking."

For consumers, credit and debit cards already provide convenient noncash payments without explicit transaction fees. The credit card allows the consumer to borrow or enjoy float; the debit card allows him to pay from a deposit balance that earns interest up to moment it is spent.[18] To date, the most successful niche for prepaid chip card balances has been use as a substitute for coins in unmanned point-of-sale transactions: e.g. transit systems, parking meters, laundromats (Godschalk and Krueger 2000, p. 17). Non-banks, such as transit systems, have been the most successful issuers. Such use implies small balances per card, which implies little "float" to the issuer. For example, an average card balance of US$ 10 would, at a 4% interest rate, generate only US$ 0.40 per year per card in float for the issuer, not enough to cover the average costs of launching and maintaining the card scheme. The cards alone reportedly cost about US$ 2.50 each.[19] A transit system can find a smart farecard worth issuing even with near-zero float if it replaces a more costly fare-collection sys-

Alternative noncash instruments dominate stored value cards

[18] Retailiers face higher higher transaction processing fees for credit and debit cards (typically around 3%) than for prepaid cards (typically less than 1%), but for some reason retailers seldom offer consumers a discount for paying by the cheaper method. As a result consumers have little incentive to prefer prepaid cards.

[19] http://www.cardtechnology.com/cgibin/readstory.pl?story=20040301CTDN623.xml.

tem[20], but a bank will not find a currency-like card profitable with near-zero float unless it can collect sufficient per-use transaction fees. The higher the transaction fees, however, the less attractive is the card to the consumer as a cash substitute.

Lack of apparent profitability is presumably why, after test-marketing trials in the late 1990s (e.g. Visa Cash at the Atlanta Olympic Games of 1996; Mondex at Burger King restaurants on Long Island, NY in 1998; a joint trial in Manhattan's Upper West Side in 1997-8), little has been heard from Visa Cash or Mondex. MasterCard was reportedly pursuing "more than 400 smart card projects" in late 2003, but many if not most involved storing information other than money balances, such as loyalty points, event tickets, and personal data.[21]

Internet Currencies

Low diffusion of internet currencies

characterized by the Fed study as "intended to be spent on the Web," presumably refers to such now-abandoned schemes as Beenz and Flooz. Current startups that may belong in this category include the Peppercoin (http://corp.peppercoin.com/) and BitPass (http://www.bitpass.com/learn/) "micro-payment" systems. Promoters of these systems are hoping that pay-per-download music sites will be a "killer application" for micro-payments. Unlike Beenz and Flooz, Peppercoin and BitPass do not involve proprietary units of account, but denominate their payments in dollars. Thus they might alternatively be categorized as P2P systems (akin to PayPal, except that they emulate bearer currency rather than deposit transfer) or as the online equivalent of prepaid card balances. As in the case of prepaid cards, internet currencies limited to small payments should not be expected to pose a challenge to monetary policy.

Internet currencies denominated in alternative units of account suffer from negative network externalities

There also exist "internet currencies" today that are not dollar-based: the gold-based systems as e-gold.com and GoldMoney.com. Both offer gold ownership accounts, denominated in gold grams, with account balances transferable online. (As PayPal does, the services allow transfer to anyone with an email address and will create an account for the recipient if he does not already have an account.) E-gold currently claims 732,000 gold-denominated accounts (contrast PayPal's 45 million accounts), and processed 25,000 spending transactions on a recent day totaling 136kg, which at $ 12.815/g amounts to $ 1.74 million (compare PayPal's $ 47 million per day). The marketplace has not stampeded to e-gold, or to bricks-and-mortar gold banks, because of the well-known network property of a monetary standard (or "critical mass" problem, from the point of view of a potential competitor): customers who try to spend gold-denominated account balances around the internet (or around town) will discover relatively few stores willing to accept them in payment. The incentive to join the network of those who accept e-gold is weak so long as the network is small, so smallness of the network is self-perpetuating.[22]

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[20] As a replacement for collecting paper notes and coins from farecard vending machines, the Chicago Transit Authority now offers a "prepaid smart fare card" with an "automatic replenishment" feature whereby the commuter authorizes the CTA to reload the card balance when necessary by charging the commuter's credit card or debiting his bank account, http://www.cardtechnology.com/cgi-bin/readstory.pl?story=20040108CTDN004.xml.

[21] http://www.cardtechnology.com/cgibin/readstory.pl?story=20040303CTDN652.xml.

[22] Schmitz (2002) discusses how network effects reinforce the dominant unit of account in the context of electronic money systems.

The inertial barrier to a new monetary standard can be overcome by high inflation that makes the incumbent standard costly to use: in recent decades chronic high inflation in countries with peso and ruble standards has led to spontaneous "dollarization", the displacement of local currencies by US dollars. The most plausible scenario for spontaneous displacement of dollars by gold-based payments is likewise the advent of a high dollar inflation that is expected to persist. *In the event* of high inflation, the availability of a gold-based (or Euro-based, or Swiss-Franc-based) substitute for dollar-based payments will amplify the price-elasticity of demand to hold dollars and thereby compound the Fed's problems. But this correspondingly means that the availability plays the salutary role (from the public's perspective) of increasing the Fed's incentive to avoid high inflation. So long as the Fed does responsibly avoid high inflation, the availability of gold-based payment systems will not seriously weaken the demand to hold base dollars and therefore will not threaten the Fed's ability to conduct monetary policy.

Alternative units of accounts will not take off unless inflation is very high

Phone-based payments

The use of mobile phones for micropayments ...

have taken over much of the new-technology "buzz factor" that card-based payments have lost. A number of different models are being discussed and test-marketed, mostly outside the US. Although there are no apparent legal barriers to their development within the US, mobile phone penetration is slightly lower in the US.

Visa International and Philips Electronics have a joint venture to equip mobile phones with chips allowing them to conduct micropayment and credit-card transactions at unmanned points-of-sale.[23] Similarly the Hungary-based consortium SEMOPS (www.semops.com), for Secure Mobile Payment System, is developing a system for mobile point-of-sale payment, eliminating the consumer's need to wait in a line when the store is busy. These schemes offer new "front-end" access to established credit card systems rather than any fundamentally new payment system (the "back end" remains the same).

... is in a test phase

PhonePaid is a UK-based service, accessible either via the web *or* by calling a toll-free number and following the prompts, that appears to be closely modeled on PayPal. To pay someone you need his mobile phone number (rather than his email address, as with PayPal).[24] As an alternative P2P system, the monetary policy implications of PhonePaid appear identical to those of PayPal.

Phone-based systems might turn operators into competitors of banks

The British telecom firm Vodafone has launched "m-pay," a system that "allows Vodafone consumers to make remote micropayments [5 p to £ 5] by charging to their phone account." Merchants need m-pay hardware in order to accept m-payments. A consumer's payments during the month appear on his monthly phone bill. (Lonie 2003, p. 5) Such systems represent a potentially important innovation, because they turn phone companies into direct competitors with banks and credit card networks as payment service providers. They provide a substitute not only for deposit transfer and credit card, but also for cash payment.

In parallel with the historical emergence of par acceptance among private banknote issuers, mobile payment providers are already discussing hardware interoperability agreements in order to widen acceptance (see Mobile Payments Forum 2002). Should they provide any payment recipient the option to

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[23] http://www.cardtechnology.com/cgibin/readstory.pl?story=20040109CTDN020.xml.

[24] http://www.phonepaid.com/home/home.htm.

credit his own mobile account with whichever telecom (which would be more useful to him that a claim on the payer's telecom, thereby further widening acceptance), the participating telecoms would find it convenient to form an inter-telecom clearinghouse for mobile payments. To the extent that customers with net payment inflow choose to carry positive mobile account balances (rather than demand a transfer to their bank accounts at month-end), the phone billing system has become a parallel deposit-transfer system.

2.2 Conclusion

Shrinkage of the size of CB balance sheets will not lead to the inefficacy of monetary policy

Payment system innovations, in the United States as in Europe, continue (as they have for centuries) to promote the substitution of alternative payment media for direct use of base money. Though no revolution is evident, the real demand for central-bank-issued currency may shrink relative to transactions volume and to demand for broader monetary aggregates. In some respects, though no trend is evident in the United States, central-bank-issued deposit liabilities may be challenged as a medium for settling interbank flows. As argued elsewhere (Selgin and White 2002, pp. 147-154), the central bank's power to influence nominal variables is not proportional to the size of its balance sheet. Shrinkage of the central bank's balance sheet will therefore *not* usher in a new era in which monetary policy has no effect, either for good or for ill.

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3 Modelling Institutional Change in the Payments System, and its Implications for Monetary Policy[1]

By Forrest H. Capie[2], Dimitrios P. Tsomocos[3] and Geoffrey E. Wood[4]

3.1 Introduction

Many institutional changes have taken place to payments systems. Indeed, they have been in continual change ever since money first emerged as the dominant technology for conducting transactions. Means of settlement between banks have changed: cheques replaced cash in many transactions, and they have in their turn been replaced partially (much more in some countries than others) by cards. Technology is even developing whereby mobile telephones can be used to effect instantaneous settlement of transactions. These have all affected the relationship between the quantity of money demanded and income. But none of the innovations has threatened to move us from a money-using society to one which transacts by some other means.

Payment system has changed continuously over its entire history

The implications for monetary policy have therefore been, in theory at least, trivial. And this has also been true in practice. Central banks have remained able to use monetary policy to influence, and to control within surprisingly narrow limits, the course of the price level. Indeed, as the short-to-medium relationship between money and income has become looser (as evidenced by increasing difficulty in fitting well-behaved money demand functions), central bank control of inflation has improved. The changed constitutional relationship between central bank and government that has occurred in many countries appears to have produced benefits which have more than offset the increasing difficulty of using monetary policy to control inflation.

Monetary policy has remained effective

But how long can that benign outcome last? It would be too much to expect still further improvements to inflation control; that would be an excessive demand on monetary policy and central banks. Our concern is whether the *present* benign situation can persist. Will developments which appear to be on the horizon loosen still further the money-income relationship, or even end it by eliminating money as a transactions technology?

Are current innovations different?

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[1] The views expressed here are those of the authors and do not necessarily reflect those of the Bank of England, City University, LSE or the University of Oxford.

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The aim of this paper is to appraise one such possible technological development, and to model both it and money as transactions technologies. By comparing the models, we shall be able to appraise the future of fiat money.

The structure of the paper is as follows. We first set out an outline of the technology that may replace money. Then we provide an informal description of the model we use to appraise both this technology and fiat money as means of conducting exchanges. This is followed by the development of our formal model. We then develop the implications of our analysis for the survival (or otherwise) of fiat money. This leads to a discussion of economic policy, and then to a concluding overview of our findings and policy conclusions.

Monetary vs. barter systems of exchange

One preliminary remains: definition. McCallum (1985, 2003) distinguishes very clearly between a monetary system of exchange, a barter system of exchange, and an accounting system of exchange. The first is one which uses a "tangible mechanism of exchange"; a "monetary system of exchange", he goes on, is "… one in which the vast majority of transactions involve money on one side". This he contrasts with barter, "… in which commodities are directly exchanged without any intermediate conversion into money". The third type of system is one in which "… there is no money by which McCallum means at this point a medium of exchange] but exchanges are conducted by means of signals to an accounting network, with debits and credits to the wealth accounts of buyers and sellers being effected with each exchange." McCallum goes on to say that he regards that system as non-monetary, as a "highly efficient form of barter".

In the present paper we follow him in that. It must be noted, though, that whether such a system would dominate barter conducted electronically but *without* an agreed medium and unit of account should be demonstrated rather than assumed. We do, however, leave for another paper whether electronic barter with a mechanism and a unit of account would dominate electronic barter without these two features. The question is interesting, for only if the former does dominate is the concept and controllability of a price level a logically possible subject for discussion in an electronic barter world. But making the comparison would require detailed modelling of transactions costs in the two systems, and the results would not be relevant to the present paper's conclusions.

3.2 Technology and Exchange

Will computer technology lead to the displacement of fiat money?

The development of electronic, and in particular of computer, technology has led to speculation that electronic technology will replace fiat money in facilitating exchange. Just as barter was supplanted first by commodity money and then by fiat money because these were superior transactions technologies, so, it is argued, information storage and transmission will be so facilitated by computer technology that in its turn fiat money will be displaced.

Generally accepted medium of exchange function of money central to analysis

Central to analysis of this proposition is the medium-of-exchange function of money. The crucial distinction is between a money-using economy and a barter economy, whether it is one of primitive or of electronic barter, is that in the former a medium of exchange is used. Our aim in this paper is to establish a simple formal framework which will let us examine the crucial determinants of whether or not a medium of exchange will be used. To do this, we construct a model of exchange with costs of transacting an intrinsic part of it; for if there are no costs of transacting then there are no transactions costs on which a medium of exchange can economise.

As was observed some years ago by George Stigler (1972), a world without transactions costs would seem a very strange place. There would be no firms – and therefore no banks, insurance companies, or other financial institutions. And further, there would be no money. The essence of our argument is that so long as there are transactions costs there will be money, and that even electronic barter will not, except under very special circumstances which we set out below, be able to replace 'fiat' money because it will not be as effective in reducing transactions costs. To develop the economic intuition underlying our model we first argue informally why some form of money to mediate trade in mass anonymous markets evolved as a device to reduce the costs of transacting. Then, we go on to show that once the *concept* of using money had developed, still further cost reductions were achieved by a further development – convergence to a very small number of commodities which were used as money. Indeed, a single money is, subject to certain constraints on its issuance, the optimal outcome. We would remark at this point that while all the subsequent arguments are set implicitly or explicitly in an exchange economy the conclusions would be expected to hold *a fortiori* in an economy with production, for if there is production then the *number* of exchanges will exceed these in an exchange economy with the endowment that our production economy produces.

Transaction costs play a crucial role in the analysis

Barter, whether with or without electronic accounting, involves the double coincidence of wants. The buyer must want what the seller is selling – and *vice versa*. That could be eliminated by what Meltzer (1998) calls 'barter credit' – supplying goods now in exchange for a promise of goods later. But such transactions are rare even in economies with developed and reliable legal systems. Why? The reason is that there is a cheaper way of transacting. Credit, whether barter credit or not, requires the seller to know about the buyer – about his or her creditworthiness, and the features (such as income) which contribute to that. If a money which is widely accepted and recognised is available, then the personal attributes of the buyer become irrelevant. All that matters is what he is offering. *Less information has to be gathered, so trade becomes cheaper*. This expands the possibilities for trade, so both buyer and seller gain. (The analogy with a tariff reduction is clear.)

For something to *evolve* as the *sole* medium of exchange of a society, rather than be imposed as such, two conditions have to be satisfied. These are as follows. First, not all goods are equally suitable for use as money; the costs of acquiring information must depend on the good selected. Second, the marginal cost of acquiring information about whatever is used in exchange falls the more frequently it is used. These two features let us explain the once widespread use of precious metals as a means of payment. Such metals can be assayed for fineness, are divisible, can be readily quantified by weighing, and are homogeneous – an ounce of gold of a certain fineness is identical to another ounce of that fineness. Alternative monies – cattle, stones, and tablets of salt – did not possess these attributes to anything like the same extent. These are the attributes that guide us towards the monetary commodity. But, it should be emphasised, the information – economising attribute is crucial. Precious metals are not always available. If they are not, something else is used. Cigarettes were used as money in German prisoner-of-war camps in the Second World War (Radford (1945)). They were used because everyone could recognise them, and knew that everyone would accept them in any exchange

The costs of acquiring information depend on the good used as money and on the number of times it is used in exchange

We can thus see that a society will tend to evolve towards the use of a very few commodities as money, given the assumption that not all commodities are equally good at satisfying the medium of exchange function; and that one good will come to dominate if the marginal cost of acquiring information about that good falls the more it is used.

A generally accepted medium of exchange reduces transaction costs

Not only does the use of money eliminate the need to know about the buyer in a transaction. When it has evolved into use as a unit of account, another saving is achieved. Without a medium of account and unit of account, any transactor must know the bilateral exchange value of each commodity for every other commodity.[5] 'If there are n commodities, there are at least $(n(n\text{-}1))/2$ separate values. The number of bilateral exchange ratios (prices) rises quickly. With $n = 100$ commodities, there are at least 4,950 prices to know. At $n = 500$, the number if 124,750, and with 1,000 commodities there are at least 499,500 prices. Without a unit of account, trade would be very limited by costs of information. Use of a unit of account to express value reduces the number of prices from $(n(n\text{-}1)/ 2$ to n.' Meltzer (1998).

So far we have argued that evolution to the use of a few commodities and subsequently to one commodity as money, is beneficial. Subject to certain constraints going beyond that brings still further benefits. Paper money, so long as there is not overissue that leads to inflation, brings a resource saving if it substitutes in whole or in part for the commodities which heretofore had served as money.

To summarise, we have argued that the concept and use of money emerged through a process of search and discovery. Its advantage over barter credit, which has some advantages over simple barter, is that it reduces transactions costs still further by shifting attention from the qualities of the prospective purchaser of a good to the qualities of what he is offering to pay for it. From (in Allen Meltzer's words, *op cit*) 'a unique and possibly obscure set of attributes to a common and widely known set of attributes'. A money-using society requires less information than a bartering society.

Carl Menger and Adam Smith have emphasised the role of transaction costs in the emergence of money

Before going on to develop a formal demonstration of the above conclusions, and then to show their relevance to the future of electronic barter and paper money, it is useful to place the above arguments in their historical context, for the view of the development and role of money set out above is not new. A thorough exposition of it was provided over 100 years ago, by Carl Menger (1892).[6] He maintained that money was a 'social' creation, a product of the invisible hand. His was an example of an invisible hand explanation – in contrast to a government-based explanation – of a social institution (see Latzer and Schmitz (2002)). The basic point was not original to Menger, either. (It is a bold writer who asserts that he has found the original inventor of any economic concept!) Adam Smith had made the point in the *Wealth of Nations*.

'In order to avoid the inconvenience of such situations [where the would-be seller of a good does not want what the would-be buyer offers] every prudent man in every period of society, after the first establishment of the division of labour, must naturally have endeavoured to manage his affairs in such a manner, as to have at all times by him, besides the peculiar product of his own industry, a certain quantity of some one commodity or other, such as he imagined few people would be likely to refuse in exchange for the product of their industry.' (1981 ed., pages 37-38).

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[5] McCallum (2003) emphasises that the choice of a *medium* of account is of great importance and that once that choice has been made, the subsequent choice of a *unit* of account is of little significance. The example he gives is that the choice of gold or silver as a medium of account can be vital, but once that choice is made, the quantity of it which is the unit of account in unimportant. The debate over bimetallism in the US in the run up to the Presidential Election of 1896 makes the point.

[6] The complete text of this paper has recently been translated in English and is available in Latzer and Schmitz (2002).

And that money was originally a social institution, although it had subsequently become a government one, was also noted by Keynes (1935, pages 4-5).

'Thus the Age of Money had succeeded to the Age of Barter as soon as men had adopted a money-of-account. And the Age of State money was reached when the state claimed the right to declare what thing should answer as money to the current money of account – when it claimed the right not only to enforce the dictionary but also to write the dictionary.'[7]

Strong economic rational for generally accepted medium of exchange to serve as unit of account

Now, it is not logically necessary for the medium of exchange to serve also as the medium of account. But as several authors (Wicksell, 1935; Niehans, 1978; and McCallum, 1985) have emphasised, if they do not coincide the "computational benefits" of having a medium of account are incomplete unless the simple step of having it coincide with the medium of exchange is taken. Severe inflation can disrupt this, but it does need to be severe; the two seem to continue to coincide even at inflation rates well into three figures per annum.

3.3 Strategic Market Games: A Bird's Eye View

Strategic market games as useful methods to model monetary institutions

Strategic market games provide a framework to rigorously introduce money, other financial instruments as well as financial intermediaries to closed models. The need for accounting clarity, institutional detail and the criterion of 'playability' is such that minimal institutions (e.g. clearinghouses, central banks and other financial intermediaries, credit, default etc) and well-defined price formation mechanisms (sell-all, bid-offer, double auction) naturally emerge as logical necessities in the rules of the game and the equilibrium concept used. Ultimately, this class of games contributes to the development of formal micro foundations to money, financial economics and macroeconomics.

Strategic market games are related to the design of resource allocation methods introduced by Hurwicz (1960, 1973). They were formally introduced by Dubey and Shubik (1978, 1980), Shapley (1976), Shapley and Shubik (1977), Shubik (1973) and Shubik and Wilson (1977). Three main price formation mechanisms were introduced: one-sided Cournot type of model, a two-sided Cournot type and a double auction (or two-sided Bertrand-Edgeworth model). Fiat or commodity money is used and other market structures are also modelled. For example, foreign exchange markets whereby no natural *numéraire* or fiat money as a medium of exchange then one can employ a modified price formation where trading posts between any two instruments or commodities are set and consistent prices that clear all markets are determined via a giant clearinghouse.

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[7] The most fully developed modern statement of the 'transactions cost' theory of money can be found in the work of Karl Brunner and Allan Meltzer. The most detailed statement of their view is given in Brunner and Meltzer (1971). Alchian (1977) also develops the argument and Yeager (1968) draws out the implications of it for the behaviour of the macroeconomy. The argument that money evolved as a result of private initiative of course leaves unexplained why all money is now state money. Some scholars (eg Goodhart (2000)) argue that state money is an inherently superior 'institutional symbol of trust' (to use Shubik's definition of money), while others (eg Glasser (1989)) point to the successful existence of private mints until they were extinguished by law and maintain the opposite. A formal model of an explanation for the dominance of state money can be found in Monnet (2002). An additional factor which may predispose a society to state rather than private fiat money is the comparative irrelevance of the solvency of the state. See also footnote 14.

Refinement of strategic market games makes them suitable for modelling payment systems

Endogenous default, credit, financial intermediaries and incomplete asset markets are introduced and, therefore, one can formally model and analyse payment systems, monetary, fiscal and regulatory policies. For an excellent presentation of these models one can consult, Shubik (1990, 1999), and for a more technical analysis Giraud (2003). In principle, inefficiency in this class of models arises due to insufficient liquidity, or oligopolistic effects, or institutional restrictions. Hence, active policy has non-neutral effects and possibly, but not always, ameliorates welfare losses because of the transactions technology present in the models. Last but not least, abstracting from the oligopolistic effects, there exists a large literature on monetary general equilibrium models which is akin to the strategic market games one since money and institutions are introduced into the standard Arrow-Debreu model (e.g. Drèze and Polemarchakis (2000), Dubey and Geanakoplos (1992, 2003), Grandmont (1983), Lucas (1980)).

In sum, since the institutions of society in general, and the financial institutions in particular are the carriers of economic process a *mathematical institutional economics* is needed as it has been argued by Martin Shubik. This is what strategic market games attempt so that to achieve a better understanding of production, distribution, policy and, more generally, of political economy.

3.4 Formal Model

A formal model of payment systems based on cash-in-advance constraints

We use the strategic market game developed in Shubik and Tsomocos (2002). Money depreciates (ie it wears out through deterioration of notes and coins' quality) when used in exchange, and its replacement is costly.[8] The stipulated means of exchange is fiat money and all transactions need cash in advance (see footnote 11 for the motivation of this constraint). Thus, agents borrow fiat money to make their transactions. The government extracts seigniorage costs from the players in the form of interest rate payments. In order to do so, it participates in exchange and bids to provide for its inputs of production. The objective function of the government for the purposes of our argument, without loss of generality, is to minimise the interest rate subject to the requirement to replace worn out fiat money used in exchange, and the interest rate which is a choice variable of the government determines its revenues. We assume that the initial money supply enters exogenously. Figure 3.4-1 shows the extensive form of the game. The exchange game is a one-period game with four subperiods. At each subperiod, as we explain below, an agent or a group of agents move. We first modify the game to admit both fiat money and electronic barter. We conceptualise electronic barter mediated as through a giant clearing house run by an institution, perhaps the government. We then analyse the condition under which fiat money dominates electronic barter.

[8] Calculations of the rate of depreciation of various types of money can be found in Shubik and Tsomocos (*op cit*).

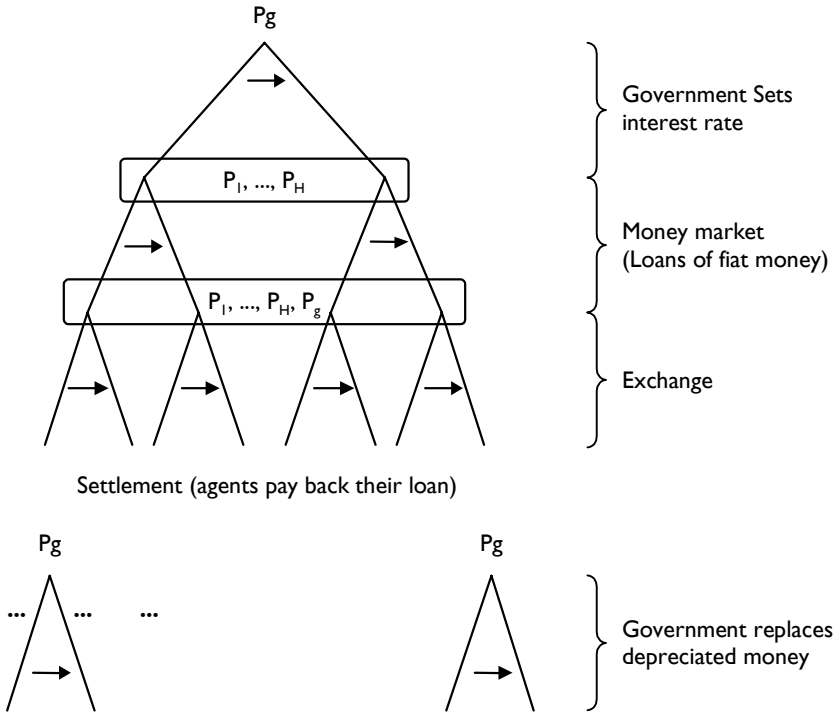

Figure 3.4-1: Trade with seigniorage cost of fiat money

(Note that the labelling P_1, ... ,P_H and similarly P_1, ... ,P_H, P_g indicate that all agents move simultaneously. Also, the arrows indicate that there is a continuum of their respective strategies.)

Government sets interest rate ...

At the first move the government P_g, determines the interest rate. At the second move, individuals, P_1, …, P_H, obtain fiat money in the money market at the predetermined interest rate. At the third move, individuals exchange commodities and the government buys inputs of production to be used in the replacement of depreciated fiat money. We maintain simplicity of strategy sets by assuming a continuum of traders, simultaneous moves, and a minimum of information at the second and the third stage. Then traders pay back their loans, and finally the government replaces depreciated money.

... and collects seigniorage to replenish depreciated money

The government levies seigniorage costs to replenish depreciated money and also participates in exchange.[9]

Let $h \in H = \{1, ..., H\}$ be the set of agents and $l \in L = \{1, ..., L\}$ be the set of tradable commodities. Each agent is endowed with a vector of commodities $e^h \in \Re_+^L$.

Agents maximise utility

The utility functions of agents are of the form $u^h : \Re^L \to \Re$.

9 A more extensive presentation and discussion can be found in Shubik and Tsomocos (2002).

The following assumptions hold:

(i) $\sum_{h \in H} e^h >> 0$

(ie every commodity is present in the economy).

(ii) $e^h \neq 0, \forall \ h \in H$

(ie no agent has the null endowment of commodities).

(iii) u^h is continuous, concave and strictly monotonic $\forall \ h \in H$.

(ie the more consumption the better).

Agents maximise their utility of consumption subject to the following constraints:

$$\sum_{l \in L} b_l^h \ \leq v^h \qquad \textbf{(1)}$$

(ie expenditures in commodities ≤ borrowed money).

$$q_l^h \leq e_l^h, \ \forall \ l \in L \qquad \textbf{(2)}$$

(ie sales of commodities ≤ endowment of commodities).

$$(1+r)\, v^h \leq \sum_{l \in L} p_l q_l^h + \Delta(1) \qquad \textbf{(3)}$$

(ie loan repayment ≤ receipts from sales of commodities + money at hand).

where, $b_l^h \equiv$ money bid of *h* for the purchase of commodity $l \in L$,

$q_l^h \equiv$ quantity of commodity $l \in L$ offered by *h*,

$v^h \equiv$ loans contracted by *h*,

$r \equiv$ loan interest rate,

$p_l \equiv$ commodity price of $l \in L$ and

$\Delta(1)$ is the difference between the right and left-hand sides of equation **(1)**.

A cash-in-advance constraint applies

As can be seen from the budget constraints **(1)** and **(3)** receipts from sales of commodities cannot be used contemporaneously for financing purchases of other commodities. This is the essence of the cash-in-advance constraint which can also be thought as a liquidity constraint.

The exogenously fixed money supply *M* depreciates at a rate η.

Thus, if the total amount of fiat money borrowed by the agents from the government (or central bank) is $\sum_{h \in H} v^h = \bar{\mu}$ and the expenditure of the government for the purchase of inputs of production is $\bar{g}$ then $\eta(\bar{\mu} + \bar{g})$ is the depreciated amount of money, since $(\bar{\mu} + \bar{g})$ is the total amount of money in circulation.

The government's production function for money exhibits decreasing returns to scale in order to generate a unique optimum.[10]

$$z_{L+1} = F\left(x_1^g,...,x_L^g\right) \quad \textbf{(4)}$$

with

$z_{L+1} \equiv$ amount of fiat money produced,

$x_t^g \equiv$ inputs of production.

We impose the standard technical assumptions on the government's production set, $y^g \in \Re_+^L$, that guarantee feasibility and the existence of a solution to the government's maximisation problem.

(iv) $0 \in y^g$,

(v) y^g is convex and closed

(vi) $\exists\ B > 0$ ∋ if $\left(x_1^g,...,x_L^g;z_{L+1}\right) \in y^g$ then

$x_l^g \in B,\ \forall\ l \in L$ and $z_{L+1} \le B$.

Government minimises interest rate given costs of production of money

The government seeks to minimise interest rates because it simply aims to levy the necessary seigniorage to replace depreciated fiat money. Thus the government's optimisation problem becomes,[11]

$$\max_{r,b_l^g,l\in L} \ ^{(12)} \quad -r$$

s.t

$$z_{L+1} = \eta\left[\sum_{h\in H} v^h + \sum_{l\in L} b_l^g\right] \quad \textbf{(5)}$$

$$\sum_{l\in L} b_l^g = r\sum_{h\in H} v^h \quad \textbf{(6)}$$

Where **(5)** is the amount of depreciated money that needs to be replaced, and **(6)** is the budget constraint of the government (ie its expenditures to finance the cost of production come from seigniorage).

The final allocations for the agents and the government are:

$$x_l^h = e_l^h - q_l^h + \frac{b_l^h}{p_l},\ \forall\ l \in L \quad \textbf{(7)}$$

(ie consumption = initial endowment – sales + purchases).

---

10 For example, a Leontief production technology with coefficients γ_l, $\forall\ l \in L$, $z_{L+1} = \min[\gamma_1 x_1^g,...,\gamma_L x_L^g]$.
If another technology were chosen, a unique equilibrium could be guaranteed by an exogenous institutional constraint, such as a price level target.

11 Government purchases are all used in the production process, ie government does not obtain utility from consumption.

12 Mathematically, minimisation of *r* is equivalent to maximise *–r*.

and

$$x_l^g = \frac{b_l^g}{p_l} \tag{8}$$

(government's inputs of production = money offered / prices).

Note that the relation between η and *r* is a complicated one and depends on gains from trade that in turn determine the volume of transactions. The interest rate *r* is set by the government to raise seigniorage revenue for the financing of fiat money production so as the replace depreciated money.

Finally, a Nash equilibrium (NE) or $\Gamma\left(H,u^h,e^h,\eta\eta,M,^h,x^g\right)$ is a set of strategy choices,

$$s = \left(s^h,s^g\right) = \left(b_l^h,q_l^h,x_l^h;b_l^g,p\right);\ \forall\ h \in H \text{ and the government, and}$$

$$\alpha = \left(\alpha^h,\alpha^g\right) \in \sum = \underset{h\in H}{X} B^h \times B^g,\ \text{э}$$

$$\Pi\left(s/\alpha\right) \le \Pi\left(s\right) \tag{9}$$

where B^h,B^g are the choice sets of the agents and the government

(ie $B^h = \langle (b_l^h,q_l^h,v^h)_{l\in L}:(1)-(2) \text{ hold}\rangle$ and

$B^g = \langle (r,b_l^g)_{l\in L}:(5)-(6) \text{ hold}\rangle$), and $\left(s/\alpha\right)$ is *s* with either s^t or s^g replaced by any other strategy choice a^t or a^g.[13] Also, Π(·) represents the payoff functions of agents ($\Pi^h(\cdot) = u^h$) and of the government ($\Pi^g(\cdot) = -r$).

Price formation based on nominal demand = nominal supply

Prices are formed using the Dubey and Shubik (1978) price formation mechanism. Prices are by that mechanism formed as the ratio of the aggregate cash bid in a particular market to the aggregate quantity of commodities offered for sale. This is equivalent to an equilibrium condition; its accounting clarity allows for cash flows in the economy to be traced precisely.

$$\text{Thus,}\quad p_l = \left\{ \begin{array}{ll} \dfrac{\sum_{h\in H} b_l^h + b_l^g}{\sum_{h\in H} q_l^h}, & \text{if } \sum_{h\in H} b_l^h + b_l^g; \sum_{h\in H} q_l^h > 0 \\ 0, & \text{otherwise} \end{array} \right\} \tag{10}$$

The existence and inefficiency theorems for these outcomes are stated and proved in Shubik and Tsomocos (2002). Here we will focus our attention on the relative efficiency of using alternative means of payments (on fiat money versus electronic barter).

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[13] Without loss of generality, we consider the case of perfect competition (ie a continuum of agents). Thus, agents regard prices as fixed in the optimisation problems.

3.5 Trade with fiat money versus electronic barter

Fiat money can be exchanged against all commodities

We conceptualise exchange using fiat money as follows. Consider a simple case in which L = 4. Fiat money can be exchanged against every commodity but commodities cannot be exchanged with each other. Figure 3.5-1 describes the situation. The arcs connecting *m* with commodities 1, 2, 3, and 4 indicate that money can be exchanged against all commodities. On the other hand, commodities cannot be exchanged with each other (ie there are no arcs connecting them).[14]

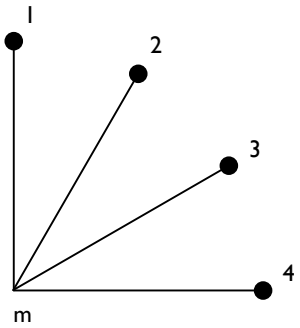

Figure 3.5-1:
Trade with fiat money

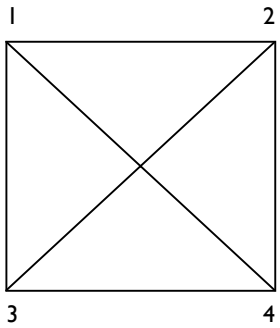

Figure 3.5-2:
Trade via electronic barter

Thus, there exist four markets. If on the other hand we want to conceptualise 'electronic barter' we assume that commodities can be exchanged with each other, perhaps via an accounting device of e-barter, which now becomes the stipulated means of exchange, through a clearing house that matches demand and supply.

In this case there will be $\frac{L(L-1)}{2}$ markets, ie, six markets altogether.[15]

Thus, in Figure 3.5-2 arcs connect all commodities with each other indicating that exchange occurs via electronic barter.

Information problems are dealt with by commercial banks

Let us assume that the combined cost of gathering and then processing information on each transaction is *c*. On the other hand trade with fiat money, by virtue of its anonymity, divisibility, fungibility and its other properties does not require any additional costs except its production and replacement costs. These are covered in its production process as described in **(4)**. Also, information costs concerning the creditworthiness of borrowers in a fiat money economy are dealt by commercial banks and not by the original issuers of money (ie central banks) or by those who accept money in exchange for goods or services. These costs cannot be avoided by the operators of the central clearing house (or a similar transactions institution) that implements electronic barter. Then the total cost of exchange with e-barter is:

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14 Note that the constraint that goods cannot be directly exchanged for goods is not imposed but naturally emerges as a consequence of our prior argument that trade with money dominates primitive barter.

15 Extensive discussion on various market structures and how these affect exchange is contained in Shubik (1999).

$$\overline{C} = \frac{cL(L-1)}{2}(H + 1)^{(16)} \qquad \textbf{(11)}$$

We note that each agent participates in only one side of the market since wash sales (ie the same individual participating in both sides of a particular market) are not profitable in a strategic market game without oligopolistic effects. If we assume that set-up costs for establishing either of the two market structures are negligible we have proposition 1. We also note that the total cost of fiat money and of electronic barter is endogenously determined; both depend on the volume of transactions; see equations **(6)** and **(11)**.

Proposition 1:

Fiat money is more efficient in exchange than barter

The cost of exchange with fiat money is lower than exchange with e-barter provided that,

$$\frac{L(L-1)}{2} c\,(H + 1) - r\,M > 0, \text{ where } M = \sum_{h \in H} v^h$$

Proof:

The cost of exchange with fiat money is $r\sum_{h \in H} v^h$ (∗),

since replacement of depreciated money is financed by seigniorage which is levied by interest rates.

Hence, **(11)** $- (*) = \frac{L(L-1)}{2} c\,(H + 1) - r \sum_{h \in H} v^h$

represents the cost difference of exchange with electronic barter versus fiat money.

One point can usefully be made here about this relationship. If we imagine technical progress lowering *c*, the very same process is likely to increase the number of commodities, *L*. Indeed, over time we have seen a proliferation of traded commodities most of them being associated with technical progress. Note also that while the lower bound of *r* is zero, that of *c* is inevitably above zero.[17]

Proposition 1 underlines the fact that fiat money is a decoupling device that economises on transaction costs regardless from where they emanate (ie processing, information acquisition etc). On the other hand, electronic barter is a centralised accounting mechanism that requires detailed knowledge of every transaction. Thus, it inevitably entails higher aggregate costs in complicated market systems with multiple markets and commodities. It is not a coincidence that the advent of money (or equivalently the decline of barter) occurred contemporaneously with the development of the market system.

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16 We implicitly assume that we are in equilibrium such that agents participate in all markets.

17 Why money is replaced by barter as a result of hyperinflation is summarised in the above relationship. In hyperinflation, the nominal interest rate rises enormously. See Capie (1986) for a review of some such episodes.

Proposition 2:

e-barter only as efficient as fiat money if r = 0 and c = 0

The equilibria of

$$\Gamma\left(H,u^h,e^h,\eta\eta,{}^h,x^g\right)$$

with trade with fiat money coincide with those of the corresponding game with e-barter only if $r = 0$ and $c = 0$.

Proof:

If $r = 0$ and $c = 0$ the two alternative methods of financing trade produce same commodity allocations. To get the same prices and allocations set

$$\frac{\sum_{h\in H} b_l^h}{\sum_{h\in H} q_l^h} = p_l \text{ and } x_l^h = e_l^h - q_l^h + \frac{b_l^h}{p_l} \qquad \forall\ l \in L,\ h \in H.$$

Then, regardless whether trade is conducted with fiat or through electronic barter the same equilibrium obtains.

Proposition 2 underlines the fact alternative methods of financing become distinct only when transactions costs are present in the economy. Unless one introduces process and the organisational details of market transactions, it is difficult to delineate the differences between alternative media of exchange. Both of them, without transactions costs, are identical units of account. Money is both neutral and super-neutral. Trade, no matter how organised, generates the same allocations. Whenever $r = 0$ and $c = 0$ then money is a 'veil'. For more on this see Shubik and Tsomocos (2002) and Tsomocos (1996), (2003a, 2003b). Even in the case of bimetallism or multiple means of exchange as long as there are determinate conversion rates among the media of exchange the analysis can be conducted in terms of a 'primary' means of payment. However, the allocations generated by the two methods of financing trade are not unambiguously Pareto ranked whenever $r, c \neq 0$. It remains an open question to determine the conditions on r and c that allow one method to generate Pareto superior allocations over the other.

Without transaction costs there is no need for media of exchange in the first place

A natural question that emerges from this analysis is whether it is possible for fiat money and electronic barter to coexist in equilibrium; in particular, whether fiat money can be used for a subset of commodities and electronic barter for the rest. This issue is complicated and beyond the scope of our present analysis, since the volume of transactions with each medium of exchange is endogenously determined and in turn determines the subset of commodities whose trade might occur with each medium of exchange. Also, the gains from trade of each commodity influence the marginal benefit and cost using different methods of financing trade. For example, if there exist big gains from trade in a specific commodity, the government may reduce the marginal cost of trading in that market by introducing electronic barter and thus avoiding depreciation of fiat money used in this particular very liquid market. We plan to explore this question in future research.

3.6 The price level – meaningful and determinate

Demand for CB money will remain positive

The intrinsic informational superiority of central bank issued base money will ensure that demand for it is not extinguished by the growth of e-barter. Demand will remain from the non-bank public, and, because of that, derived demand will remain from the banking sector. The central bank will thus retain control of short-term interest rates.[18] This might seem at first glance sufficient for it to retain control of the price level; for in many models a short rate is the sole transmitter of monetary policy actions. For example, much recent work on monetary policy uses small macroeconomic models which include an IS function analogous to that in a basic IS-LM model. These can be backward looking, and thus very close to the traditional specification (eg Fuhrer and Moore (1995)), or forward looking, embodying rational expectations (eg McCallum and Nelson (1999a)). But whatever the specification, a common feature is that demand for current output is a function of the real rate of interest, and that rate in turn is typically assumed to be a short-term nominal rate. There is a crucial assumption of slow price level adjustment; monetary policy in such models affects output and inflation only through its effects on the real rate of interest.

Reductions of transaction costs increase speed of price adjustment

This is surely a somewhat hazardous assumption in the present context. Sluggish price adjustment is a result of price adjustment being costly. In a world where transactions costs have been drastically reduced by technical progress, it would be strange to assume that the costs of price adjustment remained unaffected. Accordingly, it also seems strange to continue to argue that monetary policy depends crucially for its effectiveness on prices being statutory.

It is all the stranger since no such dependence is necessary.

Viewing short term interest rates as only transmitters of monetary policy is overly restrictive …

Viewing the short rate as the sole transmitter of monetary policy is unnecessarily restrictive both theoretically and empirically. Allan Meltzer (1999a) has recently summarised the body of theory and evidence which considers that specification to be inadequate. He argued that although so long as prices are sticky the real interest rate is indeed affected by central bank operations, so too is the real monetary base, and changes in the latter affect aggregate demand in ways additional to the effect of changes in the real interest rate. Meltzer (1999b) reports empirical results for the United States which support this argument, as does Nelson (2000) for the United Kingdom. (The result is not novel; earlier work (eg Mills and Wood (1977)) found a relationship between the base and the price level over long runs of data in the United Kingdom.) Nelson (*op cit*) provides a clear summary of his results as follows:

… also the real quantity of money plays a role

"The common feature of the regressions is that for the United States and the United Kingdom, real money growth enters output regressions sizeably, positively, and significantly. The real interest rate generally enters with a negative sign, though both the sign and the significance of the real interest rate term appear to be less consistent across sub-samples than those of the money growth terms?" (page 13, emphasis added.)

These empirical results are consistent with two quite distinct bodies of analysis. One is on an approach which assumes utility is non-separable in consumption and real money holdings. This justifies a real money balance term in the IS function as a result of optimising behaviour. Koenig (1990) reports results

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[18] We do not imply that without such demand it would lose control of short rates. The argument in Goodhart (*op cit*) that the central bank can control rates through its being able to sustain losses seems to us to be correct, despite objections of Selgin and White (2002).

which support this; but others (eg McCallum (1999)) suggest that the coefficient on real balances is likely to be small).

A *direct* role for money is perhaps better defended and explained by an approach with much earlier origins. David Hume (1752) thought that money affected the economy through a wide variety of channels, and expressed this thought in a metaphor – water flowing from one place to another – that frequently recurs in the discussions of the money transmission process.[19]

'Money always finds its way back again by a hundred canals, of which we have not notion or suspicion … For above a thousand years, the money of Europe has been flowing to Rome, by one open and sensible current; but it has been emptied by many secret and insensible canals.' (page 48, 1955 reprint).

The many channels view is also articulated by Friedman and Schwartz (1982, pages 486-87).

> '… The attempt to correct portfolio imbalances (resulting from an increase in the money stock) raises the prices of the sources of service flows relative to the flows themselves which leads to an increase in spending both on the service flows and then produce a new source of service flows….Sooner or later the acceleration in nominal income will have to take the form of rising prices, since the initial position was assumed to be one of equilibrium and we have introduced nothing to change the long-run trend of nominal income.'

This argument is also expressed in Brunner and Meltzer (1993) and was stated very succinctly in Meltzer (1999b), as follows:

> 'Monetary policy works by changing relative prices. There are many, many, such prices. Some economists erroneously believe … monetary policy works only by changing a single short-term interest rate.'

He also argues (1999a) that money balances are crucial in the transmission mechanism. He sees '…the gap between desired and actual real balances as a measure of the relative price adjustment required to restore full equilibrium'.

Our formal model (Section IV) which compared fiat money with electronic barter (Section V) also yields the result that control of the issue of fiat money controls the price level without any intermediation through an interest rate channel. Our model manifests *real* as well as *nominal* determinacy as has been shown in Tsomocos (1996, 2003a, 2003b). This is unlike the classical competitive model which possesses a 'finite' number of equilibria with respect to real allocations; only relative prices can be determined. Our model resolves nominal indeterminacy through the presence of *private liquid wealth* (Tsomocos (1996)). By liquid wealth we mean a commodity or a monetary instrument which can be used interchangeably with money in real, financial, or bank transactions, and its conversion rate is institutionally predetermined. The essence of the determinacy argument and consequently of the non-neutrality result is that monetary policy affects nominal variables, yet if private liquid wealth is non-zero then monetary changes affect directly the endowments of agents resulting in different optimisation choices and consequently different real consumption. The issues of determinacy and money non-neutrality are intimately connected and are analytically equivalent.

The formal model also yields the result the control of monetary aggregates is sufficient to implement monetary policy

[19] See Wood (1995) for a discussion of the development of the quantity theory and the history of the 'water' metaphor.

Finally, if a model does not possess equilibria that are nominally determinate then any discussion of exchange with a particular means of payment (either fiat or e-barter) is not legitimate. If multiple price levels support the same equilibrium real allocations then it is impossible to compare the relative virtues of exchange with different means of payment.[20]

3.7 Conclusion

In this paper we first set out the argument (a very traditional one) that money evolved to reduce transaction costs by economising on information.

Fiat money dominates electronic barter, unless inflation drives up the nominal interest rate

A formal model in which money existed by virtue of that property was then developed and the costs of operating a fiat money system were compared with the costs of operating a system of electronic barter. The key cost parameters were identified. It was shown that within this framework fiat money dominates – is cheaper than – electronic barter, unless inflation drives up the nominal interest rate. Secondly, increases in the number of commodities increase the costs of electronic barter faster than they do the costs of using fiat money; and finally that the lower bound to the cost of using fiat money is always below that of electronic barter. Thus fiat money is a superior transaction technology to electronic barter; transaction chains that use it have intrinsically lower information requirements. The resulting demand for fiat money by the non-bank public will in turn give rise to demand by the banking sector. Their joint demands will ensure both that central banks survive, and that they will retain control of a price level measured in the money they issue. Institutional change in the payments system will no doubt have quantitative implications for central bank operations, but it will not have qualitative implications for them.

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[20] McCallum (2003) reaches this same conclusion by a different route. It is, however, clearly related to the above argument in that it focuses in a voluntary demand for base money on the part of banks – that is, of demand for it in the absence of reserve requirements. He, as an alternative, suggests that payment of interest in reserves could also achieve such a demand.

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4 eMoney and Monetary Policy: The Role of the Inter-eMoney-Institution Market for Settlement Media and the Unit of Account

A Critical Assessment of the Literature

Stefan W. Schmitz

Introduction

This paper presents a critical assessment of the literature on eMoney and monetary policy. After briefly summarizing my own results on eMoney, redeemability, the unit of account and monetary policy, I arrange the alternative models of eMoney and monetary policy in three categories. Firstly, I present models which assume that central bank money will be replaced by another medium of exchange. Secondly, I review models that argue that the residual demand for base money will remain positive, and thirdly, those that propose payments systems with a publicly sanctioned unit of account but without a generally accepted medium of exchange (GAME) in which net balances are either settled by privately issued fiat-type money or the transfer of wealth. In the case of the latter I discuss the implicit models of the market for media of settlement between eMoney-institutions and the role of the unit of account. I emphasize the relationship between the function of money as the generally accepted medium of exchange (GAME) and its function as the unit of account, in doing so. I conclude that the alternative models of a world without money are inconsistent and incomplete, thus, confirming my own results on eMoney, redeemability, the unit of account and monetary policy by rejecting the alternatives.

In Schmitz (2002b) I present the arguments for the likely evolution of the institutional structure of electronic money schemes and the implications for the monopoly of the central bank (CB) to provide the generally accepted medium of exchange (GAME) and the unit of account. In section 4.1 I briefly summarise the methodological approach, the arguments and the results on eMoney, redeemability, the unit of account and monetary policy.

Analysis of alternative models

In this paper I focus on the discussion of alternative models and opposing views of the ongoing institutional change in the economy-wide payments system with particular attention to electronic money. I argue that these alternatives are incomplete and inconsistent, thus, strengthening the conclusions in Schmitz (2002b) by rejecting the alternatives. The analysis focuses on the role of the inter-eMoney-institution market for settlement media (henceforth "money market"), the existence of a GAME and its function as the unit of account.

This paper is structured along the following lines: In section 4.1 I present a short summary of the appropriate methodological approach to the analysis of the institutional structure of eMoney-schemes and the ensuing results as derived in Schmitz (2002a, b). In section 4.2 I classify the vast literature on eMoney and a world without money according to common approaches to the GAME and the unit of account and provide a critical assessment of each class of models in turn. Section 4.3 summarises the results and concludes the paper.

4.1 eMoney: Redeemability, the Unit of Account and Monetary Policy

Method of institutional analysis is the appropriate concept to investigate the likely consequences of the diffusion of eMoney

The evolution of payments systems is subject to ongoing institutional change, e.g. the emergence of coinage, transferable deposits and banknotes, fiat money and credit card systems. The diffusion of electronic money schemes is a further instance of institutional change. The method of institutional analysis is the appropriate concept to investigate the likely consequences of the diffusion of eMoney. The evolution of the retail payment system is path dependent as the existence of a generally accepted medium of exchange (GAME) and a uniform unit of account can be interpreted as information networks that exhibit network effects.[1] In the current state of payments systems a dominant medium of exchange prevails in the respective market where it also entails the function of the uniform unit of account. The analysis of the effects of the diffusion of eMoney-schemes has *(i)* to derive the necessary and sufficient conditions for a transition from one GAME and the associated unit of account to another and *(ii)* the effects of the diffusion of new technologies on the evolution of payments systems with respect to these conditions. I.e. will the diffusion of eMoney lead to a sufficient reduction in the marginal costs of adopting a potentially emerging new GAME individually?[2] How does the payments system operate in the phase of transition form one GAME to another? Is the parallel use of multiple units of account efficient and sustainable? An appropriate methodology to address the individual decisions at the margin – i.e. the individual choice of medium of exchange and unit of account in a given institutional arrangement – is based on New Institutional Economics, i.e. methodological individualism, transaction and information costs and an explicit analysis of the process of transition between equilibria. In Schmitz (2002a) I argued that current neoclassical models of money based on comparative static analysis are inappropriate to analyse institutional change in the payments system, as they do not account for the dynamics of transition between equilibria.[3]

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[1] See Menger 1909, Krüger 1999, Schmitz 2002b, Selgin/White 2002 and Streissler 2002.

[2] Another potential direction of research would address the following question: Will the institutional change in the payments system reduce the marginal costs of coordination to reduce the marginal costs of a socially concerted adoption of a new GAME and a new unit of account? This question is, however, beyond the scope of this paper.

[3] In the literature on New Monetary Economics and its predecessors the transition is not conceptualised uniformly. Some models argue that a new unit of account emerges in an evolutionary manner with the potential for the parallel use of multiple units of account, others assume that a new unit of account can only be introduced by government regulation (see Cowen/Kroszner 1992, 1994, Krüger 1999).

Schmitz (2002b) shows that the parallel use of multiple units of account is not desirable, and in the case of fiat-type currencies not feasible.[4] The argument does not provide a rational for legal barriers against potential currency competition.[5] I demonstrate that users and issuers face strong strategic incentives not to opt for an alternative unit of account in eMoney schemes under current inflation rates. On the one hand this result is due to network effects, sunk costs[6], information costs and switching costs which are characteristic for retail payment systems and the choice of the unit of account.[7] On the other hand the argument rests on the findings regarding the underlying mechanism of price formation: In the case of a price matching strategy, the existence and sufficient liquidity of markets denominated in the dominant unit of account are necessary preconditions for eMoney-schemes – denominated in alternative units of account – to be able to quote prices in the alternative unit of account. Trading on markets denominated in the alternative unit of accounts involve higher prices due to a spread in exchange between the dominant unit of account and the alternative ones.[8] In the case of a price discovery strategy, the market denominated in the eMoney unit of account is less liquid relative to the one denominated in the dominating unit of account. Thus, the intensity of competition and the information content of prices are lower, the spread between bid and ask prices is higher. The institutional analysis of eMoney and monetary policy analyzes the choice of unit of account in an environment of a dominant unit of account. At moderate levels of inflation, participants in the payment system have no incentive to switch from the dominant unit of account to an emerging alternative in the relevant market. Consequently, the most likely institutional structure of emerging eMoney schemes includes denomination in the dominant unit of account and redeemability, which is argued to be a necessary but not sufficient precondition for the sustainable exchange of eMonies for CB money at par.

Parallel use of multiple units of account is not desirable, and in the case of fiat-type currencies not feasible

The role of national currencies as units of account will not be diminished by the diffusion of eMoney at current moderate levels of inflation. As CBs hold on to the monopoly of the supply of the GAME, they retain control of its supply and its purchasing power, in principle. The balance sheet of CBs will shorten relative to a world without eMoney which is mainly a positive sign as institutional change in the payments system (e.g. net settlement systems, electronic wholesale and retail payments systems) increases its efficiency – which

The role of national currencies as units of account will not be diminished by the diffusion of eMoney at current moderate levels of inflation

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[4] Crede (1995), Matonis (1995), England (1996), Kobrin (1997), Cohen (2001) and Kroszner (2001) suggest the parallel use of multiple units of accounts is desirable and indeed likely due to the diffusion of eMoney.

[5] Models of the parallel use of multiple units of account often confuse this concept with currency competition (e.g. Cohen 2001, Kroszner 2001).

[6] Individuals joining a new electronic payments system invest in the new technology in various ways (including software, acquiring the necessary technology competence, and buy an initial balance of electronic funds) .

[7] Similar arguments with respect to the role of network effects are also advanced in Krüger 1999.

[8] The spread is determined by the degree of uncertainty, the risk and uncertainty preferences of individuals, resource costs of holding inventory positions in different risky assets (i.e. not nominally fixed with respect to the GAME) and the related risk and uncertainty, the market structure, potential asymmetries of information amongst traders, and transaction as well as information costs (see O'Hara 1997, Goodhart 1989). It is the price for the service provided by market makers – the service of immediacy. The GAME is the most liquid good in the economy, the good with the highest marketability and, thus, involves the lowest spread (Menger 1909). It is unlikely that the spread is completely eliminated by technological innovation unless transaction costs are completely eradicated (see Krüger 1999 and Schmitz 2002b).

implies that monetary policy becomes rather more than less effective.[9] Moreover, CBs have proven to cope well with similar changes in the past (e.g. diffusion of credit and debit cards[10], elimination of reserve requirements in Australia, Canada, New Zealand, Sweden, United Kingdom[11]). In an economy in which CB money serves as the GAME and the unit of account, the crucial question is how the emergence and diffusion of eMoney will affect the predictability of the relationship between the instruments (i.e. US federal funds rate, ECB main refinancing operations minimum bid rate), aggregate spending and the objectives of monetary policy.

4.2 The Inconsistency and Incompleteness of Alternative Models of eMoney and a World without Money

In this section I provide a critical assessment of models of monetary policy in economies without CB money. I classify the models according to their approach to the institutional structure of the monetary system.[12] In section 4.2.1 I present models which assume that CB money will be replaced by other media of exchange. In section 4.2.2 I review models that focus on arguments that the residual demand for CB money remains positive. In section 4.2.3 I analyse models that propose payments systems with a publicly sanctioned unit of account but without a generally accepted medium of exchange (GAME) in which net balances are either settled by privately issued fiat-type money or the transfer of wealth. In the discussion I focus on the (often) implicit institutional structure of the monetary systems presented; that is on the models of the market for media of settlement between eMoney-institutions, the existence of a GAME and a unit of account. I emphasize the relationship between the function of money as the GAME and its function as the unit of account.

4.2.1 Models assuming the Proliferation of other Media of Exchange and Units of Account

Friedman doubts that CBs will be able to conduct monetary policy in the future

Despite the large number of papers addressing the issue of electronic money and monetary policy dating prior to the year 1999, the current debate was strongly influenced by *Friedman* (1999, 2000).[13] He does not doubt that the CB retains its monopoly to influence the level of reserves in the economy denominated in CB money but he questions the relevance of that monopoly over

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[9] Selgin 1996 and Selgin/White 2002 argue that monetary policy becomes even more effective as the elimination of currency would reduce the variability of the money multiplier and, thus, increase the predictability of the relationship between central bank (CB) money and nominal spending. Furthermore, the ratio of CB money to broad money is so reduced that each unit change becomes more effective at the margin.

[10] See Freedman 2000.

[11] See Sellon/Weiner 1997 and Woodford 2002.

[12] Many proposals discussed in this section display similarities to the BFH approach to monetary economics pioneered by Black, Fama, Hall, developed by Greenfield/Yeager (1983) and summarized in Cowen/Kroszner (1994) as New Monetary Economics. Krüger (1999) critically discusses the BFH approach to eMoney and the structure of the financial/monetary system.

[13] E.g. Crede (1995), Matonis (1995), England (1996), Selgin (1996) and Kobrin (1997).

the next quarter century. It is challenged by a potential reduction of the demand for CB reserves due to privately operated retail payment systems – namely private (electronic) monies which are not redeemable in CB reserves. Examples include issuers like the MTA (Metropolitan Transport Authority) and telephone service providers. Furthermore, currency is supposed to be of little relevance to transactions in the economy and is viewed as largely endogenous as the CB accommodates the public's demand for currency.

He conjectures that at the same time, institutional change in financial markets – largely driven by innovations in information and communication technology (ICT) pose a threat to the credit channel of the monetary transmission mechanism. Non-bank financial intermediaries play an increasingly important role in the provision of credit to the real sector without being subject to reserve requirements. Disintermediation and securitization enable the real economy to allocate savings and investment on financial markets directly. "From the perspective of the "credit view", therefore, the CB's monopoly over the supply of reserves is irrelevant." (Friedman 1999, 332).

Banks hold reserves at the CB because CB money is the only means of payment that provide settlement finality – they are the medium of final settlement. Private competition might challenge that role of CB reserves too, as private clearinghouses can provide net settlement in terms of their own liabilities. Currently, these liabilities are denominated and redeemable in CB money such that the clearinghouse needs to hold reserves on the books of the CB. In addition, all balances not netted out during the day continue to be settled in CB money so that the system remains ultimately anchored in CB money. If the balances on the clearinghouse's books gain settlement finality, the demand for CB reserves derived from inter-bank settlement might be reduced to an extent that renders CB policy instruments ineffective.

Private competition will challenge the role of CB money as means of final settlement

Friedman (2000) clarifies the argument in the light of critique put forward by Goodhart (2000), Freedman (2000) and Woodford (2000). Extreme events such as the elimination of demand for CB money (reserves and/or cash), he argues, are not necessary preconditions for the loss of efficacy of traditional monetary policy instruments. Monetary policy actions still affect the level of economic activity and asset prices in those parts of the economy that are directly or indirectly based on CB money. He questions, however, that these economic consequence are related in any close manner to the general price level, to aggregate output fluctuations and asset prices in the entire economy, at the margin. The monetary policy decisions of the CB will fail to move market rates, as the market might no longer attribute the CB the power to move the real market rate at its own discretion without large market interventions. Already the volume of CB market intervention is relatively low compared to total volume and as the balance sheets of CBs will shrink, they will have to relay on "Open Mouth Operations" even more.

No extreme events necessary to render monetary policy ineffective

Discussion

Although the effects of advances in ICT on the institutional foundations of financial markets and the financial system are uncertain and to some extent necessarily speculative, there are analytical instruments available to investigate the likelihood, the preconditions and the likely effects of such change.[14] Especially, the evolution of private and inter-bank payments systems would deserve a more detailed analysis of the institutional arrangements involved and their conse-

Friedman does not provide details of the envisaged institutional structure of payment systems nor of institutional change

[14] See e.g. the papers presented at the FRBNY Conference on Financial Innovation and Monetary Transmission, 5-6 April 2001, New York <http://www.ny.frb.org/pihome/news/speeches/finmon/finmon.html>.

quences for the role of CB money as the unit of account and the medium of final settlement. Neither in the case of privately issued fiat-type monies and the parallel use of multiple units of account nor in the case of privately operated wholesale payments system does Friedman provide any details of the institutional structure of the model nor of the transition between the current institutional arrangements and the envisaged monetary and financial future.[15] The different strands of reasoning in Friedman (1999) show a common structure: ongoing trends that imply the reduction of the ratio of CB money to aggregate spending – through privately operated clearing mechanisms (e.g. CHIPS) or innovations in the area of retail payment systems (credit, debit and smart cards) – are extrapolated further to the mathematical limit. The amount of CB money necessary to operate wholesale and retail payment systems finally reaches zero. Friedman implicitly assumes that the behaviour of the monetary system while approaching the limit, and once it has reached the limit, exhibits structural continuity, in principle.[16] Even though CB money is expected to become irrelevant in the limit, the monetary system does not exhibit any signs of instability or structural changes. It remains unclear whether another medium of exchange will assume the GAME and the unit of account-function. The consequences for the real economy and the monetary system of neither option are considered. Structural effects of an economy approaching the limit and finally reaching it are neither explicitly nor implicitly discussed.

Friedman does not provide arguments for CBs losing power of markets

Both, the institutional structure of inter-bank settlement systems and of retail payment systems have changed considerably over the past decades due to financial innovation.[17] The economy-wide payments system has had to adapt to the interdependent trends of globalisation, liberalisation, advances in ICT and increasing financial sophistication. Friedman fails to present convincing arguments and evidence that these processes towards the limit have reduced the efficacy of monetary policy so far. Furthermore, he presents no detailed argument for the assertion that the link between monetary policy instruments and aggregate spending will loosen at the margin. The argument rests upon the claim that the market might no longer attribute the CB the power to move the real market rate at its own discretion without large market interventions. Friedman claims that extreme events – such as the elimination of demand for CB money – are a sufficient but not a necessary condition for the loss of efficacy of monetary policy, he fails to demonstrate why the market should discontinue to act upon the announcements of the CB as long as the CB retains its monopoly to supply the GAME and the unit of account at zero marginal costs. He does not expand on the preconditions under which the CB looses its monopoly before the limit is reached, nor does he discuss the institutional structure of the monetary system in the limit.

Goodhart (2000), Freedman (2000) and Woodford (2000) present a number of counter-arguments to Friedman's gloomy forecast.

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[15] See Freixas/Holthausen/Terol/Thygessen 2001 for wholesale payment systems. For alternative media of exchange and the parallel use of multiple units of account see Crede (1995), Matonis (1995), England (1996), Selgin (1996) and Kobrin (1997), Cohen (2001), and Kroszner (2001) and for criticism of their positions see Schmitz 2002b and Selgin/White 2002.

[16] A similar approach is adopted in Woodford (1998) and discussed in McCallum (2000).

[17] For related empirical evidence see Pringle/Robinson (2002).

4.2.2 Models focusing on the Evolution of the Demand for Central Bank Money

Goodhart (2000) focuses on the question whether the diffusion of ICT will completely eliminate the demand for currency and renders the CB impotent in its pursuit of monetary policy. He argues that currency has two distinct advantages over electronic money: (i) Notes and coins offer anonymity to both the payer and the payee. Advocates of electronic money occasionally emphasize that the technology to ensure anonymity for the payer and the payee by strong encryption is also available.[18] But Goodhart points out that confidence in anonymity is a more complex issue and that the protection of personal data requires the decisive political will and a detailed legal framework.[19] Currency continues to have a comparative advantage relative to electronic money as individuals favour currency whenever they want to maintain their anonymity. *(ii)* Currency is legal tender in many countries so that it cannot be refused as a means of payment in cases the underlying contract does not explicitly specify another form of payment. In addition to a first mover advantage, anonymity and legal tender legislation result in currency having a comparative advantage vis-à-vis electronic money. Therefore, its demand remains positive despite the diffusion of electronic money. Capie/Wood (2001) generalizes the argument with respect to anonymity by pointing out that currency is the most cost effective means of payment with respect to transaction costs (i.e. information costs). Krüger (1999) provides anecdotal support from foreign exchange wholesale markets for the thesis, that even if marginal transaction costs are already very low due to advanced information and communication technology, the transaction costs can be reduced even further by the use of a GAME.

Goodhart discusses whether innovations will reduce the demand for CB money to zero

Capie/Tsomocos/Wood (2005) model an economy in which the role of fiat money as medium of exchange is contested by advances in ICT that reduce the costs of barter. The costs of operating the monetary system are fixed costs given the quantity of money, which depends on the number of trades only indirectly via individual money demand. The costs of barter consist of transaction costs of gathering and processing information, which are incurred in each transaction by each individual. While technological progress is likely to reduce the transaction costs of barter, they expect that it might as well raise the number of commodities and, hence the number of markets and transactions. Thus, the total costs of barter – aggregated across markets and transactions – do not necessarily fall and might even increase. It should be added that technological progress might also reduce the operational costs of the monetary system, i.e. the diffusion of electronic means of payment could reduce the tear and wear of cash as well as the costs of cash logistics and, thus, the costs of operating the monetary system. They conclude that the transaction costs associated with electronic barter are likely to remain so high that the demand for fiat money will not vanish. The results hold for any fiat money (e.g. foreign currency) and not just for the CB money of the national CB.

Capie et al. compare fiat money to e-barter

Implicitly they assume that the demand for CB money will be sufficient to maintain its role as GAME and as the unit of account. The structure of the money market is not entirely clear. Agents in the economy obtain fiat money at the beginning of the period via loans granted by the CB on the money mar-

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[18] E.g. Chaum 1996. But he also argues that – while technologically possible – complete anonymity might not be desirable in electronic payment systems.

[19] Credibility and enforceability of the respective legislation as well as the appropriate organizational structure of the operator of the payment system and its effective supervision might be added.

ket at the going rate. It remains unclear why the transaction costs in the money market are supposed to be negligible. In the commodities markets trade credit is ruled out, due to transaction costs, hence, the cash in advance constraint. The latter is imposed on the grounds of high information costs on transaction costs not settled in cash on the spot. The question arises whether agents have to provide collateral or whether the CB has a legal information advantage over other agents in the economy. Furthermore, the authors abstract from operational costs of the monetary system such as the costs of maintaining the institutional set-up, i.e. the trust of agents in the stability of the price level etc., and, hence, underestimate these costs. As these additional costs would not depend on the number of commodities markets directly, the structure of the argument would not change, but the parameter values for which money dominates e-barter might shift in favour of e-barter.

Berentsen suggests that the demand for CB bank notes might vanish

Berentsen (1998) suggests that due to the low transaction costs associated with electronic money the demand for currency eventually vanishes. But as electronic money is predominantly used in small-value payments and due to the low costs of converting interest bearing deposit balances into electronic money holdings, the stock of electronic money is expected to be small. Most liquid assets would be held as demand deposits. Even in the absence of binding reserve requirements banks would hold settlement balances to settle daily net positions in the inter-bank payment system. Hence, the demand for CB money would remain positive and the CB would maintain its monopoly to provide the GAME at zero marginal costs. Berentsen implicitly assumes that electronic money is denominated in the dominant unit of account of CB money and that it remains the GAME and the means of final settlement in the inter-bank payment system. However, he does not consider the case in which electronic money were denominated in a unit of account different from the dominant one in the respective market. He does not provide any arguments for the continuing role of CB money as the GAME and unit of account. Furthermore, he fails to establish a link between electronic money, the GAME and the unit of account. The institutional set-up he has in mind seems to involve the redeemability of electronic money into CB money and, thus, its denomination in the unit of account. Finally, the inter-bank payment system is based on CB money as the banks' settlement demand for CB reserves is expected to remain positive. Neither of the two interdependent crucial implicit postulations is supported by analytical arguments. In sum, the CB is basically assumed rather than demonstrated to maintain its monopoly position in the provision of the GAME and the unit of account at zero marginal costs. Consequently, there is no threat to the implementation of monetary policy by assumption.

Freedman emphasises the link between alternative payment instruments and CB money

Freedman (2000) distinguishes between stored-value-cards (SVCs) and network money in his definition of electronic money. He emphasizes that a number of means of payment are currently in use and that SVCs should simply be interpreted as an additional choice. Credit and debit cards have already reached a considerable market share in medium sized transactions. SVCs offer less protection from loss and theft than other means of payment, so that they will be used for low value payments. Even in the unlikely event that they fully substitute for currency the entire payment system continues to be based on CB money, as final settlement takes place on the books of the CB. The crucial issue, of how the link between SVCs and CB money is institutionally designed, is not elaborated any further. One can only assume that SVCs are denominated in the dominant unit of account and that redeemability in CB money is the rule. Consequently, CB money remains the GAME and the unit of account. The balance sheet of CB shortens, but current monetary policy instruments (i.e. announced target level for the main operating target in combination with OMOs and standing facilities) ensure the efficacy of monetary policy implementation.

Freedman (2000) regards the settlement of inter-bank balances by either private clearing-houses or the transfer of low risk assets (i.e. treasury bills) as the more serious threat to the efficacy of monetary policy. But even in these cases he regards CB money as superior means of final settlement and expects the demand to remain positive. The major drawback of private-clearing houses are supposed to be *(i)* potential bankruptcy of the clearing-house[20], *(ii)* an informational disadvantage of private clearing-houses vis-à-vis a CB which combines prudential supervision with the operation of the payment system, and *(iii)* the banks' reluctance to see a competitor gaining a competitive advantage by resuming the role as a clearing-house. However, the disadvantages of private clearing-houses can be overcome in principle, as the informational disadvantages disappear if the supervision of members and the operation of the wholesale payment system are combined.[21] The institutional structure and the accompanying governance mechanisms can be adapted to a level playing field for the participants. An entity different from the privately operated clearing-house seems to maintain a monopoly to issue the GAME. Hence, Freedman's model of private clearing- and settlement systems presupposes the continuing role of CB money as the means of final settlement and the unit of account. In this case the model collapses to one where even private clearing-houses would not at all endanger the position of the note-issuing authority as the systems remains firmly rooted on the GAME (CB money). However, participants of the payment system would economize on their holding costs of means of final settlement by netting arrangements.[22]

But Freedman takes his thought experiment a step further – banks could transfer low risk assets to settle imbalances rather than reserves at the CB or at private clearing-houses. He concludes that *(i)* the lack of a lender of last resort (LLR), *(ii)* holding costs of low risk assets, and *(iii)* declining volumes of outstanding government debt present the major drawbacks of the alternative system. It remains unclear whether there is a GAME, a unit of account and a means of final settlement in his model at all. Finally, he rejects the hypothesis that the world will regress towards a pure barter economy, as the costs would be too large. Thus, the demand for CB money will remain positive since CB reserves will maintain their function as means of final settlement for inter-bank imbalances so that the CB continues to be able to steer money market interest rates. CB money seems to remain the GAME and the unit of account.

Freedman argues that the demand for CB money as means of final settlement will not vanish

Woodford (2000) argues that a sharp reduction of the demand for CB money makes the implementation of monetary policy by quantity-targeting techniques (e.g. targeting non-borrowed reserves) increasingly difficult. But as long as that demand remains positive, the CB maintains the ability to control short-term interest rates. He discusses the "channel"-approach as a feasible alternative institutional arrangement for the implementation of monetary policy. Under such a system the CB can control the short-term interest rate without changing the size of its balance sheet substantially. The "channel"-system is based on the provision of standing facilities, i.e. a deposit and a lending facility at which the banks can draw on reserves from the CB without limits. Since there is a spread – of about 50 basis points in the case of New Zealand – banks

Woodford concludes that CBs will be able to control short term interest rates

[20] The major reasons for the stability attributed to CBs are *(i)* its rather narrow field of activities, *(ii)* its large reserves and seigniorage and *(iii)* the backing by government, and, most importantly, *(iv)* its comfortable monopoly to issue liabilities which the government forces other banks (reserve requirements) and individuals to accept. As these are a legal tender, the bank's debtors cannot refuse to accept it – the CB can always restore its own solvency and liquidity at negligible marginal costs.

[21] See Selgin/White 1987.

[22] See Selgin/White 2002.

have an incentive to trade reserves in the money market to settle their net-balances at the end of the day. The target rate, i.e. the equilibrium money market rate, usually is halfway between the deposit and the lending rate. In theory the banks' objective would involve zero overnight balances, so that due to the absence of reserve requirements the expected overnight reserves of the entire system would be zero on average. In practice, however, a small positive target for the aggregate level of overnight reserves ensures that the equilibrium money market rate is close to the target rate. Monetary policy is implemented by changing the rates on the standing facilities without adjusting the target level of overnight reserves. Quantity adjustments by intraday credit are limited to manage short-term liquidity shocks in order to avoid excessive volatility of the market rate.

The diffusion of electronic money does not pose a threat to the efficacy of monetary policy, in a "channel"-system. The demand for currency is not a prerequisite for the system to work. Its elimination would reduce exogenous shocks to the volume of settlement reserves and, hence, might reduce the scope of liquidity management operations. A reduction of the demand for settlement balances due to improved treasury management by the participants in the payments system would reduce the average, aggregate volume of overnight settlement balances. But as, both, theory and experience show, the size of these is of limited relevance, in principle. A reduction of the interest elasticity of the demand for settlement balances would lead to a higher volatility in the equilibrium money market rate within the channel. Narrowing the channel could reinforce the stability of the market rate. Finally, Woodford counters the argument that alternative settlement systems among commercial banks would render monetary policy ineffective by invoking the low costs of the "channel"-system. In the worst case the channel would narrow further to decrease the expected opportunity costs of holding overnight settlement reserves so that banks would not switch to alternative settlement mechanisms.

Palley expects bank to settle interbank claims in real assets

Palley (2002) models the threat to CB money as arising from the emergence of e-settlement money that eventually replaces settlement balances in CB money. He argues that the spread of innovations in information technology would enable banks to value their assets to market in real time. Instead of settling mutual debts in CB money, banks would exchange assets – which are not further specified – directly (so called "mutual fund e-settlement"). Also nonbank agents would increasingly rely on the transfer of assets in settling debt. The relevant interest rates would be set in a "loanable funds"-style asset market, so that mutual fund e-settlement dominates CB money in the rate of return. Palley fears that the system of mutual fund e-settlement would be unstable. Despite the prevalence of mutual fund e-settlement in normal times, agents would prefer CB money in times of crises. The reduced demand fro e-settlement balances could lead to the return of "old-fashioned bank runs" (Palley 2002, 223). The inherent uncertainty of mutual fund e-settlement leads to a positive demand for CB money, because it is subject to zero nominal price fluctuations.

In addition to the analysis of the demand for bank settlement balances, Palley studies the effect of eMoney on the demand for required reserves, on nonbank currency demand, on tax payment balances, and on international interbank settlement balances. With respect to required reserves he concludes that the ongoing decline in their importance is likely to continue. Several countries abolished required reserves. Their ability to implement monetary policy effectively rests on the positive demand for CB money for transactions and settlement balances. The current role of nonbank currency demand in monetary policy implementation is negligible, so that a further decline does not affect the efficacy of monetary policy implementation.

The demand for tax payment balances remains a source of demand fro CB money. Governments must require taxes to be paid in CB money to ensure that this source of demand to constitute an effective channel for monetary policy. The demand for CB money resulting from international interbank settlement balances results primarily from the choice of reserve media of other CBs. Palley conjectures that CBs are likely to hold their foreign reserves in CB money rather than in risky mutual funds, in order not to gamble with national welfare. He concludes that in the future the demand for CB money will be further reduced relatively to total assets and liabilities in the economy, but that it will remain positive due to a positive but highly volatile demand for settlement balances (due to the inherent uncertainty of mutual fund e-settlement) and due to governments requiring tax payments in CB money. The reliance of tax payments to implement monetary policy would lead to increased interest volatility, as tax payments are highly seasonal and often paid with delay.

Discussion

A positive demand for currency is not a sufficient condition for the efficacy of the traditional instruments of monetary policy ...

... but the role of CB money as GAME is

Currency transactions routinely require face-to-face contact so that their advantage in terms of anonymity might partly vanish. But be that as it may. A positive demand for currency is not a sufficient condition for the efficacy of the traditional instruments of monetary policy. Goodhart's position is criticised by Friedman (2000) as the "one drug dealer" argument. Discretionary changes in the supply of currency are usually not an instrument of monetary policy implementation. The fundamental issue is not addressed in the controversy. Instead of focusing on the choice of means of payment the choice of the GAME is critical for the analysis of the future efficacy of monetary policy. Whether economic agents transfer claims on the GAME via checks, credit or debit cards, bank transfers, direct debit is of interest for fine-tuning the liquidity operations of the CB and the sponsors of the relevant retail and wholesale payment systems but not for the elementary position of the CB as a monopoly provider of the GAME at negligible marginal costs.

The size of the underground economy using currency is of indirect relevance only. Unless demand for currency is large enough to maintain its unit of account function, currency will be comparable to contemporary alternatives to money, e.g. LETS (Local Exchange Trading Systems) or widely accepted coupon schemes.[23] Despite the positive demand for alternative currency units in LETS the expansion and contraction of their supply has no effect on macroeconomic activity neither at the margin nor on average. The currency units of various LETS possess neither the GAME function nor the unit of account function of money. The coupon schemes are denominated in the unit of account of the relevant market and offer redeemability in goods and services by the issuer. Some of them are also accepted at par by establishments other than the issuer. Their supply and demand are determined by the equilibrium condition that the real marginal revenue (i.e. the real interest earned on the float at the margin) equals the real marginal costs of operation, and that the real marginal costs equal marginal utility (i.e. real opportunity costs of holding vis-à-vis expected discounts etc.). Equivalently, neither the growth rate nor the level of supply of coupons affects aggregate economic activity. Furthermore, The CB could exert some control over the supply and demand of coupons via its ability to influence the real rate of interest and, thus, the equilibrium condition.

[23] See Eichenbaum/Wallace 1985 and Good 1998.

Woodford still assumes that CB money remains the GAME

Woodford (2000) basically avoids dealing with the threat to the demand for CB money posed by the diffusion of electronic money. Throughout most of his paper, the role of CB money as GAME and its function as the unit of account are never mentioned – let alone challenged.

He argues that low expected opportunity costs of holding overnight settlement reserves in the "channel"-system and the creditworthiness of the CB result in a comparative advantage of CB sponsored settlement relative to potential competitors. It would even suffice that the CB provided infinitely elastic borrowing and lending facilities regardless of the actual volume of transactions on the CB's book. The crucial assumption is that the CB maintains its position as the sole provider of CB money at zero marginal costs. This argument, therefore, presumes the critical points in the discussion – the positive demand for CB money and the CB's monopoly in the provision of the GAME at zero marginal costs. Even if the CB can continue to offer clearing and settlement services at very low operating costs in its own liabilities, it would not suffice to implement monetary policy unless these are the GAME. If its own liabilities cease to be the GAME in the economy, sponsoring a settlement system will not enable the CB to steer the market rate of interest in the GAME. It will become impossible to offer infinitely interest elastic standing facilities at zero marginal costs in the GAME.[24] Instead the CB maintains the ability to steer the interest paid on its own liabilities in terms of its own liabilities at zero marginal costs. However, these interest rates would be of no relevance for the demand and supply of the GAME and would not influence aggregate economic activity.

In the last two paragraphs, Woodford recognises the potential challenge to the role of CB liabilities as GAME and unit of account. He light-heartedly embraces Hayek's model of the parallel use of multiple units of accounts. But his confidence in the market to provide a stable unit of account seems to be rather low. He maintains that stable money would continue to be a vital public service best provided by the CB, which could retain some influence over the exchange rate between its own liabilities and those of other issuers. He fails to question the feasibility of the private issue of fiat-type money and the parallel use of multiple units of accounts. The crucial issues of price formation and the GAME are not touched upon.

Palley's model is incomplete and inconsistent

Palley's (2002) model of mutual fund e-settlement assumes that mutual fund shares used in e-settlement are valued in real time. He does neither state what the assets are denominated in nor against what they are valued in real time. There are basically two options. First, the assets are traded against each other and not denominated in a unit of account, but rather claims to real wealth. That would imply that there are $[n_A(n_A\text{-}1)]/2$ relative asset prices in the economy for n_A assets. As Palley does not mention a GAME or a unit of account, there would be $[n_A n_G]$ goods prices for nG goods in the economy. The economy would resemble a barter economy based on an electronic exchange mechanism, but still relying on a double coincidence of wants. The assets exchanged in mutual fund e-settlement would exchange at a spread, unless they were perfect substitutes. Consequently, the equilibrium is unstable as mutual funds that exchange at lower spreads would dominate others as means of settlement.[25]

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[24] That is the economic rational behind Friedman's critique of Woodford's argument: "With nothing to back up the CB's expression of intent [of changes in the equilibrium rate of interest on the money market], I suspect that the market would cease to do the CB's work for it." (Friedman 2000, 16).

[25] For a more detailed discussion of the final settlement by the transfer of wealth see section 2.3.2. below.

The second interpretation of Palley's model is more likely, namely that it resembles the current tiered system of payments. Individuals employ bank balances to pay debts and to acquire goods. Rather than writing checks on nominally fixed bank deposits, they draw them on mutual funds. The cheques continue to be denominated and settled in CB money, eventually. The means of payment will be subject to change, but CB money will remain the GAME. Mutual fund e-settlement would add another layer to the tiering structure of the interbank settlement system. In order to reduce their demand for CB reserves, banks defer settlement by extended netting arrangements, in which they employ mutual funds as collateral. According to Palley, the demand for CB money remains positive and it is the only asset that exhibits zero nominal price fluctuations. It is therefore the only asset the guarantees economic finality in settlement. This interpretation is more likely to reflect Palley's underlying model, as he argues that agents demand settlement in CB money in abnormal times and that the sharp increase in demand fro CB money causes a liquidity shortage. That implies that liquidity refers to CB money.

4.2.3 Models based on a Publicly Sanctioned, Uniform Unit of Account without a GAME

Privately Issued Fiat-Type Electronic Monies

Costa/De Grauwe analyse monetary policy in a cashless society

Costa/De Grauwe (2001) analyse the efficacy of current monetary policy instruments (standing facilities and open market operations – OMOs) in a cashless society. They assume that the unit of account remains tied to the nation state and continues to be "provided" by the state. Banks and other institutions issue private fiat-type money in the form of deposits or eMoney. These institutions are not subject to minimum reserve requirements nor do they hold settlement balances with the CB. Instead, they are assumed to hold liquid assets such as shares or bonds as assets.

In a cashless economy the nominal price level is indeterminate

The nominal share price equals the discounted expected nominal dividend stream. As the expected nominal dividends are a function of the expected money stock, Costa/De Grauwe argue that the price level is indeterminate as any expected growth rate of the nominal stock of money leads to a corresponding growth rate of future nominal dividends and, consequently, to an increase in the current nominal value of assets. The current value of the "nominal money stock" increases as well. There is no inherent equilibrating mechanism to pin down the price level.

If the bank's portfolio consists of bonds the dis-equilibrating forces arise in a more complex fashion. As the bond price eventually returns to its face value, destabilizing effects are supposed to arise via the quantity of bonds on the bank's balance sheet. An increase in the stock of money has positive affects on economic activity so that firms issue more debt. At the same time the transactions demand for money increases and both sides of the bank balance sheet expand in parallel. Again there is no inherent constraint to the expansion of banks' balance sheets and, thus, money creation.

Furthermore, the expansion might also work via the value of collateral. The expansion of the money stock leads to an increase in the value of assets in general and to that of collateral in particular. The value of banks' assets increases as the money stock does. Costa/De Grauwe concludes that the price level might be indeterminate and inflation might arise in their model.

Can the CB steer nominal interest rates?

As the demand and supply functions of all agents in the model are homogenous of degree zero in nominal prices the price level cannot be pinned down. But what about a CB that does focus on nominal variables – can it steer nominal interest rates in the model and anchor the system?

No, CB would incur large losses due to arbitrage opportunities for commercial banks

An increasingly accepted view among monetary economists holds that the CB does not have to conduct large-scale financial transactions in order to manipulate money market rates. Its monopoly power to create settlement balances at zero marginal costs suffices to ensure the credibility of its target announcements for the main operating target.[26] In Costa/De Grauwe the CB has lost its monopoly in providing the GAME. As the CB has to borrow funds in order to lend funds via its standing facilities, arbitrage opportunities arise. Not only will the CB incur large losses, it will also fail to affect the available liquidity in the system but merely redistribute funds, according to Cost/De Grauwe. A similar line of reasoning applies to OMOs: In this case, though, the CB can buy treasury bills with its own liabilities, i.e. bank deposits similar to those issued by commercial banks. The commercial banks will present these for re-conversion into treasury bills afterwards and, thus, keep the amount of treasury bills circulating outside the CB largely unaffected. Furthermore, the small size of the CB's balance sheet and the potentially large losses it incurs in attempts to steer money market rates result in a loss of control over short-term money market interest rates.

Can the CB regain control over money market rates if granted unlimited access to funds by the treasury at zero marginal costs? Costa/de Grauwe argue that this would only increase the opportunities for arbitrage without empowering the CB to manipulate the total liquidity in money markets. If the CB had unlimited access to treasury bills, it could manipulate the outstanding quantity of these bills based on a given market demand schedule. "Thus, in a sense in a cashless society, treasury securities become the ultimate means of payments." (Costa/De Grauwe 2001, 20).

Alternative instrument to implement monetary policy – prudential supervision

Costa/De Grauwe suggests prudential regulation and supervision as alternative instruments for monetary policy. The CB certifies eMoney-institutions. By taking macroeconomic conditions into consideration the CB can employ the capital adequacy ratio as an instrument of monetary policy. Legal reserve requirements in "high quality" private money are judged to be of less importance in practical policy implementation, as their impact is supposed to be large and their flexibility low making their accurate implementation very hard.

Discussion

The model is incomplete and inconsistent

In the following discussion I argue that the Costa/De Grauwe model is theoretically inconsistent, its institutional set-up is incomplete and the main results are questionable; i.e. there is no institutional arrangement that links the privately issued fiat-type monies to the unit of account, there is no GAME in the model, it remains unclear what "liquidity" in the market for inter-issuer settlement balances (money market) means exactly and the price levels of privately issued fiat-type monies are not indeterminate but infinite. The electronic monies do not perform the GAME function of money, let alone the unit of account function.

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[26] See e.g. Borio 1997, Guthrie/Wright 2000 and Thornton 2000.

The literature on the time inconsistency problem associated with the issue of private fiat-type money concludes that there is no effective constraint on individual issuers credibly preventing them from inflating infinitely.[27] Costa/De Grauwe offer a number of explanations for the indeterminacy of the price level that all involve the argument that there are multiple equilibria consistent with an infinite set of expectations concerning the nominal money supply and the resulting nominal value of assets (shares/bonds/collateral). In the case of redeemable privately issued commodity monies the argument is wrong, as the redeemability constraint can be binding for each individual bank at the margin even if it were not binding in the case of a concerted expansion of banks' balance-sheets.[28] However, in the case of privately issued fiat-type monies their argument can be simplified. The most straightforward way for each individual bank to increase its note issue and its assets in unison is to purchase assets (stocks/bonds etc.) on financial markets at the prevailing market price. As the issuers of fiat-type electronic money face zero marginal costs of issuing additional money, they buy collateral until the expected marginal return is zero as well.[29] Consequently, the price levels are determined – they are infinite for each of the privately issued fiat-type monies. There is no GAME, no unit of account in the model and consequently no money. Therefore, it is not surprising that there is neither a meaningfully defined price level nor any monetary policy instruments available to the CB for its stabilisation.

Fiat-type private money infeasible …

… and the model reduces to barter

According to Costa/De Grauwe the inability of the CB to manipulate the liquidity in the system results form the fact that its deposits would be reconverted into financial assets immediately, thus, leaving the amount of outstanding deposits unchanged. The same argument holds true for any of the issuers in the model, at the margin. It remains unclear why CB deposits are supposed to be inferior to other banks' deposits so that they are not held for transaction purposes. Furthermore, there are no arbitrage opportunities in the Costa/De Grauwe model: As the CB's bid price for financial assets (stocks, bonds, treasury bills etc.) is above the market price in terms of CB deposits and the CB is expected to convert these deposits into financial assets at predetermined prices on demand, the market price would increase in terms of CB deposits. But that does not necessarily affect the market price in terms of any other bank's deposits so that the deposits of various banks – the various privately issued fiat-type monies – do not exchange at par necessarily. Costa/De Grauwe mentions "high quality" electronic money in their argument concerning reserve requirements. If there are quality differences between electronic monies, they will not exchange at par, unless they are adjusted for by interest payments on electronic money, which does not seem to be the case in this model.

Why are CBs deposits are inferior to commercial bank deposits

Consequently, the question arises what the unit of account in this model is. Costa/De Grauwe (2000, 2) state that it is "provided by the state" as one *US$* or one *€*. The continuous availability of market prices in each electronic money in terms of the unit of account is a necessary precondition for the model. For a high quality electronic money (EM_1) the price of a certain good in terms of the number of units of account (x US$ in terms of EM_1) is lower than for a low quality electronic money (z US$ in terms of EM_2; $z > x$). As the various electronic monies are not perfect substitutes their exchange will involve spreads. In general, prices will be lowest for the electronic money that exchanges at the lowest spread, which will, as a consequence, drive the others out of the

The unit of account and its role in the model are not clear

[27] See inter alia White 1999 and Schmitz 2002b for a discussion and the related literature.

[28] See Selgin 1994.

[29] See Taub 1985.

market.[30] But the model faces a more fundamental critique than its inherent instability, namely that the unit of account is not meaningfully defined. Either the denomination of particular electronic money is a purely nominalistic exercise or the denomination is determined by market exchange. *(i)* In the absence of redeemabilty the nominalistic denomination is entirely arbitrary and different prices would have to be paid in different electronic monies. *(ii)* If denomination is determined by market exchange, each electronic money serves as a unit of account as prices in different electronic monies differ. Hence, there is no uniform unit of account, in both cases. There is neither a discussion of the mechanism of nominal price formation nor an analysis of the institutional setup that links the publicly sanctioned unit of account to the eMonies in the model.

There is no medium of final settlement in the model

There is no medium of final settlement in the model as eMonies can only be reconverted into financial assets, which in turn pay dividends or interest rates in electronic monies or more stocks and bonds. The model suffers from circularity so that no electronic money is linked to any good embodying the unit of account directly or indirectly.[31] There are no relative prices between electronic monies and any good, the price of which does not vary in terms of the unit of account. Equivalently, there is no exchange between any such good and all other goods in the economy so that no prices in terms of the unit of account can be determined in exchange. Only nominal prices in terms of various electronic monies could be observed, if they were not infinite due to the prevailing time inconsistency problem.

The institutional structure of the money market is not clear

The model is incomplete as the authors do not model a money market (or a market for settlement balances between issuers of electronic monies). The authors state that CB money will no longer be used as medium of (final) settlement. They analyse a market for liquidity[32] but fail to state what is supposed to be exchanged there, in what kind of (financial) asset(s) this liquidity is embodied. Due to the circularity of conversion there is no medium of final settlement and, therefore, no market in which such a good can be traded. The authors mention that treasury bills might assume the role of final settlement media in a cashless world. They conclude that the CB could control the total amount of liquidity in the economy in that case by varying the volume of treasury bills. Their conclusion is only valid if the treasury ceases to issue treasury bills without consent of the CB. Otherwise, the treasury would control the total amount of liquidity in the economy. The scenario implies that treasury bills would assume the role of the GAME and the incidental functions of money (i.e. the unit of account and store of value function). The liabilities of the treasury would substitute for the liabilities of the CB as money. Again, the general acceptance of these liabilities in exchange would depend predominantly on the credibility of the treasury to provide a nominal anchor to the system.

In addition the model is incomplete because there is no rational for intermediation. The banks that issue electronic money do not offer any service – there is no risk, liquidity, maturity, and volume etc. transformation. The question arises why individuals should transfer electronic money that is convertible into stocks and bonds rather than the stocks and bonds themselves. Presumable the transaction costs involved in the transfer of assets are larger than those involved in the transfer of eMonies, but the authors do not make that assumption explicit nor do they discuss its bearing on the consistency of their model.

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[30] See Schmitz 2000b.

[31] See White 1984.

[32] See in particular Costa/De Grauwe 2001, Figure 2.

Final Settlement by the Transfer of Wealth

King (1999) offers a similar but more radical proposal as he eliminates intermediation from the payments system and attempts to develop an indirect exchange economy with a unit of account. Transactions are settled in real time by the transfer of wealth so that there is neither demand for CB money nor for a GAME. The buyer obtains funds by a real time sale of a financial asset, transfers these to the seller who immediately reinvests in financial assets. In order to reduce transaction costs all financial markets transactions are completed automatically based on pre-agreed algorithms. Financial assets qualify for inclusion in the barter system, if they are traded on markets administered by the system which would match demand and supply, ensure efficient price formation and settlement continuously. All prices are supposed to be quoted in a publicly announced, uniform unit of account. King concludes that there is no role for CB money. Hence, CBs cannot implement monetary policy.

King argues that final settlement might take place in real wealth

Discussion

King's model presumes that market prices for electronically traded financial assets exist, that market prices for the goods and services exchanged exist, and that all these prices are quoted in the uniform unit of account. In fact, the model does not describe an indirect exchange economy. Financial assets are sold instantaneously and "funds" are transferred which are reinvested upon receipt. However, it remains unclear what these "funds" are. If they are risky financial assets that are as liquid as the initial portfolio held by the buyer, then there is no point in exchanging them for "funds" in the first place. If they are more liquid then other financial assets, then these "funds" are a means of payment and possibly a GAME and the economy is not an indirect exchange economy. Similarly to Costa/De Grauwe's (2000) term "liquidity", the term "funds" is not clearly defined.

Market prices are assumed to be given …

… and liquidity is not clearly defined

Furthermore, it remains unclear how these funds – and indeed the financial assets in general – are linked to the unit of account. In a Walrasian economy all goods are equally liquid and any one of them can be chosen as the numeraire. As it is traded on markets continuously against all other goods, there are always well-defined relative prices available for all goods vis-à-vis the numeraire. Via the going market price of any good in terms of the numeraire all nominal prices are determined at all times. In King's model there is no good or service that is the numeraire. Instead the unit of account is subject to regulation and supervision such as weights and measures. In principle, the weight or the length of an arbitrary good can be defined as the unit of measurement. The weight and length of any other good is derived from a comparison with the standard good that entirely relies on objective criteria. But how does this logic apply to goods and financial assets? An arbitrary good, an abstract unit called e.g. *US$*, is defined as the unit of account and the value of any other good is derived form the standard by a direct comparison of value. Unfortunately, the comparison involves subjective values and cannot be undertaken objectively, compared to the inspection of weights and measures. Consequently, any such comparison necessarily presupposes the existence of markets in which goods are exchanged – directly or indirectly – for the standard. The exchange of goods for the good embodying the standard (e.g. the GAME) constitutes the intersubjective comparison. The analysis of separability of GAME and the unit of account usually lacks an analysis of the formation of nominal prices.[33] The standard can be linked to a financial asset by fixing its price through redeemability in the GAME. If that is what King has in mind, then the commodity

There is no unit of account

[33] E.g. Cowen/Kroszner 1994.

("funds"?) in his model is the GAME and the unit of account. Final settlement would take place in the GAME and various forms of financial assets could serve as means of payment (e.g. deposit transfers, checks etc.). Without any such means of final settlement the model is characterised by circularity, as financial assets are claims to financial assets. If, however, some financial assets are claims to goods and services (e.g. one ounce of gold) at a fixed ratio, the system will be nominally anchored. In that case it would resemble a traditional commodity standard. Whether or not the CB has the power to manipulate the nominal and/or the real short-term interest rate of the GAME depends on the institutional set-up, i.e. control over the production of the commodity, large stocks of the commodity, regulation of international flows of the commodity etc.

The model is either a Walrasian economy without transactions costs and barter is efficient ...

King's model can be interpreted in two ways: *(i)* the first interpretation resembles a Walrasian economy with all goods and services being equally liquid. There is no money and no CB. One of the goods is arbitrarily chosen as the numeraire but it has to be a good or services. It would be as liquid as any other good and continuously traded vis-à-vis all other goods and services. An illiquid abstract unit of account would not do the job. But as information is not costly in this economy there is no need for a numeraire in the first place. No transaction would be intermediated by "funds"; every transaction would be settled by direct or indirect barter, which are equivalent in terms of transaction costs as these are all zero. Monetary policy is impossible and indeed would only be harmful as all markets clear instantaneously and the resulting allocations would be Pareto-efficient.

... or reduces to a traditional commodity standard

(ii) The second interpretation reveals that the model is basically a traditional commodity standard with an advanced electronic retail payment system with very liquid financial assets (e.g. mutual money market funds). The underlying commodity would serve as the GAME and resume the unit of account-function and financial assets could be increasingly employed as means of payment. The challenges to monetary policy implementation would largely result from the nature of the system as a commodity standard and not from the technology of the means of payment. Although a more sophisticated system could increase the costs of supervision of any underlying regulation (e.g. regulation of international flows of the underlying commodity). If the "commodity" ("funds") is CB money, the CB will retain the monopoly of issuing the GAME and the unit of account at zero marginal costs. Hence, the efficacy of monetary policy would not be affected, in principle.

Further Models Proposing Final Settlement by the Transfer of Wealth

Browne/Cronin argue that the unit of account would be preserved by numismatists and that technology reduces the spread in financial markets ...

Browne/Cronin (1995) propose a model similar to King's that is based on the transfer of shares of mutual funds and a unit of account without a GAME. New technology in retail and wholesale payment systems eliminates the demand for CB money. The unit of account function of money would be preserved by numismatists collecting CB coins and banknotes. Another option would be a commodity-based unit of account. Similar criticism applies to their concept as to King's (1999). However, they provide a few counter-arguments to White's (1984) criticism of the separation of the unit of account and GAME, in particular the reduction of (operational) transaction costs by advances in technology (i.e. optic fibre and smart cards) and the low share of currency in the total transaction media already observable, to mention but two. To argue that a reduction in operational costs could eliminate the spread reveals an unduly narrow concept of the determinants of the spread (see section 4.1). That currency constitutes only one percent of the transaction media is irrelevant for the argument because CB reserves constitute CB money as well. But more importantly, the argument confuses the different concepts of "medium of exchange" and "means of payment". Even if most payments are conducted by credit, debit cards, bank transfers,

... but their concept of the spread is too narrow

checks and other non-cash means of payment, the underlying GAME remains CB money and the non-cash transactions constitute claims to CB money. Contrary to their claim, a transaction initiated by non-cash means of payment does not constitute a separation of the GAME from the unit of account.

Kroszner assumes the parallel use of multiple units of account

Kroszner (2001) envisages a future of the parallel use of multiple units of account rather than a single abstract one but the various units would all be based on mutual funds. In addition to confusing currency competition and the parallel use of multiple units of account, he also treats competition of means of payment as equivalent to competition in GAME (see FN 11, 14). Neither in his analysis nor in Browne/Cronin's is price formation in such an institutional setting discussed.

Centi/Bougi model transaction media backed by equity claims ...

Similarly to King (1999), *Centi/Bougi* (2003) base their "New Monetary Order" on a world, in which transaction media are backed by equity claims. They also reach the conclusion that CB money (i.e. outside money in general) and monetary policy would vanish. Contrary to King, they do not mention a unit of account explicitly. It remains unclear what the GAME, the unit of account, and the medium of final settlement are in the model. The institutional structure of electronic money schemes is at best sketched rudimentarily. Competition of issuers of fiat money backed by real assets is conceptualised in a way similar to Klein (1974). Issuers invest in brand name capital in order to generate trust among customers. However, as shown by White (1999) and Schmitz (2002b) the potential loss of brand name capital does not provide sufficient incentives to prevent overissue and hyperinflation. They conclude that competition of privately issued fiat monies is infeasible. Centi/Bougi briefly discusses dynamics in the market, according to which "good" money would drive out competitors. They seem to insinuate that more than one competing monies would prevail in equilibrium, but fail to derive the conditions, under which such an equilibrium would proof to exist and to be stable.[34]

... but the model is incomplete and inconsistent

4.3 Conclusion

Friedman (1999, 2000) argues that the proliferation of alternative media of exchange and units of account will render monetary policy irrelevant (section 4.2.1). He rests his case on the observation that privately operated retail and wholesale payments systems economize on CB money. The reduction of the ratio of CB money to measures of aggregate economic activity (e.g. GDP) will eventually lead to its irrelevance, particularly in the limit when CB money is eliminated. He does not present evidence that this ongoing process has already reduced the efficacy of monetary policy. He assumes that reaching the limit has no structural effects on the economy. In response to his critics he argues that – in due course of the economy approaching the limit – the markets will eventually discontinue to act upon the announcements of the CB. But he fails to demonstrate why the markets should change their perception of CB power as long it retains the monopoly to supply the GAME and the unit of account at zero marginal costs – that is, before the limit is reached. He does not highlight the conditions, under which the CB loses this monopoly before the limit is reached, nor under which circumstances a new GAME emerges, if at all, and what the process of transition would look like once the limit is reached. He implicitly assumes that the economy would display no structural change

Friedman does not demonstrate why the CB should lose its monopoly in providing the GAME

[34] For a detailed demonstration of the inefficiency of the parallel use of multiple units of account see Schmitz (2002b).

once it reached the limit. The institutional structure of the monetary system in the limit is not discussed in any detail.

His critics focus on the positive demand for CB money without taking into account the its function as GAME and unit of account

In response to Friedman (1999, 2000), a number of papers argued that the demand for CB money will not vanish and that the limit will not be reached (section 4.2.2). Some of the models focus on the public's demand for currency others on the banks' demand for CB reserves. The motifs for the positive demand for CB money vary (e.g. anonymity, first mover advantage, transaction costs of electronic barter, precautionary reserves). Models that highlight the residual demand for currency usually fail to discuss whether the residual demand is sufficient to ensure that CB money maintains the GAME- and unit of account-functions. Arguments that stress the comparative advantage of CBs to provide final settlement usually rest on the critical presumption that the CB maintains its monopoly to supply the GAME and the unit of account at zero marginal costs. The argument is circular in as far as it assumes the crucial role of the CB (as provider of the GAME and the unit of account) to demonstrate the comparative advantage of the CB to provide final settlement so that the demand for CB reserves remains positive and CB money remains the GAME and the unit of account.

The provision of the unit of account and its role in the economy are unclear in this class of models

Models that are based on a publicly sanctioned, uniform unit of account either envisage privately issued fiat-type electronic money (section p. 71) or final settlement by the transfer of wealth (section p.75). Discussing the first vision of a cashless society, Costa/De Grauwe (2001) argue that the price level would be indeterminate and monetary policy based on traditional instruments (OMOs) impossible. The model is incomplete and inconsistent as there is no institutional arrangement that ensures that the privately issued fiat-type eMonies will perform the unit of account function of money, there is no meaningfully defined money market in the model and the price levels in the various eMonies are infinite rather than indeterminate. As eMonies do not exchange at par, their exchange will involve spreads. The model is unstable, as the eMoney with the lowest spread will, in principle, drive its competitors out of the market. Without means of final settlement the model is characterised by circularity. A further problem arises, as financial intermediaries do not seem to offer any intermediation services – it remains unclear why individuals should exchange eMonies backed by assets rather than the assets themselves.

Models that are based on a publicly sanctioned, uniform unit of account and the transfer of wealth face similar difficulties: there is no GAME, no well defined price level and no unit of account, as the models fail to establish a link between the publicly sanctioned, uniform unit of account and the means of payment. They also lack an analysis of the formation of nominal prices and simply assume market prices as given. Wealth is exchanged in an indirect manner via "funds" but the term is not clearly defined. In 2.3.2 I suggest two interpretations that either resemble a Walrasian economy without any transaction costs or a commodity standard. While monetary policy is indeed ineffective, its feasibility depends on the choice of the underlying good in the "commodity" standard. If eMonies or assets are redeemable in CB money, it resumes the function as the GAME and the unit of account and the CB remains in control of the short-term interest rate.

Many of the models discussed assume an institutional structure of the monetary system that involves the separation of the unit of account from the GAME

Many of the models discussed assume an institutional structure of the monetary system that involves the separation of the unit of account from the GAME. The analysis demonstrates that these models lack an analysis of the mechanisms of price formation and that nominal prices in the unit of account presuppose the direct or indirect exchange of goods for the GAME which embodies the unit of account in competitive markets.

Table 4.3-1 summarizes the common features of many models discussed in the previous sections albeit few of them combine all the features.

Table 4.3-1: Common Features of Models on eMoney and Monetary Policy

Common Features of Models on eMoney and Monetary Policy
Neglect of transition process from existing monetary system based on GAME & uniform unit of account to monetary systems envisaged for the future
Monetary systems envisaged for the future usually neglect the question whether GAME & uniform unit of account exist
Neglect of literature on time inconsistency and privately issued fiat-type monies
Concepts of "means of payment" & "medium of exchange" often confused
Neglect of analysis of price formation mechanisms under envisaged monetary systems
No link between publicly sanctioned unit of account & means of payment
"Liquid funds" traded in money market not well defined
On closer inspection: Models collapse to Walrasian economy or commodity standard or current monetary systems

Models collapse to Walrasian economy or commodity standard or current monetary systems

If ICT is supposed to overcome all frictions, all goods are equally liquid and there is no need for a GAME and a uniform unit of account. All demand and supply schedules are homogenous of degree zero in nominal prices and neither the price level nor the rate of inflation is defined unambiguously. Any good or service can serve as numeraire. But relative prices remain to be determined. As there are no transaction costs and there are relative market prices for all goods at all times, their prices in terms of the numeraire are available permanently at no cost. All markets clear and there is no need for monetary policy, there is no need to nominally anchor the economy.

All models fail to provide a clear institutional structure of the underlying payment system

Until the world economy resembles the Arrow-Debreu model, transaction costs will remain positive and a GAME – that also fulfils the function of the uniform unit of account – will further reduce transaction costs relative to an economy without a GAME. The institutional structure is likely to involve redeemability of eMonies in the GAME and the respective uniform unit of account will prevail in the economy. The dominant medium of exchange in the respective market has a comparative advantage with respect to alternative units of account at current moderate levels of inflation. The diffusion of eMoney might reduce the threshold for currency substitution in high inflation regimes slightly. But the CB is likely to maintain its monopoly in the provision of the GAME and the unit of account at zero marginal costs. Current EU-regulation (Directive 2000/46/EC of the European Parliament and of the Council of 18 September 2000 on the taking up, pursuit of and prudential supervision of the business of electronic money institutions) reinforces that prediction (i.e. article 3 on redeemability of eMoney). In principle, monetary policy will remain effective. In the unlikely case that the monetary system discontinues to be rooted in CB money, another GAME and unit of account emerge (e.g. commodity standard). In that case the efficacy of monetary policy depends on the concrete institutional arrangements. Nevertheless, the ongoing institutional change in the payments system – at the retail and the wholesale level – will necessitate adaptations of monetary statistics and of the instruments and the implementation of monetary policy. A challenge CBs have proven to cope with quite successfully so far.

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5 Monetary Policy in a World without Central Bank Money

Stefan W. Schmitz

Introduction

This paper analyses the prospects of monetary policy in a world without central bank money. The role of CB money as GAME is a precondition for the implementation of monetary policy in the current institutional set-up. In the paper I show that conferring certain regulatory competencies (including the power to impose financial obligations on third parties) to CBs would enable them to implement an equivalent to monetary policy in a world without CB money. The analysis is based on the conceptualisation of a payment system that does not settle in CB money; in which the demand for CB money is actually zero. As shown by an analysis of the legal foundations of the operations of the ECB and the Fed, CBs do in fact already possess the necessary regulatory powers. Politico-economic objections to granting CBs the necessary regulatory competencies do also apply to the institutional frameworks currently in place in the Euro area and the US.

Alternative models of monetary policy in worlds without money fail to elaborate the institutional structure of the payment system

A number of papers in the current debate on the impact of innovation in payment systems on monetary policy address the issue in an economic set-up without money. I demonstrate that these models fail to elaborate the institutional structure of the payment system they attempt to model and they neglect issues regarding the existence of a generally accepted medium of exchange (GAME) and of a medium of final settlement in the underlying payment systems.

Schmitz (2002b) concludes that the most likely institutional structure of the payment system will maintain the pivotal role of CB money. Nevertheless, it is important for CBs to understand the potential implications for monetary policy implementation of a hypothetical world without CB money; even if it is considered unlikely at the moment.[1]

Certain regulatory powers enable CBs to implement an equivalent to monetary policy in a world without CB money

The role of CB money as GAME is a precondition for the implementation of monetary policy in the current institutional set-up. In the paper I show that conferring certain regulatory powers to CBs enable them to implement an equivalent to monetary policy in a world without CB money. The analysis is based on the conceptualisation of a payment system that does not settle in CB money; in which the demand for CB money is actually zero. It explicitly provides a role for a GAME and a medium of final settlement. The relevant instruments available to CBs are the imposition of minimum reserve requirements in the medium of final settlement and the competence to grant or charge interest on reserves held as deposit balances at the CB. The ability to apply these instruments is independent of the monopoly position of CBs to provide the GAME at zero marginal costs. It is a consequence of their role as public institutions endowed with certain regulatory competencies. Thus, CBs would be able to manipulate the opportunity costs of holding minimum reserves without ma-

[1] CPSS 2003, 7.

nipulating the market price of the medium of final settlement. As shown by an analysis of the legal foundations of the operations of the ECB and the Fed, CBs do in fact already possess the necessary regulatory powers. Politico-economic objections to granting CBs the necessary regulatory powers would also apply to the institutional frameworks currently in place in the Euro area and the US.

In the first section I review the current proposals for monetary policy in "moneyless" worlds. The second section discusses monetary policy implementation in a world without CB money that explicitly provides a role for a GAME, a unit of account, and a medium of final settlement. First, I conceptualise the sequence of instruments of monetary policy implementation in a world with CB money. Second, I discuss their potential application by a CB that does not issue the GAME[2] to conduct a functional equivalent to monetary policy. Thirdly, I analyse politico-economic issues of the proposed alternative instruments of monetary policy implementation. The last section summarised and concludes the paper.

5.1 Proposals for the Conduct of Monetary Policy in a World without Central Bank Money

Goodhart's model does not provide for a GAME nor a unit of account

For the purpose of his analysis of monetary policy without money *Goodhart (2000)* assumes that all payments are based on the transfer of eMonies denominated in various distinguishable units. The various electronic means of payments (eMonies) float against each other. There is no GAME and, hence, no uniform unit of account. The CB also offers an eMoney and quotes a bid price (deposit rate) and an ask price (loan rate) just like all other financial institutions operating in the market for liquid funds. The spread between the bid and the ask price of liquidity is determined by real factors such as uncertainty, uncertainty preferences, resource costs of holding inventory positions in various financial assets and the related uncertainty, potential asymmetries of information among market participants, operating costs as well as transaction and information costs.[3]

As the CB is a not-for-profit organisation and the government's bank, it can afford to offer a lower spread and incur potentially large losses, because the government offers unlimited financial backing. Assuming credibility of the government's commitment, the CB's bid and ask price move the market rate for liquid funds even if it is not the monopoly supplier of liquidity.[4] Apart from the fact that the government might eventually face a budget constraint[5] as well, the proposal seems incomplete and inconsistent. As there is no uniform unit of account, there is no uniform price level the CB can attempt to stabilise.[6] The market for liquid funds seems to consist of short-term financial assets but

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2 E.g. a CB under a gold standard.

3 Inter alia O'Hara 1997.

4 The Austrian central bank (OeNB) monopolised market making in the ATS/DEM foreign exchange market in the 70s in basically the same way. It offered lower bid and ask prices and drove commercial banks out of the market.

5 The parallels to forex market intervention and potential currency crisis are apparent.

6 If demand for CB money were positive, the CB could attempt to stabilise the price level in its own currency.

there is no tradable, most liquid asset that exchanges at the lowest spread relative to all other assets. The market for liquid funds seems to consist of funds that are less liquid than electronic means of payment (eMonies), that's why there is demand for eMonies despite the spread involved in acquiring them in exchange for liquid financial assets. As there is no medium of final settlement the model is faced with problems of circularity. If issuers offer bid and ask spreads (interest payments) solely in their own electronic money unit the exact form of the budget constraint is opaque, unless the units are redeemable in some asset that is costly to acquire or produce for each issuer (outside money). It is unclear to what extent monetary policy provides a nominal anchor for the real economy in the proposal, as the concept of nominal prices is not well defined in this model.

Furthermore, the effects of monetary policy on macroeconomic activity appear to be limited in the model. A contraction of monetary conditions in the eMoney issued by the CB directly affects the price level measured in the respective eMoney unit and, hence, directly influences macroeconomic activity only in the share of the economy dealing in this particular electronic money unit. The system seems to be unstable. What are the indirect effects of the CB's policy on eMonies issued by competing institutions? Expansionary monetary policy implies that the CB decreases its spread on the market for liquid financial assets so that it potentially attracts more agents willing to sell and, correspondingly, issues a larger volume of its own electronic means of payment. Firstly, assuming the competitors follow – as the face a strict budget constraint – losses and, eventually, bankruptcy would be the consequence. The CB eventually emerges as the sole issuer of eMoney and it can resume the role of the monopoly issuer of the GAME and uniform unit of account. Secondly, its competitors leave their spread unchanged. The CB attracts all trades and drives its competitors out of the market, unless the respective price level in the CB eMoney unit and its exchange rates vis-à-vis its competitors adjust. The CB eMoney unit depreciates relative to its competitors and the price level in the CB unit increases. However, the price levels in all other units remain unchanged. Covered interest rate parity ensures the isolation of all other nominal spheres from that of the CB.[7] Admittedly, the argument assumes that the exchange rates between eMonies are more flexible than the prices quoted in the other eMonies. But as the entire debate rests on the assumption that information and communication technology overcomes frictions in the economy, exchange rates between eMonies are likely to be less sticky than goods market prices.

Monetary policy does not affect macroeconomic activity in the model

Goodhart further assumes that electronic money issued by the CB is "… always acceptable, (since it is the government's bank), so it can always force out unto the system as much [of its own electronic money] as it wants …" (Goodhart 2000, 28). This insinuates that it is the GAME and, hence, the unit of account. In that case the model collapses to the current institutional arrangement for the conduct of monetary policy.

Freedman (2000) also offers a thought experiment on the implementation of monetary policy in a world of alternative settlement mechanisms off the CB's books. He provides two proposals: *(i)* the CB could sell treasury bills and restrict acceptable means of payment to its own liabilities. Unless the CB is the sole source of treasury bills, it remains unclear why other banks cannot buy treasury bills at the going market rate from other market participants or the Treasury. Regulation ensures the acceptance of CB money as means of payment for treasury bills, but not necessarily as GAME and medium of final set-

Freedman's institutional structure is incomplete

[7] Covered interest rate parity assumes the existence of some form of option or futures markets for eMonies.

tlement in other transactions. It remains unclear what the unit of account is in the model, what the treasury bills are denominated in, and how final settlement is supposed to take place when treasury bills mature.

(ii) The CB continues to provide liquidity to the market via standing facilities even when settlement takes place off its books. It would finance these standing facilities by its own liabilities, which apparently continue to be accepted by market participants. Furthermore, CB money seems to remain the GAME, the unit of account and the medium of final settlement. But the details of the institutional structure of the payment system are not explicated in the model and can only be inferred from the general description of the model. Consequently, the model does not offer much of an alternative to current systems. Private settlement systems reduce the demand for CB money further, but in principle, it remains positive and the entire system continues to be firmly rooted on CB money. Essentially, the model fails to describe a world without CB money.

Henckel et al. assume that final settlement takes place in treasury bills ...

Henckel/Ize/Kovanen (1999) discusses the conduct of monetary policy without base money in the following model. Automatic end of day settlement takes place on the books of private clearing and settlement institutions (CSI). Net debtors and net creditors would pay and receive, respectively, the rate of interest for their end of day net positions. Treasury bills would collateralise these credit transactions. The exchange of treasury bills would provide finality without settlement on the books of the CB. Collateralised overnight positions would extend the netting process infinitely. Although there is no money in the model, the CB retains the power to set the overnight rate, by narrowing the spread between the borrowing and the lending rates on its overnights facilities. The CB sets the rate solely for the net positions in the overnight market and not for the stock of reserves. In the model the stock of reserves consists of treasury bills and the opportunity costs of holdings these define the costs of liquidity rather than the rates on end of day net positions, which are largely a residual of the payments process.

... but the CB is assumed to set the respective interest rate

The ability of the CB to set the overnight interest rate – for the automatic end of day settlement – lends support to the interpretation that CB money remains the GAME and the unit of account and, hence, that the demand for CB money must be positive. The authors argue that the CB can impose its target rate on the market for overnight settlement by narrowing the spread between the borrowing and the lending rates on its overnight facilities sufficiently. But the credible ability to provide funds and accept funds from the market without limits is a prerequisite for the efficacy of such a policy instrument, as Friedman (1999, 2000) and Woodford (2000) point out. Only the institution that provides the GAME at zero marginal costs is credible with respect to the (potentially) infinite elasticity of its demand and supply of funds in the money market.

Despite the continuing monopoly position of the CB the authors attempt to provide a solution to the problem of price level determination with purely endogenous money. They derive a Taylor-type rule from a small macro-model to show that the announcement of the target inflation rate is sufficient to anchor the system and determine the price level in this economy.

The model neither mentions the role of the GAME nor that of the unit of account

The model neither mentions a GAME nor a unit of account. As the CB does not forego the monopoly power to "corner" the settlement market, it seems that CB money remains the GAME and the unit of account in the model. Consequently, the transfer of Treasury bills does not principally provide finality, as these constitute claims to CB money. As the authors admit themselves, the transfer of treasury bills rather extends the netting process. Instead of a model without CB money the authors discuss a model with aggregate overnight settlement balances in the interbank market equal to zero. Nevertheless, CB money remains the medium of final settlement while treasury bills are means of set-

tlement for end of day net positions without settlement finality. Otherwise the model would imply circularity. Freedman's (2000) arguments clearly highlight the potential advantages and disadvantages of infinitely extended netting in interbank settlement.

In order for a Taylor-type rule to be sufficient to determine the price level in this economy the price level must be defined. If the demand for CB money is zero the price level in CB money is defined; it is infinite. Again the set-up of the model is inconsistent, unless the demand for CB money – also the GAME in the model – remains positive and the money supply is not purely endogenous as the authors claim. Consequently, their model reduces to an exposition of net settlement and Taylor-type rules in a model with positive demand for CB money but zero aggregate overnight settlement balances. In principle, the individual overnight reserves can remain different from zero for at least some nights due to uncertainty. As such the institutional arrangement of the model is quite similar to the monetary framework in New Zealand.[8]

Lahdenperä (2001) offers a conceptualization of the future state of the monetary system. Privately issued electronic monies compete while a uniform unit of account is maintained and provided (*sic!*) by the state (p. 29). The eMonies are backed by tangible assets (e.g. precious metals) or low risk government (p. 40). The author does not discuss the role of the money market or the role of the unit of account. As the paper reviews a lot of literature, it is not always clear whether the author merely draws from the literature or subscribes to one or more particular future monetary arrangement(s). The author devotes a section (pp. 34) to an original analysis of the implementation of monetary policy in a model of electronic money, which I shall discuss in more detail.

Lahdenperä assumes privately issued monies to compete

The model assumes two competing settlement systems that both provide final settlement in electronic money. One is operated by the CB the other one by a private clearing and settlement institution (CSI). Participants are free to choose but switching between systems involves transaction costs. Both settlement agents provide standing facilities at the respective rates. Alternatively, participants can obtain funds in the money market. CB and privately issued eMoney trade at par and a single money market rate prevails. In order to cope with liquidity shocks in both settlement systems participants hold reserves in both eMonies. Can the CB steer the money market rate? It is determined by the weighted average of the respective lending rates of the competing settlement agents. Lahdenperä concludes that the CB maintains the power to manipulate the lending rate in its own settlement system and, hence, the money market rate. Its influence on the money market rate is only partial as it is no longer the monopoly supplier of the medium of final settlement and of reserves in the system. The alternative provider of final settlement commands similar influence on the overnight rate. The relative impact of the policy decisions of the two settlement agents depends on the weights of their respective lending rates in an "aggregate lending rate".

The model is incomplete and inconsistent. It assumes that the competing eMonies trade at par but does not discuss how parity is supposed to be maintained. The institutional arrangement supporting the assumed structure of the model is not discussed at all. It remains unclear whether the privately issued eMoney is backed by commodities, financial assets or fiat-type money.[9] Furthermore, there would be no mechanism in place ensuring parity. If CB money remained fiat money and the competing eMoney were backed by commodities or finan-

His model is incomplete and inconsistent

[8] Sellon/Weiner 1997 and Woodford 2000.

[9] If both eMonies were fiat-type currencies the literature predicts that the price level is infinite. See White 1999 and Schmitz 2002b and the literature quoted therein.

cial assets, parity would be maintained if and only if the respective portfolios were expected to remain perfectly stable in nominal terms at all times. Unless privately issued eMoney is backed by CB money that condition is unlikely to be met. The eMonies differ only with regard to the respective lending rates. If eMonies are perfect substitutes in the money market, the differences of the lending rates can only be a temporary and transitory phenomenon caused by transaction costs of switching between systems. Over time the differences are expected to average out unless other characteristics of the settlement systems (e.g. settlement and operational risk, supervisory functions etc.) exactly balance the interest rate differential. Otherwise, the system with the lower lending rate would gain market share and eventually a monopoly position. The weights correspond to the market shares of the competing settlement systems and their respective probabilities of a reserve deficiency or excess.

Furthermore, Lahdenperä does not even mention whether any of the competing eMonies fulfil the role of the GAME and the medium of final settlement. In a different section (p. 29/FN 18), however, he subscribes to King's (1999) position that a uniform unit of account "[…] could be provided mechanically by regulation as other weights and measures today". As argued in Schmitz (2004) the analogy between the regulation of weights and measures and the unit of account is based on a misconception of the subjective nature of exchange in economics.[10]

The model collapses to the current institutional setup

If the model is taken seriously, the following implicit institutional arrangement supports its main features, i.e. perfect substitutability, a single money market rate but different lending rates: CB money remains the GAME and the medium of final settlement. The alternative privately issued eMoney is denominated and redeemable in CB money. The alternative settlement system economizes on CB reserves through netting arrangements. By incurring a higher settlement risk compared to real-time gross-settlement in CB money through netting and pooling of reserves the settlement agent can invest the resulting excess reserves in low risk government debt and the system can be profitable.

How does monetary policy work under this institutional arrangement? The CB maintains the monopoly provider of the GAME at zero marginal costs. The demand for settlement balances to meet the redeemability requirement constitutes a constraint for the alternative eMoney issuer that consequently faces positive marginal costs in the provision of eMoney. The alternative eMoney is a means of payment but neither the GAME nor the medium of final settlement. Such arrangements are already wide spread (e.g. CHIPS) and have posed no serious threat to the efficacy of monetary policy implementation, in principle, as Lahdenperä emphasizes in section 5.2.2.

[10] See also Schmitz 2002b for an analysis of the unit of account function of the GAME and price formation.

5.2 Monetary Policy in a World without Money

In section 5.2.1, I present a conceptualisation of the instruments employed by CBs to implement monetary policy in a world with CB money. Subsequently I discuss the choice of the medium of final settlement in a world without CB money (section 5.2.2, p. 98). Then I assess whether and to what extent the instruments available to CBs are sufficient to conduct and implement an equivalent to monetary policy in a world without CB money (section 5.2.2, p. 99). Finally, I briefly consider the ensuing politico-economic implications of the proposed instruments of monetary policy implementation in a world without CB money (section 5.2.2, p. 102).

5.2.1 The Money Market and Monetary Policy in a World with CB Money

Bindseil (2004) presents a historical account of monetary policy implementation at the Bank of England, the Deutsche Bundesbank (formerly Deutsche Reichsbank), and the US Federal Reserve System. Throughout most of their histories the Bank of England and the Deutsche Bundesbank focused on the money market rate as their main operating target rather than quantity variables. The Fed on the other hand favoured targeting quantity variables until the 1990s. In recent years the ECB, the Fed, and the Bank of England all rely on interbank money market interest rates as operating targets in monetary policy implementation.[11] Also Borio (2001) shows that CBs in industrial countries implement monetary policy by manipulating interbank money market interest rates and through open market operations (OMOs)[12]. CBs implement monetary policy by manipulating the relative price, the opportunity costs of holding the medium of final settlement, i.e. the spread between the rate of interest on CB money held on accounts with CBs and the rate on the optimal alternative investment.

Interbank money market rates are the main policy variable

I will restrict the analysis to five instruments of monetary policy implementation, namely (1.) the communication strategy of CBs – the announcement of a specific level for the operating target (the main policy variable), (2.) minimum reserve requirements, (3.) open market operations, (4.) intraday credit[13] and (5.) standing facilities.

Analysis focuses on five instruments of monetary policy implementation

Although payment system participants are not necessarily legally required to settle in CB money, they generally do so. The role of CB money in wholesale payment systems is the nexus between the CB, the economy wide payment system, and nominal GDP as well as the price level. Its role as medium of final settlement is an incidental function of its role as GAME. In principle, the reliance on CB money at the level of wholesale payment systems eliminates credit and liquidity risks after settlement, i.e. vis-à-vis the clearing and settlement institu-

CB money usually means of final settlement in payment systems …

… which follows from its functions of as GAME

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[11] For the role of excess reserves in the implementation of monetary policy in the Euro-area see Bindseil/Camba-Mendez/Hirsch/Weller (2003), for the framework for monetary policy implementation in the Euro-area, the UK, and the US see ECB (2004), Wetherilt (2002), and Edwards (1997), respectively.

[12] For details concerning OMOs of the ECB, the Fed and the Bank of England see also ECB (2004), Bartolini/Prati (2003), and Allen (2002).

[13] In fact, intraday credit is not an instrument of monetary policy implementation. I have included it in the current discussion as it forms an important feature of the wider implementation framework.

tion (CSI).[14] Settlement in CB money ensures finality in an economic sense (as opposed to finality in a legal sense as unconditional and irrevocable payment), since CB money is neither an explicit claim to real resources nor to nominal payments. Reserve requirements are usually averaged over a fulfilment period and the same account at the CB can usually be employed to administer settlement balances, to fund and defund in the interbank settlement process, and to fulfil reserve requirements. In interbank payment systems CB reserves are the medium of final settlement. This guarantees a positive demand for CB money, irrespective of the means of payment employed in retail payment systems, as long as these are denominated in the CB money and, thus, linked to the interbank market.[15]

Settlement on the books of CBs has additional advantages. As a public institution the CB is required to provide access to its accounts and to intraday credit on fair, equal, and non-discriminatory conditions. Freedman (2000) argues that settling on the books of a competitor could lead to a competitive advantage for the private CSI, that the liabilities of a private CSI carry some credit risk, and that a private CSI cannot increase liquidity at zero marginal cost as can CBs and credibly act as lender of last resort (LLR).

The impact of CB policy announcements on the interbank money market rate is a consequence of the capacity of CBs to increase aggregate reserves in the GAME at zero marginal costs

The starting point of the analysis is the *announcement of a level for the main operating target* directly (e.g. Federal funds rate) or indirectly (e.g. via the rate at which OMOs are conducted such as the minimum bid rate). The credibility of the announcement and its impact on the interbank money market rate are a consequence of the capacity of CBs to increase aggregate reserves in the GAME at zero marginal costs. Despite the relatively small size of their OMOs, CBs can manipulate the main policy rate very well. It was frequently argued that CBs can largely rely on the impact of their communicated target values for the operating target rates ("open mouth operations").[16] This simplification of monetary policy implementation is not justified, despite the relatively small size of OMOs. CBs do in fact employ a number of additional instruments, in order to actually implement the intended market rate and to contain the volatility of the operating target around its announced level.

CBs can influence demand by MRRs

At the intended level of the main policy variable (i.e. the overnight interest rate – r^{pol} in Diagram 5.2-1) a structural liquidity deficit in the payment system prevails. It is defined as the difference between demand $D(r^{pol})$ and supply $S(r^{pol})$ of overnight reserves at the intended level of the main policy rate.[17] The structural liquidity deficit implies that money market participants demand more CB reserves on aggregate than are available on the market. In principle, the variation of *minimum reserves requirements* would be an additional instrument for CBs to manipulate aggregate demand for CB reserves D and its volatility throughout the maintenance period. Minimum reserves requirements change very infrequently and their role in containing the volatility of D rests largely on averaging arrangements during the fulfilment period.

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[14] Freedman 2000.

[15] Schmitz (2002b) demonstrates that the denomination of means of payment in retail payment systems in the GAME is strategically superior for issuers and costumers than denomination in alternative units of account.

[16] Friedman (1999) and Thornton (2000).

[17] Minimum reserve requirements do play an important role in determining the size of the deficit, but they are not a necessary precondition for one to exist, as is demonstrated inter alia by the New Zealand framework of monetary policy implementation. For a description of the relevant features of the institutional framework operational in New Zealand see Woodford (2001), Sellon/Weiner (1997). Whitesell (2003) argues that even though the implementation of monetary policy also works without reserve requirements, the systems would benefit from adding reserve requirements.

CBs estimate the (expected) level of the structural liquidity deficit and set the volume of refinancing operations ΔR^S, in a way that the aggregate supply of reserves $S(r^{pol}) + \Delta R^S$ equals their (expected) aggregate demand $D(r^{pol})$ at the intended overnight rate r^{pol}, in other words CB determine the volume of OMOs according to $\Delta R^S = D(r^{pol})-S(r^{pol})$. The manipulation of aggregate supply by OMOs is the instrument to actually implement the intended market rate on the market. The equilibrium will only prevail temporarily, as CBs conduct refinancing operations which are reversed after a prespecified period (repos), such that the structural liquidity deficit is covered only temporarily.[18] The structural liquidity deficit ensures that at least some market participants have to bid for additional aggregate reserves each time their outstanding debt with the CB matures. The opportunity costs of holding reserves are determined by the stock of the aggregate supply of reserves rather than by the interest rate on excess reserves lend or deficiencies borrowed in the overnight market.[19]

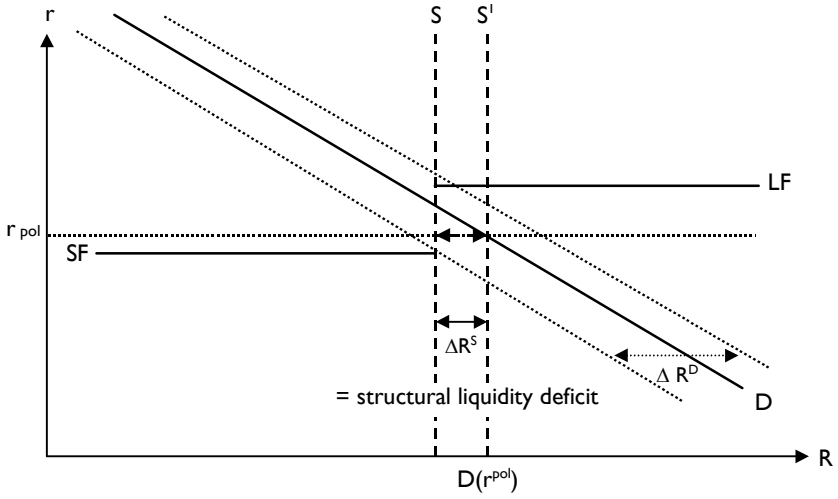

Diagram 5.2-1: Aggregate overnight reserves and the structural liquidity deficit in the overnight market

CB manipulate the level of aggregate overnight reserves by OMOs

The aggregate volume of overnight reserves consists of the sum of the overnight reserves of commercial banks. The level of aggregate overnight reserves is manipulated by *open market operations* (*OMOs*). The slope and position of the demand curve *D* are not known to CBs with certainty, neither is the size of the structural liquidity deficit. The precise demand for CB reserves varies within the band indicated by ΔR^D. The demand for CB reserves at OMOs depends on the level of minimum reserve requirements, the expected working balances over the maintenance period, the averaging arrangements in place, and the expected future overnight interest rates. In equilibrium, the expected discounted marginal costs of borrowing in the overnight market until the next refinancing operation must equal the expected marginal costs of borrowing from the CB via OMOs at the current refinancing operation. The relatively small size of OMOs compared to daily volume is irrelevant, as price formation works at the margin and the CB is in the unique position to manipulate the supply at the margin at zero marginal

[18] The maturity of the main refinancing operations in the Euro area is one week and in the UK it is two weeks.

[19] Comparing the small size of OMOs and the liquidity deficit to turnover in interbank markets is therefore misleading as it relates the continuous redistribution of aggregate reserves among market participants to one off changes in aggregate reserves.

cost. Unless the liquidity situation between OMOs deviates substantially from expectations, market participants have no incentive to borrow or lend at rates substantially over and under the intended level of the main operating target.

CBs can address this uncertainty by auctioning off aggregate liquidity ΔR^S, in order to allow some degree of flexibility. Diagram 5.2-2 illustrates that ΔR^S is endogenised between the bounds $[0, \Delta R^{Smax}]$, which are determined by CBs, as is the minimum bid rate r^{OMOmin}. If the aggregate demand for refinancing D_2^{OMO} is below the maximum volume of a specific refinancing operation, all bids will be satisfied at the respective bid rates[20] and the volume will equal the sum of the bids $\Delta R_2^S < \Delta R^{Smax}$. If the sum of the bids D_1^{OMO} exceeds ΔR^{Smax}, not all bids will be satisfied and the allotment of additional funds and the marginal allotment rate will depend on the allotment mechanism in place.

The implementation process is designed in a way to ensure that aggregate supply and aggregate demand intersect at the announced level of the operating target

The overnight rate remains close to the target level also between OMOs, as CBs determine the maximum operational volume of OMOs precisely with the intention to cover the estimated structural liquidity deficit in the money market at the announced level of the operating target. The implementation process is designed in a way to ensure that aggregate supply and aggregate demand intersect at the announced level of the operating target, unless CBs' estimates of the structural deficit are wrong and/or conditions in the money market change unexpectedly. In equilibrium, commercials banks bidding for overnight reserves have no incentive to pay overnight rates substantially above the target level, as they arrange their bidding behaviour at OMOs accordingly. In addition, the effects of temporary liquidity shocks on aggregate demand for overnight reserves are (partly) absorbed by averaging arrangements for reserve requirements over the fulfilment period. The longer the remaining fulfilment period, the more of a temporary shock can be absorbed by intertemporal substitution.[21] Given that the frequency of OMOs is relatively high with respect to the fulfilment period market participants can to some extent intertemporally substitute bidding at OMOs for overnight credit.

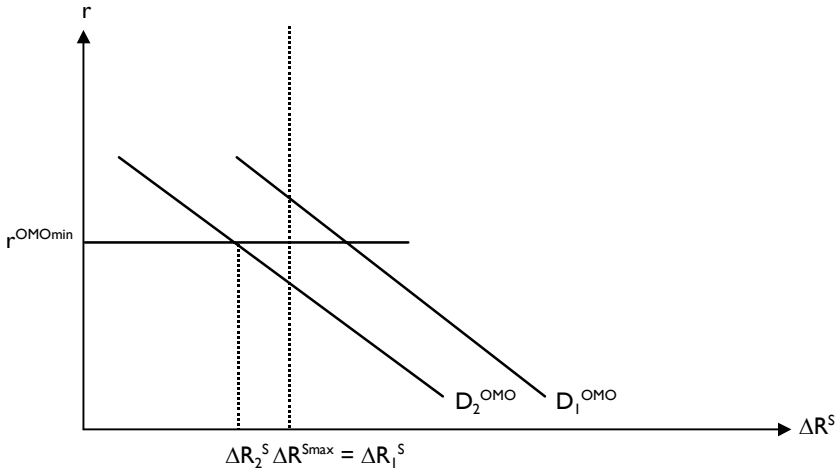

Diagram 5.2-2: The maximum volume of OMOs, demand for additional CB reserves, and the realised increase in aggregate CB reserves

[20] If the participating banks anticipate that demand will be below ΔR^{Smax}, the respective bid rates will be r^{OMOmin}.

[21] Ewerhart/Cassola/Ejerskov/Valla (2003) present evidence that both the level and the volatility of the money market rate in the Euro-area increase towards the end of the maintenance period (for the US see Woodford 2001, 30).

After refinancing operations are concluded, the supply of aggregate reserves is determined and beyond the discretion of the participants of the interbank market and the payment system. They are active on the intraday and the overnight money market and supply and demand on both markets are interdependent. In order to address larger liquidity shocks or those occurring towards the end of the fulfilment period, CBs have additional instruments at their discretion that enable them to stabilise the operating target in the period between OMOs: intraday credit and standing facilities.

Payments systems influence demand for individual banks' demand for overnight reserves

Individual banks' demand and supply of intraday liquidity on the intraday market are determined by their initial CB reserves at the beginning of the trading day, the processes of payments credited and debited, their degree of synchronicity, and the target level of overnight CB reserves as well as the institutional structure of the payment system. Intraday reserves yield a decreasing marginal liquidity service yield and the demand schedule D^{int} is downward sloping (Diagram 5.2-3). The sequence of incoming and outgoing payments is largely a stochastic process and beyond the discretion of individual banks in the very short run.[22] Hence, individual banks' demand and supply on the intraday market are to some extent stochastic and so are their aggregates. In a net settlement system these short run liquidity shocks are likely to average out during the day as participants grant each other implicit credit.

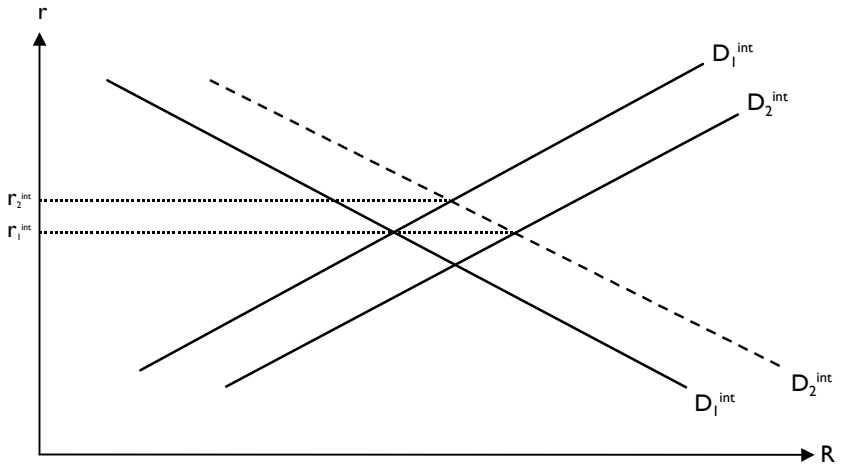

Diagram 5.2-3: The intraday money market and the availability of intraday credit from CBs in RTGS

CBs smooth intraday volatility of interbank market rate by intraday credit

Most interbank payment systems in industrialised countries are RTGS with *intraday credit* provided by CBs.[23] In RTGS the dynamics can lead to a liquidity gridlock and an increase of aggregate demand for intraday liquidity from D_1^{int} to D_2^{int} and to an increase in the intraday market rate from r_1^{int} to r_2^{int}. In order to contain the volatility in the intraday market, which would imply welfare costs due to the costs of hedging against the implied uncertainty and obscure market signals on the liquidity situation, CBs can provide intraday credit,

[22] While the institutional structure is exogenous to the decisions problems of payment systems participants, the degree of synchronicity of payment flows can be increased at increasing marginal costs to the payment system participants to some extent in the medium term, e.g. by clustering credits and debits at pre-arranged points of time. But even under such arrangements exogenous factors – payments initiated by banks' customers – play a crucial role in determining the liquidity positions of participants.

[23] Borio 2001.

which absorbs very short term temporary liquidity shocks, to market participants and shift the supply curve from S_1^{int} to S_2^{int}. Intraday credit also increases the stability of the interbank payment system vis-à-vis net settlement systems by making payment obligations more visible and enhancing risk management. Hence, the supply of aggregate intraday liquidity is endogenised to some extent. In addition, intraday credit reduces the liquidity costs in RTGS. It is usually collateralised to decrease the credit risk of CBs and has to be retired at the end of the day, in order to prevent spill over into the overnight market, where it would exert downward pressure on the main operating target.[24]

As intraday credit has to be repaid at the end of the trading day, the aggregate supply of overnight reserves is independent of intraday liquidity management by CBs. The demand for overnight CB balances is determined by a number of related factors: end-of-day balance of banks' settlement accounts, minimum reserve requirements, the remaining duration of the fulfilment period, and the expectations concerning future overnight interest rates until the end of the fulfilment period.[25]

Banks' activities in the overnight market also reflect deviations of the overnight rate from expectations

Given the remaining duration of the fulfilment period, banks' expectations concerning the future overnight interest rates until the end of the maintenance period, and their expectations concerning the overnight interest rate at the end of the day the banks formulate their targets for their overnight reserves. Given this target banks try to utilise their (limited) room for manoeuvre during the day to reach end-of-day balances equal to their targets. After realisation of end-of-day balances banks lend excess reserves or borrow to cover deficiencies in the overnight market. Their lending and borrowing decisions are not mechanically determined by end-of-day balances relative to the overnight reserve target, but also reflect deviations of the overnight rate from expectations. Given banks' expectations concerning future overnight rates, increases in current overnight rates provide an incentive for banks to decrease their overnight reserve target and to increase lending or decrease borrowing in the market. The elasticity of supply and demand with respect to overnight rates depends on banks' risk preferences.[26] Due to the decreasing marginal liquidity service yield CB overnight reserves provide their aggregate demand is a decreasing function of the overnight rate. Their aggregate supply is determined exogenously.

Changes in expectations of future overnight rates over the maintenance period shift the demand and supply curves in the current overnight money market. Increases in expected future rates shift the current demand schedule upwards as current reserves can be substituted for future reserves over the averaging period. Correspondingly, decreasing expected future rates shift the demand schedule downwards.

Standing facilities set a floor and a ceiling on overnight rates

In addition to OMOs and intraday credit CBs usually grant access to (some sort of) *standing facilities* to park (deposit facility) or to raise liquidity (lending facility) at a premium relative to market rates. The rates charged on these (r^{DF} and r^{LF} in Diagram 5.2-4) set a floor and a ceiling for the overnight money market rate. The zero marginal cost of providing CB reserves and the function of CB money as GAME are preconditions for the ability of CBs to define floors and ceilings for money market rates. CBs do not face budget constraints with respect to r^{DF} and r^{LF} at the margin. In Diagram 5.2-4 the deposit facility *DF* and the lending facility *LF* ensure that the main operating target remains within the bounds $[r^{DF}, r^{LF}]$ despite shifts in the demand from D to D_1 or to D_2.

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[24] In the Euro area intraday credits not repaid at the end of the day are treated as credit from the lending facility.

[25] For a survey of the literature on models of banks' reserve management see Ewerhart/Cassola/Ejerskov/Valla (2003).

[26] Ho/Saunders (1985).

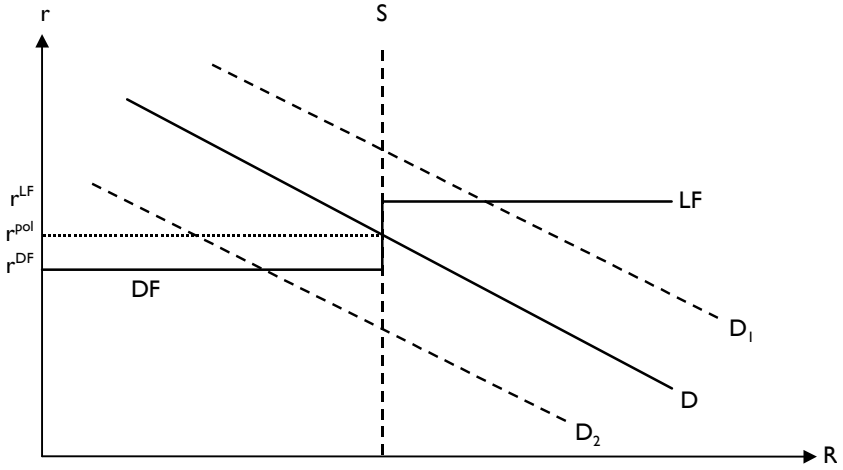

Diagram 5.2-4: The overnight market for CB reserves and standing facilities (between OMOs)

As r^{DF} and r^{LF} constitute penalty rates deviating from the interbank money market rate, participants have an incentive to borrow and deposit funds on the overnight market before turning to standing facilities. A more liquid market is an additional intermediate policy objective for CBs as it constitutes an important feature of an environment conducive to smooth monetary policy implementation and financial market stability. Standing facilities are not employed to steer market liquidity at large, but to reduce the volatility of the overnight rate in cases of temporary liquidity shocks exceeding the absorptive capacity of minimum reserve requirements.[27]

5.2.2 The money market and monetary policy in a world without CB money

Institutional structure of the payment system changes once the limit of zero demand for CB money is reached

Friedman (1999) and Woodford (1998) extrapolate trends of decreasing ratios of CB money to aggregate spending to the mathematical limit. The amount of CB money necessary to operate wholesale and retail payment systems finally reaches zero. They implicitly assume that the behaviour of the monetary system while approaching the limit, and once it has reached the limit, exhibits structural continuity, in principle. Even though CB money is expected to become irrelevant in the limit, the monetary system does not exhibit any signs of instability or structural changes.[28]

The following section explicitly discusses institutional change in the payment system once the limit is reached

Contrary to their approach, I discuss the institutional arrangements of the interbank payment system once the limit is reached and the implications for monetary policy in a world without CB money. The questions that have to be addressed are: (1.) what is the medium of final settlement in the interbank payment system? (2.) What are the instruments available to CBs to manipulate price and/or quantity on the money market? (3.) What are the politico-economic consequences of alternative instruments of monetary policy implementation?

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[27] Standing facilities are the main instrument of monetary policy implementation under the "channel"-approach. The spread between r^{DF} and r^{LF} is substantially smaller.

[28] See also Selgin/White 2002.

The Choice of the Medium of Final Settlement

GAME ensures final settlement in economic terms

In a world with CB money the GAME (CB money) also functions as the medium of final settlement in the interbank payment system. Schmitz (2002b, 2004) argues that for efficiency reasons a single GAME and a unified unit of account prevail in a world without CB money. All means of payment are claims to the medium of final settlement. In order to reduce the spread between bid and ask interest rates in the interbank market by eliminating credit, liquidity and market risk, the GAME will also serve as the medium of final settlement in the interbank market. It is the only medium that is not a direct or indirect claim on future resources and that ensures settlement finality in the interbank payment system.[29]

A number of papers that present models of worlds without money argue that debt instruments or real wealth would serve as media of final settlement.[30]

(1.) If there were no GAME and settlement took place in claims on real wealth, settlement would imply credit, liquidity, and market risk of the debt instrument. Upon maturity of the debt instruments the underlying real resources would have to be exchanged (bartered) for the goods actually demanded at additional transaction costs. The eligible instruments would only exchange at par, if they were perfect substitutes and equally liquid. Otherwise, the most liquid settlement instrument would exchange at the lowest bid-ask spread and drive out other debt instruments in the settlement process. The price level would be defined in terms of the underlying real resource. Its stability would depend on the institutional arrangements constraining the issue of the debt instruments and the production function of the underlying real resource.

(2.) The existence of a GAME would increase efficiency, as debt instruments would be dominated by instruments denominated in a GAME but indexed to the prices of the underlying real resources.[31] If there were a GAME and interbank payments were finally settled in debt denominated in the GAME, the transaction costs are higher compared to settlement in the GAME due to credit, liquidity, and market risk. Each settlement in debt instruments would require negotiations concerning the instruments accepted in settlement and the relevant relative price. The eligible instruments would be perfect substitutes at the relevant market price, if the bid-ask spread were zero and all eligible assets would be equally liquid. However, final settlement in the GAME also involves transactions costs and opportunity costs of holding reserves in the GAME. Market participants economise on reserves in various payment systems by extended netting, queuing mechanisms in money markets, and intraday credit. Nevertheless, all settlement media remain claims to the GAME and settlement finality in an economic sense is only provided by the GAME.

(3.) If debt instruments (and interest thereon) are settled in further debt instruments in the future, the process will be subject to circularity and no effective constraint of the issue of debt is in place for an individual issuer at the margin, unless debts are eventually settled in real resources. If debt instruments are eventually redeemed in outside money, the system will resemble a form of extended netting.

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[29] Notwithstanding, that in extended netting systems private CSI allow for the extension of settlement and the exchange of debt instruments (often highly liquid government bonds) as collateral in net payment systems to economise on CB reserves, final settlement takes place in the GAME eventually.

[30] Inter alia Centi/Bougi 2003, Costa/De Grauwe 2001, and King 1999. For a discussion see Chapter XX.

[31] White 1984.

In a world without CB money, the GAME will be outside money that will be available at non-zero marginal costs only. The aggregate supply of the outside money is determined by its marginal costs to the market participants.[32] Even in the case of individual transaction balances vanishing in the face of innovation in the retail payment system (e.g. credit, debit, and cash cards as well as ubiquitous electronic access to deposits) the demand for the medium of final settlement would be determined by the demand for settlement balances in the interbank payment system.

In a world without CB money, the GAME will be outside money that will be available at non-zero marginal costs only

The Instruments Available to CBs in a World Without CB Money

The market on which CBs would implement monetary policy in a world without CB money is the market for the respective medium of final settlement (interbank or money market). CBs lose their monopoly in the provision of the GAME at zero costs at the margin. They face the same demand and supply schedules as other market participants. How does that affect the efficacy of the instruments of monetary policy implementation? The following instruments will be considered: (1.) the communication strategy of CBs – the announcement of a specific level for the operating target rate, (2.) open market operations, (3.) minimum reserve requirements, (4.) intraday credit and (5.) standing facilities.

Relevant market for monetary policy: the market for the means of final settlement

The *announcement of a specific level of the relative price of the medium of final settlement* by CBs would be insufficient to steer market rates effectively in a world, in which CBs have lost their monopoly in the provision of the medium of final settlement at zero marginal cost. CBs are no longer in a position to impose a structural liquidity deficit on the money market by shifting the supply curve of the medium of final settlement at zero marginal costs. In principle, CBs can withdraw quantities of the medium of final settlement from the market by OMOs (i.e. open market purchases) as can all other market participants, as Goodhart (2000) argues correctly. Like them CBs would have to bear the resulting costs. The volume of open market purchases necessary to effectively steer market rates and the resulting losses are ultimately empirical questions, as is the sustainability of political support for covering the resulting costs by public funds. CB interventions in foreign exchange markets can serve as analogy. Currency crises teach that, both, the funds available to CBs and the political will of societies to cover costs related to large scale foreign exchange interventions are not unlimited. Evidence is available in abundance showing that CBs failed to defend fixed exchange rates in foreign exchange markets, despite their previous explicit commitment and strong incentives in terms of often substantial welfare losses in the aftermath of currency devaluation. The monopoly provision of the GAME is a precondition for effectively steering money market rates by imposing a structural liquidity deficit on the money market and by announcing specific levels for the operating target.

CB policy announcements ineffective

CBs can impose *minimum reserve requirements in terms of the medium of final settlement* as a ratio of market participants' liabilities as instrument of monetary policy implementation. In principle, CBs could impose minimum reserve requirements in terms of CB reserves on market participants by statutory regu-

MRRs would be effective …

[32] White (1999) demonstrates why the private issue of fiat-type money is infeasible. Examples of an eligible GAME are various types of commodity monies.

lation.[33] Hence, they could force a positive demand for CB money upon maket participants. As the focus of this paper is on the analysis of monetary policy in a world without CB money, I will not consider this option further. In addition, minimum reserve requirements in terms of CB money are not necessarily sufficient to ensure the role of CB money as GAME. In order to ensure the efficacy of monetary policy implementation, minimum reserve requirements must be imposed in the GAME. Minimum reserve requirements in any asset enable policy makers to manipulate the marginal costs of financial intermediation, just like policy induced changes of any other input prices.[34] Unlike changes of the opportunity costs of the GAME, changes in input prices do not change the relative price of the medium of final settlement vis-à-vis all other assets and goods in the economy, but affect only the relative price intermediation services to all other assets and goods in the economy. The nominal price of financial intermediation will adjust faster than the nominal prices of all other goods in the economy. That is not to say that an increase in the nominal price of bank credit does not eventually affect aggregate demand and the nominal price level at all, but the transmission mechanism is essentially different from the monetary policy transmission mechanism based on manipulation of the marginal price of the GAME. In order to preserve the independence of CBs and their flexibility in monetary policy, legislatures would have to transfer the authority to set capital adequacy ratios to CBs entirely. Such a transfer of power would entail politico-economic problems as the CB lacks legitimacy as legislator. If some regulatory powers would remain with the legislature and the financial market authority, they would enable them to counteract the regulatory decisions of the CB in principle and, thus, undermine the efficacy of monetary policy implementation. The legal framework to set minimum reserve requirements in the GAME already is in place, as demonstrated in section 5.2.2, p. 102.

… but if set in CB money, it would not be a world without CB money

The proposed prominent role of minimum reserve requirements in the GAME in monetary policy stems from the prominent role of the banking system and bank liabilities in the payment system and from the role of the bank credit channel in the transmission of monetary policy. Monetary policy is implemented via the money market precisely because it is a peculiar input market, not because it is just one of the input markets of financial intermediation. In a tiered payment system all payments are eventually settled in the GAME, so that changes in the marginal opportunity costs of the GAME affect the marginal costs of all payments in the economy. The implementation of monetary policy in the market for the GAME captures other transmission mechanisms as well, such as transmission along the yield curve and the interest rate investment channel.

Proposals based on the manipulation of other input costs are ineffective to implement monetary policy

Averaging arrangements over the fulfilment period would have the further advantage of absorbing short term liquidity shocks and smoothing demand for the medium of final settlement. In order to be effective at the margin, minimum reserve requirements would have to be binding, i.e. exceed settlement balances. The ability to impose minimum reserve requirements is a consequence of the character of CBs as public institutions endowed with regulatory competencies and is independent of the monopoly to issue the GAME at zero marginal costs.

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[33] See for example Henckel/Ize/Kovanen 1999, Costa/De Grauwe 2001, Palley 2002, Arnone/Bandiera 2004. Similar proposals were also put forward in the discussion of the paper by Angelo Baglioni and Dimitrios Tsomocos.

[34] Examples of policy induced changes to input price sin financial intermediation include changes of capital adequacy requirements, personal income tax brackets applicable to employees of financial intermediaries and credit contract fees (as in place in Austria).

Intraday credit and …

The instrument of providing *intraday credit* below money market rates in RTGS is only available to CBs at positive marginal costs. These consist of the opportunity costs associated with holding reserves in the medium of final settlement and the costs of lending below market rates. Lending below market rates would provide an opportunity for arbitrage for market participants, who borrow funds from CBs and lend them at higher rates in the money market. The monopoly provision of the GAME is a precondition for the costless provision of intraday credit in RTGS.

… standing facilities costly for CB

Standing facilities provided at penalty rates deviating from the market rate, on the other hand, constitute a potential source of income for CBs. However, as long as market rates are within the floor and the ceiling defined by the penalty rates, market participants have no incentive to deposit with or lend from CBs. If market rate fluctuations exceed the bound, standing facilities can only be offered at costs to CBs and provide arbitrage opportunities for market participants. The monopoly provision of the GAME is a precondition for standing facilities to effectively define of a floor and a ceiling for money market rates.

Monetary policy in a world without CB money is feasible by a combination of minimum reserve requirements in the medium of final settlement and interest paid or charged on these

Monetary policy in a world without CB money is feasible by a combination of minimum reserve requirements in the medium of final settlement and interest paid or charged on these. These competencies are a consequence of the CBs' role as public institutions with certain regulatory authorities transferred to them by the respective legislature.[35] They are independent of the loss of CBs' monopoly to issue the GAME at zero marginal costs. They can entail the transfer of authority to impose obligations on third parties such as the authority to impose minimum reserve requirements in the medium of final settlement as well as to specify an *interest rate paid or charged* on these for the purpose of monetary policy implementation.

CBs can influence opportunity costs of holding reserves in the GAME

The opportunity costs of holding reserves of the medium of final settlement are determined by the marginal costs of obtaining it on the market minus the (positive or negative) remuneration of minimum reserve requirements. Irrespective of the loss of the monopoly provision of the medium of final settlement CBs can manipulate the opportunity costs of holding reserves. Rather than assuming the interest on reserves to be fixed and the main policy target to be endogenous, CBs treat the marginal costs of the medium of final settlement as exogenous and steer liquidity conditions by manipulating the interest rate paid or charged on minimum reserves held by market participants directly. Comparable to the implicit taxation of financial intermediation by imposing minimum reserve requirements in a world with CB money, remuneration paid or fees charged on minimum reserve requirements in a world without CB money correspond to a subsidy or to a tax, respectively, on the liabilities of market participants.

The interest paid or charged on minimum reserves shifts the stock of reserves held on average over the maintenance period and, hence, the aggregate demand for the medium of final settlement upwards or downwards, respectively. The supply schedule of the aggregate stock of the medium of final settlement is unaffected by the decreasing (or increases) opportunity costs of holding reserves as it is determined by marginal costs of providing the medium of final settlement. The equilibrium price in the market for the medium of final settlement increases or decreases, respectively. Under the precondition that the supply of the medium of final settlement is not infinitely inelastic the equilibrium

[35] Buiter (2004) recognises that the central bank trades on the unique monopoly of the state to legitimately use force (or coercion), to tax and to regulate. He conjectures that the demand for CB money will never vanish completely as the state will always be more creditworthy than private agents.

price increases (or decreases) less than the interest rate on minimum reserves and thus decreases (or increases) the opportunity costs of the stock of minimum reserves held. This eases (or tightens) liquidity conditions for market participants.

Demand and the supply of excess reserves are an unplanned residual of the payments processed

In addition to the aggregate stock of the medium of final settlement banks also supply excess reserves. But the demand and the supply of excess reserves are unplanned residuals of the payments processed. After realisation of end-of-day balances banks lend excess reserves, which are not remunerated, or borrow to cover deficiencies in the overnight market. As interest is neither paid nor charged on excess reserves they are independent of the opportunity costs of holding the stock of minimum reserves. Woodford (2000) argues that increases in the efficiency of the payment system should allow banks to operate with very low excess reserves. If minimum reserve requirements are sufficiently large relative to settlement balances, excess reserves and the share end-of-day deficiencies of minimum reserves is small. If the time it takes to adjust the aggregate stock of the medium of final settlement is below the maintenance period, market participants have no incentive to borrow from each other at costs above the marginal costs of the medium of final settlement. In analogy to the determination of the opportunity costs of holding reserves in a world with CB money, the opportunity costs of the stock of aggregate minimum reserves held are determined by the marginal costs of the aggregate stock supplied and not by the rate on the flow of the medium of final settlement due to demand and supply of excess reserves.

CBs would lose some of the instruments to absorb liquidity shocks

In principle, CBs can manipulate the opportunity costs of holding reserves but with less accuracy, as the discontinuation of standing facilities and intraday credit deprives CBs of additional instruments to absorb liquidity shocks and to stabilise money market rates. CBs lose control of the supply of the medium of final settlement, such that supply shocks add to the uncertainty CBs face in monetary policy implementation in a world without CB money.

Politico-Economic Consequences of Alternative Instruments of Monetary Policy Implementation

What are the politico-economic implications of the proposal?

The transfer of authority to pay or charge interest on minimum reserves, i.e. to levy a tax or to grant subsidies on the liabilities of credit institutions, to CBs raises *politico-economic* questions concerning the legitimacy of the transfer of such powers from the respective legislature to an independent institution.

CBs are already endowed with regulatory powers ...

CBs are public institutions endowed with regulatory powers (e.g. in areas such as monetary policy implementation and payment system oversight). As public institutions the rule of law requires their competencies to be based on explicit legal foundations like central banking acts and statutes, such as the Protocol on the Statute of the European System of Central Banks and the European Central Bank (1992) and the Federal Reserve Act (1913). These constitute the legal foundations for actions of the ECB and the Fed including decisions which impose obligations on third parties. In general, legislatures grant CBs the discretion necessary to execute the respective acts independently and effectively, while retaining legislative authority.

... to define and implement monetary policy and to promote the smooth operation of the payment system

Article 110 (1) of the Treaty establishing the European Union and Article 34.1. of the ECB Statutes confer regulatory power to the ECB to the extent necessary, inter alia, to define and implement monetary policy and to promote the smooth operation of the payment system. Article 110 (3) of the Treaty and Article 34.3. of the ECB Statutes grant the ECB the right to impose sanctions in cases of non-compliance with its regulations and decisions within the limits and under the conditions adopted by the EC Council. The acts and omissions of the ECB are subject to judicial control by the Court of Justice according to

Article 35 of the ECB Statutes. The EC Council is required to adopt the necessary complementary legislation after consultation with the Commission, the European Parliament, and the ECB (Article 42 of the ECB Statutes and Article 107(6) of the Treaty establishing the European Union).

In particular Article 19.1. of the ECB Statutes authorises the ECB to require credit institutions established in the member states to hold minimum reserves on accounts with the ECB, levy penalty interest and to impose other sanctions in cases of non-compliance. The regulations concerning the calculation and determination of the required minimum reserves may be established by the Governing Council. The application of minimum reserve requirements is restricted to the pursuance of the ECB's monetary policy objectives. However, Article 19.2. ensures that the EC Council (in accordance with the procedure laid down in the Article 106 (6) of the Treaty establishing the European Union) maintains the legislative authority over the definition of the basis for minimum reserves, the maximum permissible minimum reserve ratios, as well as the appropriate sanctions in cases of non-compliance, which are defined in Council Regulation (EC) No 2531/98 and No 2532/98 of 23 November 1998. ECB Regulation (EC) No 2157/1999 further specifies the details of infringements procedures.

ECB has large discretion concerning MRRs

In accordance with Article 110 (1) of the Treaty, Article 5 of Council Regulation (EC) No 2531/98 and Article 6 of Council Regulation (EC) No 2532/98 explicitly grant regulatory power to the ECB for the purpose of non-discriminatory exemptions from minimum reserve requirements and for the purpose of more detailed specifications than provided in Article 3 of the respective Regulation of the basis for minimum reserve requirements, as well as for the specification of the reserve ratios as well as for more detailed specifications of sanctions. Article 4 (1) of Council Regulation (EC) 2531/98 specifies that the ratios may not exceed 10% of any relevant liabilities forming part of the basis for minimum reserve requirements but may be 0%. The ECB may impose sanctions in cases of non-compliance – in accordance with Article 110 (3) of the Treaty establishing the European Union and specified in Article 7 (a) and (b) of Council Regulation (EC) 2531/98 – of up to 5 percentage points above the ECB's marginal lending rate or twice the ECB's marginal lending rate of the reserve shortage or may require the relevant institution to hold a non-interest-bearing deposit with the ECB up to 3 times the amount of the shortage. Consideration (5) of Council Regulation (EC) 2531/98 explicitly states that the ECB must have the flexibility to react to new payment technologies such as the development of electronic money. Consideration (6) of Council Regulation (EC) 2531/98 restricts the ECB's flexibility in the implementation of the regulation to act in the pursuance of the objectives of the ESCB as laid down in Article 2 of its Statutes and in the principle of not inducing significant undesirable delocation or disintermediation in the financial system. Similarly, consideration (5) of Council Regulation (EC) 2532/98 emphasises that, in order to provide an effective regime for the administration of sanctions the ECB must have some discretion within the limits and conditions of the respective Regulation.

The Treaty imposes only limits on that discretion but allows for flexibility

Based on the regulatory discretion conferred upon it the ECB specifies the details of the application of minimum reserve requirements in Regulation (EC) No 1745/2003 of the European Central Bank. Article 2 defines the institutions subject to minimum reserve requirements as credit institutions and branches according to the relevant Directive (2000/12/EC); Article 3 specifies the reserve base as consisting of deposits and debt securities issued, unless they are owed to any other institution subject to reserve requirements or to the ECB or an NCB. The reserve ratios applicable are defined in Article 4 as 0% for all deposits and debt instruments with a maturity over two years, repos, and deposits redeemable at notice over two years, and 2% for all other liabilities in-

MRRs have to be denominated in euro and can be remunerated

cluded in the reserve base. Article 6 states that institutions shall hold their minimum reserve on accounts of the NCBs and that the reserves shall be denominated in euro. Article 8 defines the remuneration of reserves.

Congress transfers substantial regulatory power to the Fed

Similar institutional frameworks are in place in the U.S. Congress transfers substantial regulatory authority to the Federal Reserve System in a number of areas including the conduct and implementation of monetary policy but also supervisory and regulatory authority over a wide range of financial institutions. The Fed issues Federal Reserve Regulations from Regulation A (Extension of Credit by Federal Reserve Banks) to Regulation EE (Netting Eligibility for Financial Institutions). The U. S. Constitution gives the right to coin money and set its value to the U. S. Congress, which delegates the right to the Federal Reserve System in the Federal Reserve Act of 1913. Accordingly, the Fed is subject to oversight by Congress.

Section 19 paragraph (2) sub-paragraphs (A) and (B) of the Act impose minimum reserve requirements on depository institutions, i.e. on their transaction accounts and their nonpersonal time deposits. The Act authorises the Board of Governors to define the terms used in the section, to prescribe regulations it deems necessary to effectuate the purpose of Section 19, and to determine the exact reserve ratio by regulation within broad bounds defined in the Act. Paragraph (2)(A)(i) determines the ratio at 3 per centum for that proportion of each depository institution's transaction accounts of $ 25,000,000 or less.[36] In paragraph (2)(A)(ii) the Act grants the Board some discretion with respect to the ratio applicable to that proportion a depository institution's transaction accounts exceeding the dollar amount in sub-paragraph (i). The Board may prescribe a ratio not greater than 14 per centum and not less than 8 per centum. Sub-paragraph (B) authorises the Board to impose minimum reserve requirements on nonpersonal time deposits. The applicable ratio has to be between zero and 9 per centum. The regulatory authority in imposing minimum reserve requirements on transaction accounts and on nonpersonal time deposits is restricted to the purpose of implementing monetary policy.[37]

The Fed enjoys similar discretion concerning MRRs

Paragraph (4) enables the Board to impose a supplemental reserve requirement on depository institutions of not more than 4 per centum, if that increases reserves to a level essential for the conduct of monetary policy. Supplemental reserves have to be maintained in Earnings Participation Accounts and are remunerated. The Board is entitled to remunerate supplemental reserves at a rate not more than the rate earned on the securities portfolio of the Federal Reserve System during the previous quarter. Subsection (c)(1) contains the promulgation of rules and regulations regarding the maintenance of balances but does not stipulate that the reserves are to be denominated in US dollar. Subparagraph (l)(9) entitles the Board to prescribe regulations establishing procedures as may be necessary to impose civil money penalties on depository institutions violating any provision of Section 19.

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[36] The Board of Governors has to increase (or decrease) the dollar amount stipulated in paragraph 2 (A) (i) each year in line with the growth rate of the total transaction accounts of all depository institutions. The Federal Reserve Act defines the method of calculation of the increase in total transaction accounts and of the increase of the dollar amount applicable in paragraph 2 (A) (i).

[37] In addition to the implicit taxation of bank liabilities the Act also contained a section on the explicit taxation of bank liabilities until 1914. Section 27 of the Act prescribed a tax on that proportion of circulating bank notes of National banks, which was not secured by bonds of the United States. For the first three months the tax rate amounted to three per centum per annum upon the average amount of their notes in circulation, an additional one-half of 1 per centum per annum per month until a tax of 6 per centum per annum is reached.

The detailed provisions concerning reserve requirements are contained in the Code of Federal Regulations Chapter II (Federal Reserve System) Part 204 (Reserve Requirements of Depository Institutions – Federal Reserve Regulation D). Paragraph 204.1 (c) defines the depository institutions which are required to hold minimum reserves. Paragraph 204.7 (a) authorises the Fed to assess charges for deficiencies in required reserves at a rate of 1 percentage point per year above the primary credit rate. The precise ratios applicable to the different categories of liabilities of credit institutions are defined in paragraph 204.9. For net transaction accounts over $ 6.6 million and up to $ 45.4 million the ratio is 3 percent and for net transaction over $ 45.4 million the ratio is 10 per cent of the amount over $ 45.4 million plus $ 1,164,000. For all other categories it is zero. The Fed may impose emergency reserve requirements under extraordinary circumstances for up to 180 days, after which affirmative action of at least five members of the Board is required for each extension (paragraph 204.5), and supplemental reserve requirements to increase the amount of reserves maintained to a level essential for the conduct of monetary policy for up to one year, after which the Board shall review and determine the need for continuation (paragraph 204.6). In both cases reports to Congress shall be transmitted promptly stating the reasons for imposing additional reserve requirements. Currently, no reserve requirements are imposed under either paragraph. Reserve requirements are not remunerated, but the Fed pays interest on service-related balances.

The Fed does not remunerate MRRs but service-related balances

The analysis of the current institutional framework concerning the ECB demonstrates that the EC Council and the European Parliament have already conferred substantial regulatory power to the ECB, but these powers are both subject to judicial control by the Court of Justice and subject to the legislative authority of the EC Council and the European Parliament. In particular, the ECB's has the competence to impose minimum reserve requirements and to remunerate them. The framework provides the ECB with substantial operational flexibility and discretion. Politico-economic objections to granting CBs the power to impose minimum reserve requirements on market participants or to pay or charge interest thereon in a world without CB money (as described in section 5.2.2, p. 99) apply to the current framework as well.

CBs regulatory powers are subject to judicial control and to legislative authority

Indeed, the current legal framework hardly needs to be adapted to govern monetary policy implementation in a world without CB money. The obligation to hold minimum reserves denominated in the euro is at the discretion of the ECB. It is laid down only in the relevant ECB Regulation but not in the relevant Council Regulations or the ECB Statutes. The framework would have to be adapted marginally with respect to the right to charge interest rates on minimum reserves in addition to the right to remunerate them. The adaptation is not one in substance as the current framework already allows imposing financial obligations on institutions subject to minimum reserve requirements in the form of opportunity costs associated with holding reserve requirements.

The current legal framework hardly needs to be adapted to govern monetary policy implementation in a world without CB money

Similarly, the Federal Reserve Act transfers regulatory authority to the Board of Governors. Despite the fact that the Act provides more details with respect to the imposition of minimum reserve requirements than the Statutes of ECB, the Fed enjoys substantial discretion in imposing and administering minimum reserve requirements. The Federal Reserve Act does not require minimum reserve requirements to be denominated in US$, nor does Regulation D.

5.3 Conclusions

Models of worlds without money fail to elaborate institutional structure of the payment system

Many papers attempting to discuss monetary policy without CB money turn out to assume that the CB maintains a monopoly in the provision of the GAME and the medium of final settlement on closer inspection of the implicit institutional structure of the monetary system presented. Unfortunately, they do not make the institutional structure explicit, i.e. the money market, the existence of a GAME and a medium of final settlement are rarely discussed in detail. The models are, thus, incomplete and inconsistent. The efficacy of monetary policy is discussed solely from the perspective of the monopoly provision of the GAME and the medium of final settlement by the CB, at zero marginal costs. It does not take into account the regulatory authority of CBs.

CBs can implement monetary policy by imposing reserve requirements in terms of the medium of final settlement and by paying or charging interest thereon

In contrast, this paper provides a conceptualisation of monetary policy in a world without CB money based on a GAME that also serves as medium of final settlement. CBs can implement monetary policy by imposing reserve requirements in terms of the medium of final settlement and by paying or charging interest thereon. These instruments are independent of the monopoly of CBs in providing the GAME at zero costs at the margin. The smaller set of instruments and particularly the loss of control over the aggregate supply of the medium of final settlement impair the power of CBs to contain the volatility of the target rate. Politico-economic objections to this institutional framework also apply to the current practice of transferring regulatory powers and substantial discretion to CBs. Indeed, the current legal frameworks of the ECB and the Fed hardly need to be adapted. They already confer the necessary regulatory authority to CBs to conduct monetary policy based on the proposed instruments of implementation in a world without money.

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6 Electronic Money in Austria: Legal Foundations, Brief History, and Monetary Policy Implications

Stefan W. Schmitz

6.1 Legal Foundations

Austrian e-Geldgesetz forms the legal foundation for eMoney in Austria …

The Austrian E-Geldgesetz (eMoney Act) became effective as of 2 April 2002. The definition (§ 2 (2)) contains all elements of Art. 3 (b) (i) to (iii) of the eMoney Directive 2000/46/EC but restricts eMoney to "small" monetary values. It clarifies that the issue of eMoney does not constitute deposit taking if the monetary value is exchanged for electronic money instantaneously, thus implementing the exclusion of deposit taking according to Article 2 (3) eMoney Directive. It further stipulates that the issue of eMoney does not constitute the issue of payment media such as credit cards and traveller cheques under the Austrian Banking Act.

… and imposes limits on activity …

The limitations of activities are implemented in the eMoney Act in two steps. The permissible activities (Article 5 (a) and (b) eMoney Directive) are enclosed in the definition of eMoney institutions in § 1 (2) eMoney Act, while § 2 (1) states that eMoney institutions are not allowed to engage in any other activities than those mentioned in § 1 (2). In addition, § 2 (2) contains the restrictions on holdings in other undertakings inline with the Directive.

… a redeemability requirement …

The provisions for redeemability are identical to those in the Directive. They do not constitute deposit taking, but are meant to increase consumer acceptance. Schmitz (2002) argues that the respective provision was adopted under the pressure of the ECB. The latter wanted to ensure the unit-of-account function of the euro. In low inflation environments such a clause is not necessary, due to strategic advantages for issuers and consumers of eMoney, which are associated with denomination of eMoney in the dominant unit of account in the respective market and redeemability. Violations of the redeemability clause constitute a violation of administrative law and the person(s) responsible has to be fined up to € 20.000.- (§ 9 (2) eMoney Act).

… initial capital and ongoing own funds requirements …

The initial capital requirement was implemented by an amendment to Bankwesengesetz (Banking Act). It amounts to € 1 mio inline with the Directive. The ongoing own funds requirement (§ 4 eMoney Act) is identical to the provisions of Article 4 (2) and (3) eMoney Directive. Own funds are defined inline with the Directive 2000/12/EC and its implementation in § 23 Banking Act. In addition, § 8 eMoney Act states that the Minister of Finance has to collect interest (bank rate + 2%) on any amount the own funds fall short of the requirements laid out in § 4, except in cases of over-indebtedness of the eMoney institution or under conditions of § 70 (2) Banking Act. The latter refers to temporary supervisory measures by the Financial Market Authority (FMA) with respect to credit institutions under financial distress.

… limitations of investments

The limitations of investments are almost identical to Article 5 (1) to (6) eMoney Directive, apart from the exclusion of the requirement that the investments under Article 5 (1) (a) have to be sufficiently liquid. It seems that the implemen-

tation assumes sufficient liquidity for all assets qualifying under § 3 (1) Z 1 eMoney Act. The Act usually refers to the respective articles of the Banking Act when the eMoney Directive refers to Directive 2000/12/EC to define qualifying investments. No further, more detailed definitions are provided. Article 5 (6) first sentence eMoney Directive is implemented quite strictly as § 70 (4) Banking Act, which contains the provisions for cases of discontinuation of licensing conditions of financial institutions in general. As these refer to credit institutions as well, the potential sanctions range from demands to remedy the situation within an appropriate time frame on pain of a fine to the revocation of the licence. In addition, § 8 (1) 2 eMoney Act states that the Minister of Finance has to collect interest rates (bank rate + 5%) on the amount the investments fall short of the provisions of § 3 eMoney Act.

eMoney institutions are supervised by the FMA and OeNB

The requirements concerning initial capital and ongoing own funds as well as the limitations on investment have to be verified by the competent authorities (Article 6 eMoney Directive). eMoney institutions have to transmit quarterly reports to the Ministry of Finance and Oesterreichische Nationalbank according to § 5 (1) eMoney Act, in order to proof compliance with §§ 3 and 4 eMoney Act. Oesterreichische Nationalbank is required to provide expert opinions for the Ministry of Finance on the compliance with §§ 3 and 4 eMoney Act based on the quarterly reports. Offences of the reporting requirements are to be prosecuted as administrative offences and the person(s) responsible are fined with up to € 20.000.-

Inline with the objective of the eMoney Directive providers licensed in EU member states do not need an Austrian license to operate in Austria. The waiver was not implemented in the Austrian eMoney Act.

eMoney institutions are subject to supervision by the Austrian Financial Market Authority (FMA) according to § 69 Banking Act. Austrian credit institutions have to cover most of the costs of banking supervision according to § 19 Finanzmarktaufsichtsbehörden-Gesetz (Financial Market Authority Act) and to § 69a Banking Act. Consequently, eMoney institutions have to contribute as well. Their contributions are based on calculations which only marginally deviate from those applicable to other credit institutions. In addition, payment system oversight is the responsibility of Oesterreichische Nationalbank according to §§ 44a and 82a Nationalbankgesetz (Nationalbank Act).

The requirements for sound and prudent operation are not specifically implemented in the eMoney Act. The current loading maximum of € 400 and the legal maximum of € 2.000 limit the attractiveness of the available systems for money laundering activities. But §§ 39, 40 and 41 Banking Act concerning prudential operations and management, money laundering, and terror financing apply. Consequently, the money laundering requirements are very strict as they also apply to all other credit institutions. eMoney institutions have to scrutinise all transactions particularly strictly, which raise suspicion of money laundering (§ 39). In addition, § 40 stipulates specific prudential requirements to counter money laundering and terror financing.

Currently, there are no pure electronic money institutes licensed under the eMoney Act

Currently, there are no pure electronic money institutes licensed under the eMoney Act. Both providers of electronic money products operate under banking licenses according to the Banking Act, which are not restricted to but can, in principle, – and do in fact in these two cases – encompass the issuance of electronic money (e-money business) (§ 1 (1) Z 20). Europay Austria[1] who operates *Quick card* holds a banking license itself. The company is also responsible for the fulfilment of the reporting requirements for the entire sys-

[1] Full name: Europay Austria Zahlungsverkehrssysteme GmbH.

tem, irrespective of the banks that distributes the cards and provide the opportunity for their clients to load the cards from their accounts. It is jointly owned by all Austrian banks. The second issuer, paysafe.com[2] – the operator of *paysafe card* (a network based system) – is partly owned by an Austrian bank (BAWAG/P.S.K.) and operates under the bank's license. A total of 754 credit institutions hold licenses under the Banking Act which also cover the right to issue eMoney under § 1 (1) Z 20 Banking Act.[3]

Furthermore, a number of mobile network operators offer mobile-payment services (m-payments). Transactions settled via mobile phone billing transactions do not constitute eMoney. However, once they are initiated via prepaid phone cards, their inclusion under the eMoney definition of the eMoney Act is currently under discussion. One of the operators argues that the technical nature of the contract is the crucial criterion given the other elements of the definition laid down in the eMoney Act. If the respective good is provided by an undertaking other than the mobile phone service provider[4], paid for via a prepaid card and based on a contract established by dialling a number ("real" premium rate services – PRS based on SMS as well as phone calls), the payment service shall not be considered eMoney. If the respective good is provided by an undertaking other than the mobile phone service provider, paid for via a prepaid card and based on a contract going beyond just dialling a number (i.e. ordering a parking ticket, such services are referred to as "payment services"), the payment service shall be considered eMoney.[5] Mobile operators want to avoid the provisions concerning ongoing own funds and limitations of investments to gain a competitive advantage vis-à-vis other eMoney issuers. Procedural problems would also arise if the eMoney Act would be applicable to m-payments based on prepaid cards, as the share of the outstanding amount on prepaid cards that is devoted to PRS, is hard to determine ex-ante. The provisions of the eMoney Act would only apply to the latter. The approximation of ex-ante values by ex-post averages over the past six months, however, constitutes a straight forward solution to the problem. In addition, the same problem arises if the good is delivered via other channels than the mobile network, such that it is not unique to PRS. PRS providers estimate market volume to reach € 200 mio by 2005.[6] It is currently unclear which share of the pie is settled via prepaid cards.[7] In a similar direction, the UK Financial Services Authority (FSA) argued in a guideline (February 2003) that the mobile phone service and the good delivered via the same network (PRS) can be interpreted as single service.

In addition to banks mobile network operators offer m-payments and ...

... the regulation of prepaid cards as eMoney under the Austrian e-Geldgesetz is controversial

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2 Full name: paysafe.com Wertkarten AG.

3 Source: Financial Market Authority (FMA).

4 In Austria PRS are usually provided by other companies than the mobile phone service provider (e.g. Xidris, atms).

5 The distinction between „real" PRS and „payment services" is based on a draft regulation of the Austrian telecommunication regulator (X. Verordnung der Rundfunk- und Telekom-Regulierungs-GmbH, mit der eine Kommunikationsparameter-, Entgelt- und Mehrwertdienstverordnung – KEM-V festgelegt wird).

6 Source: Kurier (an Austrian daily) 7 February 2004, 17.

7 The inclination to buy content via mobile phone seems to be independent of the choice of the prepaid/contract decision. According to Orange™ 25% of prepaid customers and 30% of contract customers bought content from third parties via their mobile service provider in the previous month in 2002 and 10% of the value of prepaid cards are estimated to be spent that way. In July 2003 46% of mobile phone customers used prepaid cards in Austria. If prepaid and contract customers have similar propensities to buy content and their shares of total customers are similar, their share of the content market should be as well. Thus, the volume of transactions settled via prepaid cards would reach some € 100 mio in 2005. Only slightly below the volume of transactions settled via Quick cards in 2003 € 116,8 mio).

These interpretations are not satisfactory as they are not technology neutral and offer a wide scope for bypassing the eMoney Directive. Accordingly, the FSA interpretation would force mobile operators also to accept responsibility for the content of premium rate services distributed via their networks under provisions regarding content regulation. As a necessary consequence, this would imply substantial regulatory responsibilities which are alien to the telecommunication industry and seem hardly acceptable for mobile operators. In general, neither service providers nor network providers bear responsibility for the content delivered via their services and network. The telecom service provider collects the funds on behalf of the PRS provider, not on its own account in its own right. In Austria telecom providers do not sue customers who do not pay their PRS charges. This unpleasant task is usually left to the PRS providers. Consequently, taxation is assigned to two different companies for two different sources of return. Nevertheless, the current policy stance in Austria adopts the arguments of mobile phone operators.

Functionally their prepaid cards are eMoney even if goods purchased are delivered via mobile phone

Most of the operators hold banking licenses under the Banking Act which also encompass the issuance of eMoney, anyways, such that the issues really at stake are the ongoing own funds provisions, the limitations on investments, the redeemability as well as reporting requirements. They argue that equal treatment with other eMoney providers would hamper innovation in the area of m-payments. The crucial question remains to what extent the implicit exemption from the eMoney Act, the potential gateway to by-pass relevant regulation, and the arbitrary provision of a competitive advantage are justifiable by additional innovation in m-payments. As long as the relevant payment services are in their infancy, they would profit from the waiver (which could still be implemented), thus, leaving niche products and innovative new services unaffected at early stages of diffusion.

Most operators holds banking licences

To avoid legal disputes concerning the regulation of payment services based on different technologies, the regulatory framework for payment services should be based on a single functional definition of payment services irrespective of the underlying technology. Rather than resting the distinction between the applicability of alternative regulatory regimes on the nature of the underlying contract, it should focus on the payment service provided and the associated risks.

Functional definition of payment services preferable for regulatory framework independent of technology

The increase in the tiering structure of the payment systems, i.e. the increased reliance on commercial bank money and transactions on the books of electronic money institutions (incl. mobile service providers) raises questions with respect to the regulation and supervision of the respective institutions. The increase in the tiering structure of the payment system does not undermine the unique role of central bank money as means of settlement providing economic finality (as opposed to legal finality). Regulators want to ensure that the quality of settlement media is sufficient to warrant the efficiency and stability of the payment system. The instruments applicable, such as capital requirements, reserve requirements, and portfolio restrictions feature prominently in the eMoney-Directive. Regulators will also want to address the issue of access to central bank (i.e. accounts with the central bank) and its price for non-credit institutions, which provide payment services.

Increases in the tiering structure of the payment systems raise regulatory concerns

As the eMoney Directive has a limited scope in practice, a reform of the legal framework for payment services is called for. A unified legal framework for payment services is essential to eliminate legal ambiguities and to ensure a level playing field. Rather than basing the distinction between different payment service providers on the features of the underlying technology (i.e. eMoney Directive) or on the technical nature of the contract (i.e. PRS), differences in the restrictiveness of the regulatory framework should reflect the differences

A New Legal Framework is discussed

in the associated risks (e.g. solvency, liquidity, operational, contagion risks). In addition, increased tiering will lead to the concentration of payment transactions by top tier institutions. Central banks will want to oversee these particularly rigorously to prevent potential systemic crises.

6.2 History

Quick card launched in 1994

The Quick card system is launched and operated by Europay Austria, which is owned by Austrian Banks and holds a banking licence itself.[8] After a test launch in a small provincial city in 1994 about 2.5 mio "ec-cards" (called Maestro cards today, with the capacity of combining a range of banking services like ATM withdrawals) with an embedded chip were issued in 1995. In the following year the electronic money scheme Quick was launched nationwide. In 2001 the internet application based on card readers connected to PCs was introduced.

Diffusion of cards high ...

Since the nationwide launch the number of loading terminals increased from 1.066 to 5.879 (as of 31 December 2003) and the number of payment terminals expanded from 2.708 to 79.806.[9] In the same interval the number of loading transactions grew from about 50.000 to 1.32 mio, while the volume loaded surged from € 2.16 mio to € 120 mio. Correspondingly, the number of payment transactions increased from 86.591 to 17.7 mio and the volume of payments reached € 116.6 mio in 2003. The current maximum loading value is € 400. It is worth noting that the introduction of euro banknotes and coins in 2002 was accompanied by a significant increase in the number of loading transactions (from 0.63 mio to 1.47 mio) and in the volume loaded (from € 34.34 mio to € 145.25 mio). One of the explanations at hand is that the value of the lowest denomination Euro banknote (€ 5) is about 3.5 times as large as the lowest denomination Austrian Schilling banknote (ATS 20). Therefore, the volume of change in the pockets of Austrian consumers jumped dramatically, thus, highlighting the advantages of electronic money as a convenient substitute for coins in particular.

... but use lags behind

Currently, the system is not designed to accept other currencies than Euro or to allow for consumer-to-consumer transfers and it is not compatible with other schemes. The introduction of the Common Electronic Purse Specification (CEPS) is scheduled for 2007.

The eMoney chip embedded in the Maestro cards is provided at no extra costs. The costs of the card are subject to the fee structure of the customer's giro account, but independent of the Quick function. The fees for loading the chip are based on the fee structure of the customer's giro account. The transaction fee for retailers is about 0.5% of the transaction volume. In addition a fixed collection charge of € 0.44 is charged upon presentment of the balance on the retailer terminal.

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[8] The paysafe system is only in its infancy. It is a network-based product that is distributed via scratch cards. Neither the paysafe card nor the various eBanking and bill presentment schemes operating in Austria are dealt with any further in this brief historical sketch. There are no nation-wide software-based systems in operation at the beginning of 2004.

[9] Source: Europay Austria – www.quick.at.

Diffusion in line with G-10 countries

The diffusion of eMoney in Austria is more or less around the average of the G-10 countries based on the number of circulating Quick-cards, number of transactions, and volume of transactions.[10] According to a recent survey conducted for Oesterreichische Nationalbank (first quarter 2004, face-to-face interviews with a representative sample of 2.000 individuals of 15+ years of age), 19% of the respondents report to hold a Quick card. As 73% hold bank cards with cash withdrawal function, in which Quick cards are routinely embedded, the data suggests that many holders are not even aware of the Quick function on their cards. About 9% of respondents (48% of Quick cardholders) actually make use of it (ca. 4,5% of respondents and 23% of Quick card holders at least weekly). The average amount loaded is about € 76 per cardholder and is higher than the average amount of cash carried (€ 64). Only three percent of Austrians 15+ years of age, who do not currently hold a Quick card, plan to acquire one in the near future. Penetration is, therefore, not expected to increase much in the near future.

6.3 Monetary Policy Implications

Limited effect on monetary policy due to current penetration rate and institutional structure because ...

The effects of the diffusion of the Quick card on monetary policy are rather limited due to its current penetration and its institutional structure. The payment system is operated by Europay Austria which is responsible for clearing and settlement. The means of settlement is commercial bank money. Upon loading the card via an ATM, the respective amount is transferred from the customer's account to a pooling account at the same commercial bank. The account holder is Europay Austria which also collects the interest on the float rather than the commercial bank. As it is owned by these banks it redistributes the respective profit as dividends. The deposits of Europay Austria with commercial banks are not included in M3, but the volume of eMoney outstanding is. Consequently, the loading transaction does not increase the volume of broad money in the economy directly. It merely redistributes the respective amount from one customer's account (the Quick card holder) to another customer's account (Europay Austria).

... volume of eMoney outstanding included in M3 and subject to MRRs

Liquid deposits (maturity below two years) are subject to minimum reserve requirements of 2%. But deposits of credit institutes, which are themselves subject to minimum reserve requirements, are exempt from the respective requirements. As Europay Austria is subject to minimum reserve requirements, its deposits with commercial banks within the system are not subject to minimum reserve requirements. Consequently, the use of commercial bank money as means of settlement reduces the overall minimum reserve requirements of commercial banks by the amount of 2% of the current float. But Europay Austria has to hold the same amount as minimum reserves on eMoney outstanding. As a consequence, loading transactions neither increase the total demand of central bank reserves in the system directly nor indirectly, but merely lead to the redistribution of reserves from commercial banks to Europay Austria.[11]

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[10] BIZ Red Book 2004, Table 8 and www.quick.at.

[11] The potential effects on monetary policy of the changing demand for banknotes and coins are negligible, as these are not used to implement monetary policy. Their supply passively reacts to changes in the public's demand and to the need to replace damaged banknotes and coins.

Once the value on the card is spent, the merchant can demand clearing and settlement of the balance on the merchant terminal online with Europay Austria[12] at what frequency he deems appropriate taking into account the applicable fee (mostly daily or weekly). The value is than included in the clearing and settlement procedures between the commercial banks involved. Upon clearing Europay Austria calculates the total value of transactions among customers and merchants holding accounts at the same commercial bank and transfers the amount from the pooling account held at the respective commercial banks to the banks' own accounts which then credits the merchant's account. The remaining net positions are cleared by transfers from the pooling accounts held with the net debtors to the accounts of the net creditors via the interbank payment system. The commercial banks finally credit the merchants' accounts with the respective total amounts. As a result commercial bank money is issued as substitute for central bank money to settle transactions between customers and merchants.

Final settlement in CB money

A number of authors advanced claims that the diffusion of electronic money will lead to the private provision of money, which is not denominated in central bank money.[13] Furthermore, the ensuing parallel use of multiple units of account would enhance the efficiency of the payments system and the stability of the price level. Schmitz (2002) shows that the parallel use of multiple units of account is not desirable and in the case of fiat-type currencies not feasible. The argument does not provide a rationale for legal barriers against potential currency competition. The paper shows that users and issuers face strong strategic disincentives to opt for an alternative unit of account in eMoney schemes under current inflation rates. The most likely institutional structure of emerging eMoney schemes includes redeemability and denomination in the dominant unit of account. In addition, the EU Directive contains a redeemability requirement (Article 3). The role of national currencies as units of account will not be diminished, ceteris paribus, by the diffusion of eMoney.

Redeemability requirement not necessary to ensure efficacy of monetary policy

As central banks hold on to the monopoly of the supply of the medium of exchange, they retain control of its supply and its purchasing power, in principle. The balance sheet of central banks will shorten relative to a world without eMoney which is mainly a positive sign as institutional change in the payments system (e.g. net settlement systems, electronic wholesale and retail payments systems) increases its efficiency – which implies that monetary policy becomes more rather than less effective.[14] The effects of increased demand for m-payments (settled via phone bills or prepaid cards) are similar as transactions on the books of commercial banks or even on the books of the telecom company serve as settlement media at lower tiers of the payment system. From a monetary policy perspective the similar treatment of functionally similar payment services is called for. Moreover, central banks have proven to cope well with similar changes in the past (e.g. diffusion of credit and debit cards). The crucial question is how the emergence and diffusion of eMoney will affect the predictability of the relationship between the instruments and the objectives of monetary policy. Further research will have to focus on the effects of eMoney on the demand for money function and on the transmission mechanism of monetary policy.

CBs remain sole provider of GAME

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[12] Transaction processing and clearing takes place on the computer systems of APSS a subsidiary of Europay Austria. APSS also processes all other card-based transactions in Austria (credit- and debit cards, ATM withdrawels etc.) and provides the necessary infatsructure (ATMs, POS-terminals etc.). In 2003 it operates 7.500 ATM- and 79.000 POS-terminals, administers ca. 7 mio. credit-, debit- and Quick-cards and processes ca. 330 mio. transactions.

[13] For an overview of the arguments see Schmitz 2002.

[14] Selgin/White 2002.

eMoney increases the tiering structure of the payment system and …

Electronic money is supposed to constitute a close substitute for central bank money, in particular banknotes and coins. Electronic money increases the tiering structure of the payment system as commercial bank money serves as a means of settlement in electronic money transactions at lower tiers of the payment system (in addition to central bank money among top tier banks). As a consequence the volume of central bank money necessary to support a given level of transactions in an economy decreases and the velocity of central bank money increases. The opportunity to switch to close substitutes for central bank money in line with the increased use of commercial bank money as means of settlement and the corresponding savings in opportunity costs also raise the interest rate elasticity of the demand for central bank money (in particular by credit institutions). What does that imply for the implementation of monetary policy?

… demand for CB decreases and its velocity increases

An increased interest rate elasticity of the demand for CB money implies that a smaller change of the policy rate is sufficient to affect the demand for CB money to the extent deemed appropriate to ensure price stability

Today, the key policy variable is the money market rate of interest.[15] Central banks steer the market rate by conducting open market operations at pre-announced repo rates. An increased interest rate elasticity of the demand for central bank money implies that a given interest rate rise reduces the demand for central bank money by a larger amount. Ceteris paribus, a smaller change of the policy rate is sufficient to affect the demand for central bank money to the extent deemed appropriate to ensure price stability. The volatility of the policy rate decreases which is positive. On the other hand, the size of interest rate changes has to be determined with greater caution as potential absolute deviations from the optimal level of money market rates have larger effects. However, the pace of institutional change in the payment systems enables central banks to adapt their monetary policy operations inline with the diffusion of electronic money.

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[15] See Bindseil 2004 and Borio 2001.

Data Appendix: Statistics on payment systems in the Euro area, the United Kingdom and the United States

Florian Saurwein

The data sources for all tables are various issues of the Red Book (BIS) and the Blue Book (ECB).

Retail

Table A-1: Banknotes and coins in circulation outside credit institutions (end of year)

Total (€/$ millions)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (€)								324717	349877	348458	240341	341700
UK (€)								36286	45406	48423	53344	52224
UK ($)								42339	45612	45059	47009	54767
US ($)								463500	521700	535600	585400	630600
Germany ($)								144327	131703	117150	5928	nap
Value per inhabitant (€/$)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (€)								1110	1193	1184	784	1110
UK (€)								622	776	826	904	882
UK ($)	509	446	455	504	531	606	627	726	780	768	796	925
US ($)	1070	1167	1272	1385	1430	1499	1600	1679	1868	1896	2050	2185
Germany ($)	1411	1534	1511	1790	2025	1936	1679	1759	1604	1425	728	nap
As a percentage of GDP (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								5,5	5,7	5,4	3,5	4,8
UK	2,7	2,9	2,8	2,8	2,8	2,8	2,8	3	3,1	3,2	3,3	3,3
US	4,6	4,8	5	5,2	5,1	5,1	5,2	5,3	5,6	5,5	5,8	6
Germany	6,0	6,5	6,7	6,8	6,9	7,0	6,8	6,4	6,6	6,2	3,3	nap
As a percentage of narrow money (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								18,5	16,9	16	10,3	14,1
UK	5,6	4,8	4,5	4,6	4,6	4,5	4,6	5	5	5,1	5	4,8
US	29,5	28,5	28,5	30,7	32,6	36	39,1	41,4	45,5	48,2	48,7	50,8
Germany	28,4	29,9	29,2	29,6	29,1	26,9	26,3	24,1	23,5	21,9	11,3	nap

Table A-2: Transferable deposits held by non-banks (end of year)

Value per inhabitant	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (€)								4901	5841	6233	6831	7222
UK (€)								11944	14657	15577	17238	17459
UK ($)	8515	9357	9589	10493	11073	12797	12895	13937	14723	14495	15191	18309
US ($)	2529	2910	3182	3101	2918	2632	2465	2348	2212	2012	2135	2086
Germany ($)	3655	3591	3761	4287	4953	5309	4697	5543	5220	5080	5712	7419
As a percentage of GDP (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								24,2	27,9	28,4	30,6	31,5
UK	45,8	60	58,6	59,5	58,4	58,1	57,4	57,2	59	60	62,3	64,4
US	10,8	11,9	12,5	11,7	10,4	8,9	7,9	7,4	6,7	5,8	6	5,8
Germany	15,6	15,3	16,7	16,3	16,8	19,1	19,1	20,2	21,6	22,1	25,8	27,7
As a percentage of narrow money (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								81,5	83	84	89,7	91,7
UK	94,4	95,5	95,5	95,4	95,4	95,5	95,4	95,4	95,3	95,3	95,3	95,5
US	69,7	71,1	71,2	68,9	66,6	63,2	60,2	57,9	53,8	51,1	50,7	48,5
Germany	73,7	70,1	72,7	70,8	71,2	73,8	73,7	75,9	76,5	78,1	88,7	nap

Table A-3: Use of cards

Average number of cash withdrawls per card with a cash function	**1999**	**2000**	**2001**	**2002**
Euro area			19,8	20,2
UK			16,4	16
US			16,5	12,3
Germany			13,1	13,6
Average number of payments per card with a debit function	**1999**	**2000**	**2001**	**2002**
Euro area			33,7	37,6
UK			50,8	51,5
US			49,1	59,8
Germany			11,8	14,8
Average number of payments per card with a credit function	**1999**	**2000**	**2001**	**2002**
Euro area			21,8	21,8
UK			31,1	29,8
US			13,8	14,2
Germany			19,2	19,2
Average number of payments per card with an e-money function	**1999**	**2000**	**2001**	**2002**
Euro area			3	7,1
UK			nav	nav
US			nav	nav
Germany			0,4	0,5

Table A-4: Use of cashless payment instruments (total numbers of transactions, millions)

Cheques	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		6719	6344	6179	5865	5820
UK		2986	2859	2699	2565	2393
US		45169	43812	42500	41222	39985
Germany		596	424	392	319	150
Payments by credit/debit cards	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		6014	7107	8385	9674	11232
UK		2960	3406	3788	4257	4681
US		19153	22106	25734	29542	33441
Germany		993	1199	1622	1818	1994
Credit transfers	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		11170	11489	11841	12246	12518
UK		1726	1797	1845	1931	2008
US		2899	3167	3486	3890	3976
Germany		6217	7025	6446	6958	6739
Credit debits	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		8150	8881	9800	10092	10199
UK		1736	1863	2010	2152	2289
US		1530	1676	1947	2385	2760
Germany		4601	4806	5027	5080	4809

Card-based e-money	1997	1998	1999	2000	2001	2002
Euro area		71	98	114	135	285
UK		nav	nav	nav	nav	nav
US		nav	nav	nav	nav	nav
Germany		13,6	20,7	26,6	29,4	35,9
Total	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		32119	33918	36318	38013	40055
UK		9408	9925	10342	10905	11371
US		68752	70763	73668	77041	80164
Germany		12420	13475	13514	14204	13728

*Table A-5: Use of cashless payment instruments (*number of transactions per inhabitant)

Cheques	1997	1998	1999	2000	2001	2002
Euro area		23	22	21	19	20
UK		51	48	46	43	40
US		163	156	150	144	138
Germany		7,3	5,2	4,8	3,9	1,8
Payments by credit/debit cards	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		21	24	28	32	37
UK		50	58	65	72	79
US		69	79	91	104	116
Germany		12,1	14,6	19,7	22,1	24,2
Direct debits	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		28	30	33	33	33
UK		30	32	34	36	39
US		5	6	7	8	10
Germany		56	59	61	62	58
Credit transfers	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		38	39	40	40	41
UK		30	31	31	33	34
US		10	11	12	14	14
Germany		76	86	78	85	82
Card-based e-money	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		0,39	0,57	0,66	0,58	1,21
UK		nav	nav	nav	nav	nav
US		nav	nav	nav	nav	nav
Germany		0,2	0,3	0,3	0,4	0,4
Total	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		110	116	123	124	130
UK		161	170	176	185	192
US		249	253	261	270	278
Germany		151	164	164	173	166

Table A-6: Relative importance of cashless payment instruments (percentage of total volume of cashless transactions)

Cheques (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								21,1	17,8	16	14,6	13,8
UK	48,5	45,4	43	40,2	41,3	37,8	34,7	31,7	28,8	26,1	23,5	21
US	81,6	81,1	80,1	78,9	76,3	74,5	72,9	65,7	61,9	57,7	53,5	49,9
Germany	9,6	8,8	8,1	7,9	7,0	6,4	5,7	4,8	3,1	2,9	2,2	1,1
Payments by credit/debit cards (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								18,4	20,7	22,7	26,6	29,6
UK	16,4	18,8	21,9	23,3	24,1	27,1	29,6	31,5	34,3	36,6	39	41,2
US	16	16,2	16,9	18	20	21,4	22,9	27,9	31,2	34,9	38,3	41,7
Germany	1,8	2,1	2,6	3,1	3,6	4,2	4,1	8,0	8,9	12,0	12,8	14,5
Direct transfers (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								34,8	33,4	32,3	30,8	30,1
UK	20,9	20,6	20,4	20,1	18,2	18	18	18,3	18,1	17,8	17,7	17,7
US	1,6	1,8	1,9	2,1	2,4	2,6	2,7	4,2	4,5	4,7	5	5
Germany	51,3	49,8	45,6	48,7	48,8	49,2	48,2	50,1	52,1	47,7	49,0	49,1
Credit debits (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								26,5	27,9	29	27,7	26,7
UK	14,2	15,1	15,6	16,5	16,4	17	17,8	18,5	18,8	19,4	19,7	20,1
US	0,8	0,9	1	1,1	1,3	1,4	1,5	2,2	2,4	2,6	3,1	3,4
Germany	37,3	39,3	43,7	40,3	40,6	40,2	42,0	37,0	35,7	37,2	35,8	35,0
Card-based e-money (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								0,3	0,4	0,5	0,5	0,7
UK								nav	nav	nav	nav	nav
US								nav	nav	nav	nav	nav
Germany								0,1	0,2	0,2	0,2	0,3

Table A-7: Relative importance of cashless payment instruments (percentage of total value of cashless transactions)

Cheques (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								11,3	9,3	8,6	7,7	7,2
UK	16,1	11,6	9,4	7,6	6,3	5,9	5	4,4	2,8	2,5	2,2	2,2
US	13,7	13,1	12,6	12,2	11,9	11,2	10,5	5,5	5,6	5,4	4,9	4,9
Germany	2,8	2,4	2,3	2,3	2,1	1,8	1,6	7,1	3,6	3,1	2,7	2,3
Payments by credit/debit cards (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								0,4	0,5	0,5	0,5	0,6
UK	0,2	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,2	0,2	0,2	0,2
US	0,1	0,1	0,1	0,1	0,2	0,2	0,2	0,2	0,2	0,3	0,3	0,3
Germany	0,02	0,02	0,02	0,02	0,03	neg	neg	0,3	0,3	0,4	0,4	0,4
Direct transfers (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								82,1	83,8	84,4	85,6	86,1
UK	82,5	87,1	89,5	91,2	92,4	92,7	93,8	94,4	96,3	96,6	97	96,9
US	85,4	85,8	86,4	86,8	87	87,6	88,4	93,3	93	93,2	93,8	93,7
Germany	95,4	95,5	95,7	95,7	95,8	95,7	95,5	78,1	83,2	85,4	84,2	84,9
Credit debits (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								13	13,4	13,6	12,7	13,3
UK	1,2	1,1	1	1	1	1,1	1	1	0,7	0,7	0,6	0,7
US	0,8	1	0,9	0,9	1	1	1	1,1	1,2	1,1	1,1	1,1
Germany	1,8	2,1	2,0	2,0	2,1	2,5	2,5	14,4	12,8	11,1	12,7	12,4
Card-based e-money (%)	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								0,0009	0,0009	0,0008	0,0009	0,0033
UK								neg	nav	nav	nav	nav
US								nav	nav	nav	nav	nav
Germany								neg	neg	neg	neg	neg

Institutional Framework

Table A-8: General institutional framework for payment services

Number of institutions offering payment services (per 1,000,000 inhabitants)	**1995**	**1999**	**2000**	**2001**	**2002**
Euro area				24	23
UK	9,7	8,5		8,1	7,6
US	91,1	77,9		71	68,3
Germany				30,6	29,3
Number of central bank branches (per 1,000,000 inhabitants)	**1995**	**1999**	**2000**	**2001**	**2002**
Euro area				2	2
UK				neg	Neg
US				0,1	0,1
Germany				1,6	1,4
Number of bank branches (per 1,000,000 inhabitants)	**1995**	**1999**	**2000**	**2001**	**2002**
Euro area				561	554
UK				248,7	244,9
US				272,4	274,7
Germany				640,5	611,4
Number of post office branches (per 1,000,000 inhabitants)	**1995**	**1999**	**2000**	**2001**	**2002**
Euro area				182	190
UK				296,5	295,6
US				nap	nap
Germany				642	612,8
Total number of branches offering payment services (per 1,000,000 inhabitants)	**1995**	**1999**	**2000**	**2001**	**2002**
Euro area				666	657
UK	632,9	573,9		545,2	540,5
US	274,2	288,2		272,5	274,8
Germany					
Number of accounts on which payments can be made (per inhabitant)	**1995**	**1999**	**2000**	**2001**	**2002**
Euro area				1,12	1,13
UK	2,3	2,6		2,7	2,7
US	n.a.	n.a.		nav	nav
Germany				1,1	1,0

Table A-9: Cards with a cash function and ATMs

Number of ATMs per 1,000,000 inhabitants	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								577	618	654	683	717
UK	314	324	328	342	358	376	393	421	468	563	621	690
US	331	342	367	418	466	524	616	677	813	967	1135	1220
Germany	171	235	308	361	436	459	504	556	563	580	603	612
Number of transactions per inhabitant	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								16	17	19	19	20
UK	18,8	20,2	21,3	22,9	25,2	27,2	29,6	31,7	33,7	34,6	36,8	38,3
US	25,3	28,2	29,8	31,8	36,9	40,3	41	40,6	39,0	45,3	47,6	36,7
Germany				11,5	13,4	15,3	n.a.	17,1	18,4	20,4	19,4	19,7
Average value per transaction	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (€)								114	114	114	119	127
UK (€)								78	83	91	94	95
UK ($)	78,2	84,6	72,5	74,6	77,3	78,1	84,5	87,8	88,8	84,3	84,1	90
US ($)	76	66,9	68,2	67,2	67,7	68	67,7	68	68	69,6	68	68
Germany				157,6	196,6	179,0	n.a.	169,5	155,9	134,2	140,2	148
Increase in the number of ATMs (%)					**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								9,7	6,8	5,9	7,5	5,3
UK								6	11,4	20,5	11,1	11,3
US								13,3	21,4	20,3	18,7	8,6
Germany								10,2	1,3	3,1	4,1	1,7
Increase in the number of transactions (%)					**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								11,3	6,8	8,1	3,4	7,9
UK								6	6,4	3	7,3	4,3
US								1,8	-2,7	17,4	6,3	-22,1
Germany								nav	7,7	11,0	-4,7	1,3
Increase in the value of transactions (%)					**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area								10	8,7	8	6,6	14,8
UK								8,9	10,2	4,6	12,4	7,1
US								2,3	-2,7	21,1	3	-22,1
Germany								nav	-1,0	-4,4	-0,5	6,9

Table A-10: Cards with e-money function and accepting terminals

Electronic money cards (in thousands)	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (weighted average)			24491	25244	25715	22204	22061
UK			140	160	nav	nav	nav
US			nav	nav	nav	nav	nav
Germany			60700	60700	60700	67333	67525
Average value per reloading	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (€, weighted average)			39	32	27	29	37
UK ($)			neg	neg	neg	neg	nav
US ($)			nav	nav	nav	nav	nav
Germany ($)			60,3	42,7	29,1	25,3	25,8
Number of purchase terminals	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (weighted average)			53115	61439	77898	70223	90379
UK			1642	1921	nav	nav	nav
US			nav	nav	nav	nav	nav
Germany			60000	59732	66946	80191	98492
Average value per transaction	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (€, weighted average)			4,9	3,3	2,8	2,9	2,9
UK ($)			neg	neg	neg	neg	nav
US ($)			nav	nav	nav	nav	nav
Germany ($)			7,3	3,8	2,5	2,1	2,0

Table A-11: Number of Cards (per 1,000 inhabitants)

Cards with a cash function	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area							1036	1067
UK	1433				1881		2246,7	2399,9
US	nav				2658		2886,4	2995,5
Germany					1200		1480,2	1443,0
Cards with a debit function	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area							905	908
UK							919,9	1003,6
US							887,8	902,3
Germany							1252,3	1129,0
Cards with a credit function	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area							381	411
UK							936	1066
UK							950,8	1065,8
US							4321,6	4355,2
Germany							381,4	390,7
Cards with a debit function issued by retailers	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area							nav	nav
UK							nap	nap
US							39,9	39,5
Germany							nav	nav

Cards with an e-money function	1995	1996	1997	1998	1999	2000	2001	2002
Euro area							406	393
UK							nav	nav
US							nav	nav
Germany							817,8	818,7
Cards with a cheque guarantee function	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area							nap	nap
UK	822				911		989,4	1031,9
US	n.a.				n.a.		nav	nav
Germany	470				552		689,4	nap

Wholesale

Table A-12: Settlement media used by banks

Banks' reserves at central bank ($/€ billions)	1995	1998	1999	2000	2001	2002
Euro area (€)		13,7	18,8	20,4	21,4	22,1
UK (€)		2,3	3,3	2,5	2,8	2,8
UK ($)	2,8	2,6	3,3	2,3	2,5	3
US ($)	29,6	15,6	12,4	13,5	17,8	20,9
Germany ($)	33,4	27,7	33,5	33,0	34,3	40,5
Banks' reserves at central bank as a percentage of narrow money (%)	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		4,4	5,4	5,6	5,8	5,7
UK	0,4	0,3	0,4	0,3	0,3	0,3
US	2,6	1,4	1,1	1,2	1,5	1,7
Germany	6,0	4,6	6,0	6,2	6,5	nap
Transferable deposits at other banks ($/€ bilions)	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area (€)		114,4	85,6	92,7	90,5	92
UK (€)		329,3	368	409,1	488,1	555,1
UK ($)	347,4	384,1	369,8	380,7	430,1	582,2
US ($)	32,7	32,8	27,5	32,1	34,8	35,7
Germany ($)	115,0	281,9	114,9	105,5	108,5	133,8
Transferable deposits at other banks as a percentage of narrow money (%)	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**
Euro area		31	21,8	24,1	22,3	21,6
UK	51,3	45,1	40,9	42,7	45,7	51,3
US	2,8	2,9	2,4	2,9	2,9	2,9
Germany	20,6	47,1	20,5	19,7	20,5	nap

Table A-13: Features of selected interbank funds transfer systems (2002)

	Type	Owner	Number of participants		Processing	Settlement	Member-ship	Degree of centralisation	Pricing	Gross/ Net	Settlement finality
			total	of which direct							
ELLIPS (BE)*	L	B+CB	93	17	RTT	RTGS	RM	C	F	G	real-time
Clearing House (BE)	*R*	*B+CB*	*92*	*34*	*RTT*	*N*	*O*	*D*	*V*		
CEC (BE)	*R*	*B+CB*	*95*	*30*	*RTT*	*N*	*O*	*C*	*F*		
Kronos (DK)*	L	CB	96	32	RTT	RTGS	RM	C	F	G	real-time
Retail Clearing (DK)	R	B	166	63	ACH	N	O	C/D	S		
ELS (GE)*	nap	nap	nap	nap	nap	nap	nap	nap	nap	G	real-time
RPS (GE)	*R*	*CB*	*2188*	*2188*	*ACH*	*GS*	*O*	*D*	*F*		
*RTGSplus (GE)**	*L*	*CB*	*1382*	*75*	*RTT*	*RTGS*	*RM*	*C*	*F*	*G*	*7:00-18:00*
ELS (GE)	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*		
EAF (GE)	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*	*nap*		
HERMES (GR)*	L	CB	41	41	RTT	RTGS	RM	C	F	G	real-time
DIAS (GR)	R	B+CB/AS	35	35	ACH	N	O	C	V		
ACO (GR)	R	B+CB/AS	59	59	M	N	O	D	V		
SLBE (ES)*	L	CB	239	198	RTT	RTGS	RM	C	F	G	real-time
SPI (ES)	L	B	174	37	RTT	N	O	C	F	N	16:00/16:15
SNCE (ES)	R	CB	239	27	RTT	BN	RM	C	V		
TBF (FR)*	L	CB	705	195	RTT	RTGS	O	C	F	G	real-time
CH Paris (FR)	*R*	*B/PA*	*nap*	*nap*	*M*	*N*	*RM*	*C*	*F*		
CH Province (FR)	*R*	*CB*	*nap*	*nap*	*M*	*N*	*O*	*D*	*nap*		
SIT (FR)	*R*	*CB+B/PA*	*660*	*17*	*ACH*	*N*	*O*	*C*	*F*		
CREIC (FR)	*R*	*B/CB*	*nap*	*nap*	*ACH*	*N*	*O*	*D*	*V*		
*PNS (FR)**	*L*	*CB+B/PA*	*537*	*24*	*RTT*	*BN/RTGS*	*RM*	*C*	*F*	*G/N*	*real-time*
IRIS (IE)*	L	CB+B	22	22	RTT	RTGS	RM	C	F	G	real-time
Retail Clearings (IE)	R	CB+B	12	7	M	N	RM	D	F		
*BI-REL (IT)**	*L*	*CB*	*844*	*663*	*RTT*	*RTGS*	*RM*	*C*	*F*	*G*	

	Type	Owner	Number of participants total	Number of participants of which direct	Processing	Settlement	Member-ship	Degree of centralisation	Pricing	Gross/ Net	Settlement finality
Local Clearing (IT)	*R*	*CB*	*116*	*116*	*RTT*	*N*	*O*	*C*	*V*		
Retail (IT)	*R*	*CB*	*nav*	*205*	*ACH*	*N*	*O*	*C*	*F*		
LIPS-Gross (LU)*	L	B/CB	31	31	RTT	RTGS	RM	C	F	G	real-time
LIPS-Net (LU)	C	B/CB	13	13	ACH	N	RM	C	F		
Interpay (NL)	*R*	*B*	*73*	*73*	*ACH*	*N*	*RM*	*C*	*F*		
*TOP (NL)**	*L*	*CB*	*158*	*108*	*RTT*	*RTGS*	*RM*	*C*	*F*	*G*	*7:00-18:00*
ARTIS (AT)*	L	CB	70	70	RTT	RTGS	RM	C	F	G	real-time
SPGT (PT)*	L	CB	37	37	RTT	RTGS	RM	C	F	G	real-time
SICOI (PT)	R	B	60	39	RTT	N	RM	C	V		
SLOD (PT)	R	CB	143	143	M	GS	O	C	F		
BoF-RTGS (FI)*	L	CB	17	17	RTT	RTGS	RM	C	F	G	real-time
PMJ (FI)	R	B	8	8		BN	RM	D	F		
POPS (FI)	L+R	B	8	8	RTT	N/GS	RM	D	F		
K-Rix (SE)	*L*	*CB*	*19*	*19*	*RTT*	*RTGS*	*RM*	*C*	*F*	*G*	*07:00-17:00*
E-RIX (SE)	*L*	*CB*	*13*	*13*	*RTT*	*RTGS*	*RM*	*C*	*F*	*G*	*7:00-18:00*
Bankgirot (SE)	*R*	*B*	*19*	*19*	*ACH*	*N*	*O*	*C*	*F*		
Dataclearing (SE)	*R*	*B*	*19*	*19*	*ACH*	*N*	*O*	*C*	*F*		
Postgirot (SE)	*R*	*B*	*1200000*	*1200000*	*ACH*	*GS*	*O*	*C*	*F*		
CHAPS Sterling (UK)	L	B+CB	289	13	RTT	RTGS	RM	C	F	G	-
BACS (UK)	R	B	62000	14	ACH	N	RM	C	F		-
Cheque/credit Clearings (UK)	R	B	418	12	M	N	RM	D	F		
*CHAPS Euro (UK)**	*L*	*B+CB*	*nya*	*20*	*RTT*	*RTGS*	*RM*	*C*	*F*	*G*	
EURO 1 (EU)	L	B	74	74	RTT	SOS	RM	C	F	G	after cut off
TARGET (EU)	*L*	*CB*	*3345*	*1519*	*RTT*	*RTGS*	*RM*	*C*	*F*	*G*	*real-time*
Fedwire (US)	L	CB	7899	7899	RTT	RTGS	O	C	F	G	00:30-18:30
CHIPS (US)	L	B	51	51	RTT	N/BN/GS	RM	C	F	G/N	intra-day

Features of selected interbank funds transfer systems (2002, cont.)

	No. of transactions (thousands)		Value of transactions (€/$ billions)		Ratio of transactions value to GDP	
	2001	2002	2001	2002	2001	2002
ELLIPS (BE)*	1840	1730	14313 €	13339 €	56,3	51,2
Clearing House (BE)	*3528*	*1740*	*78 $*	*97 $*	*0,4*	*0,3*
CEC (BE)	*919044*	*985394*	*448 $*	*502 $*	*2*	*2*
Kronos (DK)*	106	109	1431 €	1931 €	8	10,5
Retail Clearing (DK)	851813	908498	546 €	556 €	3,1	3
ELS (GE)*	19031	nap	49292	nap	23,8	nap
RPS (GE)	*2197487*	*2156752*	*1971 $*	*1991 $*	*1,1*	*1*
*RTGSplus (GE)**	*4829*	*31893*	*17392 $*	*117621 $*	*9,4*	*59,2*
ELS (GE)	*19031*	*nap*	*44109 $*	*nap*	*23,8*	*nap*
EAF (GE)	*11041*	*nap*	*31343 $*	*nap*	*16,9*	*nap*
HERMES (GR)*	1058	1210	2410 €	2683 €	18,4	19
DIAS (GR)	29178	14546	67 €	70 €	0,5	0,5
ACO (GR)	5197	4477	196 €	187 €	1,5	1,3
SLBE (ES)*	2671	3086	53228 €	63444 €	81,7	91,4
SPI (ES)	1365	1776	360 €	303 €	0,6	0,4
SNCE (ES)	982283	1059621	1727 €	1423 €	2	2,1
TBF (FR)*	3801	3825	87573 €	90877 €	59,3	59,8
CH Paris (FR)	*677765*	*93303*	*683 $*	*173 $*	*0,5*	*0,1*
CH Province (FR)	*2469057*	*53640*	*883 $*	*22 $*	*0,7*	*neg*
SIT (FR)	*7131087*	*11043476*	*2187 $*	*4187 $*	*1,7*	*2,9*
CREIC (FR)	*270165*	*4316*	*21 $*	*neg*	*neg*	*neg*
*PNS (FR)**	*8004*	*7571*	*19977 $*	*18820 $*	*15,3*	*13,3*
IRIS (IE)*	543	582	4535 €	4886 €	39,6	38,1
Retail Clearings (IE)	176056	149089	311 €	245 €	2,7	1,9
*BI-REL (IT)**	*10247*	*9612*	*24291 $*	*23706 $*	*22,2*	*20*

	No. of transactions (thousands)		Value of transactions (€/$ billions)		Ratio of transactions value to GDP	
	2001	2002	2001	2002	2001	2002
Local Clearing (IT)	*105360*	*102698*	*641 $*	*685 $*	*0,6*	*0,6*
Retail (IT)	*1296828*	*1630549*	*1551 $*	*1763 $*	*1,4*	*1,5*
LIPS-Gross (LU)*	290	350	4436 €	4428 €	200,7	198,6
LIPS-Net (LU)	13100	13700	48 €	48 €	2,2	2,2
Interpay (NL)	*2558284*	*2812350*	*1410 $*	*1582 $*	*3,7*	*3,8*
*TOP (NL)**	*4023*	*4548*	*18530 $*	*19670 $*	*48,2*	*46,9*
ARTIS (AT)*	1869	2620	4981 €	4810 €	23,5	22,2
SPGT (PT)*	546	892	2209 €	2325 €	17,9	18
SICOI (PT)	1100700	1188362	361 €	308 €	2,9	2,4
SLOD (PT)	19	29	57 €	49 €	0,5	0,4
BoF-RTGS (FI)*	300	260	3582 €	3260 €	26,5	23,3
PMJ (FI)	371200	432000	146 €	168 €	1,1	1,2
POPS (FI)	700	661	415 €	392 €	3,1	2,8
K-Rix (SE)	*655*	*1100*	*10962 $*	*11731 $*	*52,3*	*48,7*
E-RIX (SE)	*70*	*100*	*1265 $*	*1305 $*	*6*	*5,4*
Bankgirot (SE)	*345200*	*363000*	*376 $*	*416 $*	*1,8*	*1,7*
Dataclearing (SE)	*66910*	*73000*	*107 $*	*124 $*	*0,5*	*0,5*
Postgirot (SE)	*540000*	*404000*	*367 $*	*345 $*	*1,8*	*1,4*
CHAPS Sterling (UK)	23962	25600	85083 €	82532 €	53,3	49,7
BACS (UK)	3527340	3735000	3483 €	3788 €	2,2	2,3
Cheque/credit Clearings (UK)	1940000	1817000	2315 €	2300 €	1,4	1,4
*CHAPS Euro (UK)**	*2600*	*3700*	*26848 $*	*28233 $*	*18,8*	*18*
EURO 1 (EU)	*28633*	34401	52034 €	47996 €	5,9	5,2
TARGET (EU)	*53664*	*64519*	*368469 $*	*372927 $*	*nap*	*nap*
Fedwire (US)	112500	115000	423867 $	405762 $	42	38,8
CHIPS (US)	60400	63300	311707 $	315709 $	30,9	30,2

Table A-14: Features of selected securities settlement systems (1995, 1999, 2002)

	1995						1999						2002				
	UK	UK	UK	US	US	GE	UK	UK	UK	US	US	GE	UK	UK	US	US	GE
Name of the system	CGO	CMO	CREST	DTC	Fedwire	DKV	CGO	CMO	CREST	Fedwire	DTC	CSB AG	CREST	CMO	NBES	DTC	CBF
Type of securities	G, O	O	G, E, O	E, O	G	G, E, O	G, O	O	G, E, O	G	E, O	G, E, O	G, B, S, O	G, C, O	G, O	S, O, B, C	G, E, B, O
Owner/manager	CB/SE	B, SE, O	B, SE, O	B, SE, O	CB	SE	CB/SE	B, SE, O	B, SE, O	CB	B, SE, O	B, SE, O	B, CB, SE, O	B, CB, O	CB	B, SE, O	SE
Number of participants	378	60	22949	527	9936	397	378	60	22949	9936	527	322	52881	58	1793	474	437
… of which direct	378	60	22949	527	9936	395	378	60	22949	9936	527	4322	nap	nap	1793	474	437
Settlement of cash leg	N	N	N	N	G	N/G	N	N	N	G	N	N/G	RTGS	nap	RTGS	N	RTGS, N
Securities settlement (delivery)	G	G	G	G	G	G	G	G	G	G	G	G	RTGS	RTGS	RTGS	G	RTGS, G
Delivery lag (T+n)	T, T+1	T	T+1, T+5	T+3	T	T+0-40	T, T+1	T	T+1, T+5	T	T+3	T+0-40	T+3	T	T, T+1	T, T+3	T+0-T+40
DVP mechanism													DVP1	DVP2	DVP1	DVP2	DVP1, DVP2/3
Intraday finality													Yes	Yes	Yes	No	Yes
Central securities depository	CB	CB	n.a.	DTC	CB	DKV	CB	CB	n.a.	CB	DTC	CSB AG	nap	CMO	CB	DTC	CBF
Cash settlement agent	CB	B, CB	B, CB	DTC	CB	CB	CB	B, CB	B, CB	CB	DTC	CB	B, CB, SE, O	CB	CB	CB	CB
No. of transactions (thousand)	2062	334	43237	18900	13400	23400	2062	334	43237	13400	18900	73158	75700	100	17400	224300	67282
Value of transactions ($ billions)	55634	3782	15328	94000	179500	8286	55634	3782	15328	179500	94000	15348	77,361	2566	228900	10400	nav
Ratio of transactions value to GDP	37,2	2,6	10,6	10,1	19,3	3,4	37,2	2,6	10,6	19,3	10,1	7,3	49,3	1,6	21,9	10	nav

Table A-15: Direct participants (2002)

	… in CPSS real-time gross settlement systems					…in other CPSS large value-payment systems				… in CPSS retail interbank funds transfer systems				
	UK	UK	US	EU	GE	UK	US	US	GE	EU	UK	UK	US	GE
Name of system	CHAPS Sterling	CHAPS Euro	Fedwire	TARGET	RTGS plus	nap	Fedwire	CHIPS	nap	EURO1	BACS	Cheque/ credit	nav	RPS
Direct participants	13	20	7899	1519	75		7889	51		74	14	12		2188
Credit institutions			7899	1424	74		7889	nav		74	13	11		2187
Central bank	12	19	1	15	1		1	nav		0	1	1		1
Non-banks	1	1	nav	80	0		nav	nav		nap	0	0		0
of which:	0	0												
… public authorities				5	0						0	0		0
… postal administration	0	0		2	0						0	0		0
… supervised financial institutions	0	0		65	0						0	0		0

Direct participants (2002)

	… in EU RTGS systems			… in EU large value-payment systems	… in EU retail IFTS		
	UK	UK	Germany	EU	UK	UK	Germany
Name of system	CHAPS Sterling	CHAPS Euro	RTGS plus	EURO 1	BACS	Cheque/credit	RPS
Direct participants	13	20	75	74	14	12	2188
Credit institutions			74	74	13	11	2187
Central bank	12	19	1	0	1	1	1
Non-banks	1	1	0	0	0	0	0
of which:	0	0					
… public authorities			0	0	0	0	0
… postal administration	0	0	0	0	0	0	0
… supervised financial institutions	0	0	0	0	0	0	0

Regulation

Table A-16: Access criteria

	… of CPSS real-time gross settlement systems			… of EU RTGS systems		… of other CPSS large-value payment systems				… of other EU large-value payment systems
	UK	US	GE	UK	GE	UK	US	EU	GE	EU
Name of the System	CHAPS	Fedwire	RTGS plus	CHAPS	RTGS plus	nap	CHIPS	EURO1	nap	EURO1
Access criteria	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes
Written rules	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes
Minimum level of data or ratios representative of financial strengh	No	No	No	No	No		Yes	Yes		Yes
Minimum number of transactions	No	No	No	No	No		No	No		No
Payment of an entry fee	Yes	No	No	Yes	No		Yes	Yes		Yes
Approval from the owner/manager or the direct participant	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes
Approval from local central bank	Yes	Yes	Yes	Yes	Yes		No	No		No
Technical requirements	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes
Removal rules	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes

Table A-17: Risk control measures

	… in other CPSS large-value payment systems				… in the EU large value NSSs
	UK	GE	US	EU	
Name of System	nap	nap	CHIPS	EURO1	EURO1
A. Settlement in central banks´accounts			Yes	Yes	Yes
B. Same day settlement			Yes	Yes	Yes
C. Compliance with Lamfalussy standards			Yes	Yes	Yes
I. Legal framework:					
… contractual (+) or advisory (-) netting			Yes	Yes	nap
… if contractual: legally enforceable or not			Yes	Yes	nap
II. Participants' awareness			Yes	Yes	Yes
III. Risk management					
… monitoring of intraday balance			Yes	Yes	Yes
… multilateral limits			No	Yes	Yes
… collateral requirements			No	Yes	Yes
… intraday closure			No	No	
IV. Timely settlement completion					
… risk-sharing agreements			No	Yes	Yes
… collateralisation of largest net debit position			No	Yes	Yes
IX. Fair open access			Yes	Yes	Yes
VII. Technical reliability			Yes	Yes	Yes
VIII. Practicability and efficiency					Yes
X. Governance arrangements					Yes
VI. Secure settlement assets					Yes

7 List of Acronyms and Abbreviations

ATM ..... Automated Teller Machine
BIC ..... Bank Identifier Code
BIS..... Bank for International Settlement
CB ..... Central Bank
CHAPS ..... Clearing House Automated Payment system
CLS..... Continuous Linked Settlement
CNS ..... Continuous Net Settlement
CPSS..... Committee on Payment and Settlement Systems
CSI..... Clearing and Settlement Institution
DNS..... Deferred Net Settlement
DVP..... Delivery Versus Payment
EBA..... European Banking Association
ECB ..... European Central Bank
EPC ..... European Payments Council
EU ..... European Union
Fed..... Federal Reserve Bank
FSAP ..... Financial Services Action Plan
G-10..... Group of Ten
GAME ..... Generally Accepted Medium of Exchange
IBAN ..... International Bank Account Number
ICT ..... Information and Communication Technology
LLR ..... Lender of Last Resort
LVPS ..... Large Value Payment System
MRR ..... Minimum Reserve Requirements
NACH..... National Automated Clearing House
NLF ..... New Legal Framework
OMO..... Open Market Operation
PEACH..... Pan-European Automated Clearing House
PEDD ..... Pan-European Direct Debit Instrument
PRC ..... Payments Risk Committee
PSR policy..... Federal Reserve Policy on Payments System Risk
PVP ..... Payment Versus Payment
RTGS..... Real Time Gross Settlement
SEPA ..... Single Euro Payment Area
STP ..... Straight Through Processing
SVPS ..... Small Value Payment System
TARGET ..... Trans-European Automated Real-Time Gross Settlement Express Transfer
UK ..... United Kingdom
US (USA) ..... United States of America