WP/04/122

IMF Working Paper

Monetary Policy, Monetary Areas, and Financial Development with Electronic Money

Marco Arnone and Luca Bandiera

INTERNATIONAL MONETARY FUND

 WP/04/122

IMF Working Paper

Monetary and Financial Systems Department

Monetary Policy, Monetary Areas, and Financial Development with Electronic Money

Prepared by Marco Arnone and Luca Bandiera[1]

Authorized for distribution by Piero Ugolini

July 2004

Abstract

Electronic money (e-money), as a network good, could become an important form of currency in the future. Such a development could affect monetary policy effectiveness. If an increased use of e-money substantially limits the demand for central bank reserves, this limitation would require changes in the central bank operational target and a closer coordination of monetary and fiscal policies. Also, the optimal size of monetary unions would be different. However, the current level of e-money use does not seem to pose a threat to the stability of the financial system. Thus, central banks can successfully implement the objectives of monetary policy.

JEL Classification Numbers: E40, E42, E50, F33

Keywords: electronic money, monetary policy, monetary unions.

Author's E-Mail Address: MArnone@imf.org, LBandiera@worldbank.org

---

[1] Luca Bandiera is a consultant at the World Bank. The paper was written while Mr. Bandiera was affiliated with the Kiel Institute for World Economics. The authors would like to thank Rodolfo Maino, Andrea Schaechter, Martin Sommer, Piero Ugolini, and participants at a Kiel Institute for World Economics seminar for their helpful comments.

Contents Page

INTRODUCTION

The recent evolution of the technology for financial transactions poses interesting questions for policymakers and financial institutions regarding the suitability of the current institutional arrangements and the availability of instruments to guarantee financial stability, efficiency, and effectiveness of monetary policy. The aim of this paper is to dispel some of the most extreme predictions.

The disappearance of money, central banks made redundant, monetary policy made irrelevant are not logical impossibilities, but extreme events. It is not impossible to envision a world with these most extreme characteristics (King, 1999) and to describe its functioning in the new setup, but how likely are these events to occur? The view that they will happen in the foreseeable future cannot be shared. From an operational point of view, we need to ask whether the actual institutional arrangements can respond properly to the recent wave of financial infrastructure innovations and if their policy instruments are still viable.

Regulatory concerns are raised by internet banking, electronic finance (e-finance), and e-money but are not addressed in these notes. Here the focus is primarily on the forces sustaining the development of e-money and on the central bank ability to conduct monetary policy in the presence of e-money.[2]

This paper argues that e-money, as a network good, could become an important form of currency in the future. Such a development would influence the effectiveness and implementation of monetary policy. If an increased use of e-money substantially limits demand for central bank reserves, it would require changes in the operational target of the central bank and a closer coordination of monetary and fiscal policies. The optimal size of monetary unions could differ should e-money play a prominent role.

However, the current level of e-money use does not pose a threat to the stability of the financial system, and central banks have the means to successfully implement the objectives of monetary policy.

With respect to the current debate on the consequences of the introduction of e-money on the implementation of monetary policy and in contrast with earlier work on this topic (Freedman, 2000; Friedman, 2000; Goodhart, 2000; and Woodford 2000), this paper argues that central banks can lose control over monetary policy if the government does not run a responsible fiscal policy. Central banks could react to this threat by introducing additional regulation or by resizing the monetary areas which they ought to regulate, as we shall argue in later sections.

This paper is structured as follows. Sections II and III describe e-money and its characteristics as a network good. Section IV analyzes payments and settlement issues.

---

[2] Details about regulations can be found in ECB (1998), and BIS (2000 and 2001a).

Financial development issues are discussed in Section V, while Section VI describes the transmission mechanism of monetary policy in the presence of e-money. Section VII redefines the optimal size of monetary areas, and Section VIII concludes.

II. Definition and Classification of E-Money

E-money is defined as an "electronic store of monetary value on a technical device that may be widely used for making payments to undertakings other than the issuer without necessarily involving bank accounts in the transaction, but acting as a prepaid bearer instrument" (ECB, 1998). There are three main types of e-money: e-cash, network money, and access products. E-cash includes reloadable electronic purses and multi-purpose stored value cards.[3] Network money defines funds stored in software products that can be used for payments or transfers over communication networks (i.e., the Internet). Access products allow agents to access their bank accounts and transfer funds (Prinz, 1999). These latter products are new ways of executing transactions with existing forms of money (OECD, 2002).

E-money schemes have some distinguishing features: (i) technical implementation requires computer and software expertise; (ii) these products are liabilities on the balance sheet of the issuer;[4] (iii) transferability is somehow limited: while relatively straightforward from consumer to merchant, to be redeemed by the issuer, it is unusual from consumer to consumer (peer-to-peer); and (iv) transactions can be easily recorded (no anonymity).[5]

Some schemes allow spending e-money on a single good or service, others on a set of goods and services (multi-purpose e-money). Technology clearly leans in the direction of expanding the set of goods and services that agents can purchase within the same scheme. Schemes can involve two parties, where the issuer of e-money is also the provider of goods and services; or schemes can involve three parties, where the issuer and provider functions are separate.

---

[3] As distinct from credit cards, debit cards, automated teller machine (ATM) cards and the like, which do not have any intrinsic value themselves but allow customers to transfer funds between bank accounts, and single-purpose payment cards which are essentially an acknowledgement of a pre-payment (Hawkins, as found in BIS, 2001b).

[4] Issuers should be appropriately supervised to avoid excess supply that could threaten market stability (ECB, 1998).

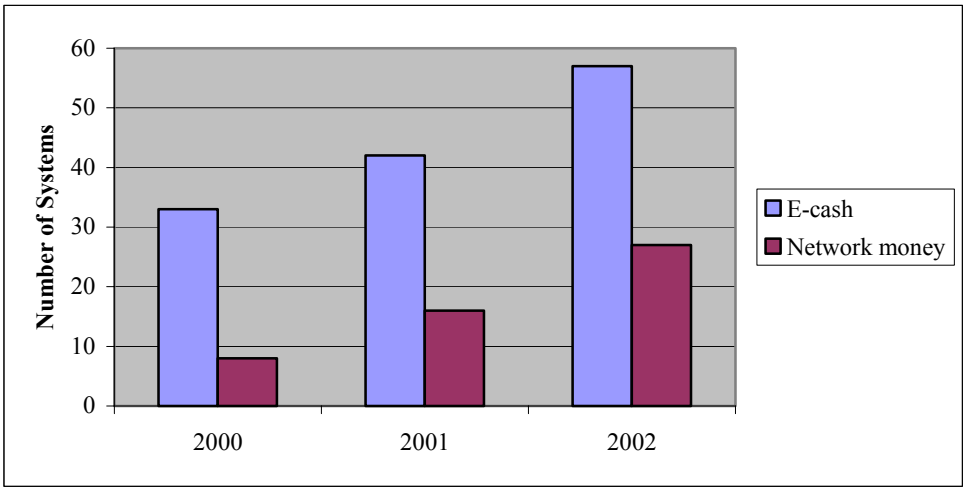
[5] Prinz (1999) considers electronic payment systems where anonymity of the consumer is guaranteed by the credit or debit transaction system supervised by the issuer. However, these systems do not preserve the complete anonymity of the buyers because the issuer controls the inherent creditworthiness.

There are several characteristics that distinguish e-money from traditional bank notes. The latter are infinitely transferable and completely anonymous, totally risk-free from a settlement point of view, and can be used for any sort of transaction without restrictions, since bank notes are legal tender. Traditional bank notes have the maximum benefit from positive network externalities, as we shall see in Section III. E-money is not a liability necessarily settled on the books of the central bank. For this reason e-money exploits network externalities to a much more limited extent, depending on the size of the scheme (number of goods and services offered, number of people using the scheme, ease of access, and so forth).

In assessing e-money as a network good (see Section III) vis-à-vis government money, the following elements could also be considered: (i) transaction costs tend to be higher compared with traditional bank notes, as e-money requires specific technologies; (ii) the potential effects of taxation could include an ex ante reduction on the use of private money; (iii) collection of seigniorage (or other forms of revenues) would be internalized by the issuing network; (iv) interest sensitivity to other forms of interest-bearing assets in the context of a multiplicity of competing monies and asset substitutability; and (v) expectations and risks regarding alternative monies.

The Bank for International Settlements (BIS) regularly surveys the development of e-money. Since 2000, annual statistics have been compiled (Tables 1 and 2). The last survey covers the period from 2002 to 2003. Even though the time period covered by the surveys is limited, a few general conclusions can be drawn on current trends in e-money developments. E-money products are generally card-based; however, the network-based systems' growth rate has been 100 percent and 67 percent in 2001 and 2002, respectively, compared to 27 percent and 36 percent, respectively, in card-based systems (Figure 1). They can be used to execute a multiplicity of payments, and most of them are adapted for network payments. The direct transferability of funds among users is limited, as is the possibility to use e-money for international transactions (Tables 3 and 4).

Figure 1. Electronic Money Schemes



Sources: Bank for International Settlements (2000, 2001a, and 2004); and own calculations.

Since 2000, the number of e-money systems has increased steadily worldwide, but Asia and Africa have experienced the fastest increase. In 2003, about 40 percent of e-money systems were located in Western Europe, down from 50 percent in 2001. New systems were introduced in Italy, Norway, and Finland. In the United Kingdom, all existing systems were discontinued by end-2001. In Central and Eastern Europe new systems were introduced in Russia and in the Czech Republic in 2002.[6] In North America, the use of e-money systems remains limited because credit cards are traditionally used to execute even small-value transactions. In Central and South America and the Caribbean, e-money systems had an early start, but many proved to be unsuccessful. Since 2000, all systems in Mexico, Costa Rica, Honduras, and Venezuela were discontinued. In 2002, a new system was introduced in Brazil. E-money products are particularly widespread in Asia, where 21 new systems were launched in India, South Korea, Malaysia, the Philippines, and Singapore. In Hong Kong SAR, the existing system has considerably enlarged the number of users. In Africa, eight new systems have been created, and none of the previously existing systems has failed.

Western Europe is the most mature market for e-money systems, with the lowest turnover rate and the largest volume of purchases. However, the number of card issued is decreasing, while the purchase volume is increasing at a very high pace. Systems existing since 2001 have considerably reduced the number of cards issued, but about 95 percent of total purchases are still carried out through these systems. Therefore, fewer end-users use e-money systems more frequently. In Asia, the number e-cards issued is increasing at a higher pace than the volume of purchases. In contrast to Western Europe, many new systems were recently launched in Asia and the number of e-cards does not correspond to the number of users that carry out transactions.

From 2000 to 2003, the value of the average purchase has decreased from US$4.7 to US$2.3. The Czech Republic and Brazil represent the only notable exceptions. This confirms the belief that e-money, as opposed to credit and debit cards, will be mainly used for small-size payments.

III. E-MONEY AND NETWORK EXTERNALITIES

E-money is a typical network good and, as such, the impact of its introduction as a means of exchange can be analyzed through the concepts of network and the theory of network externalities. E-money, as a network good, could achieve a diffusion deemed sufficient to substitute for traditional money. However, compatibility, efficiency, and regulatory issues may require the intervention of national regulators for e-money to be efficiently used in the monetary system.

Network externalities consist of the utility increase for network members derived from the increase in the number of network users (Katz and Shapiro, 1985; Van Hove, 1999). The usage of a specific good "called network good" characterizes the specific network, (e.g.,

[6] Including Turkey.

telephone, fax, computer connected to Internet). In the case under consideration, network externalities are usually positive (although limited capacity with rationing—like queuing, or limited access—is a typical example of a negative externality) and arise on the demand side.

Generally speaking, the market value of the network good is inherently related to its connection to the network: a network good has limited or no value outside the network. Moreover, the scope of the network externality is limited to the network itself, that is: no externality arises outside the network, so that only the members of the network can benefit from the externality generated by the additional member.[7]

What network size will agents consider sufficient to start using e-money for transactions? The concept of critical mass point helps answer the question. A market for network goods will not exist unless the expected size is greater than a minimum level (Economides and Himmelberg, 1995). [8] The price of a network good increases with the expected size of the network and decreases with the number of participants (Economides, 1996). Abstracting from risk considerations, the demand for network goods is downward sloping for each level of expected size. In Figure 2 (Van Hove, 1999, based on Economides and Himmelberg, 1995), the effect of network externalities is represented by the series of inverse demand curves $p(n, n^e_i)$. The price p is a function of the network participants n and of the expected dimension of the network n^e_i, where the total size of the population of the economy is normalized to 1.

In equilibrium, the level of network demand matches its expected dimension. Therefore, it is possible to construct a fulfilled expectation demand curve, joining all equilibrium points on the demand schedules. The fulfilled expectation demand curve is represented by the bold curve $p(n, n)$. The demand schedule for network goods includes the y-axis up to the origin, since e-money, as a network good, does not have any stand-alone value and nobody would like to keep e-money in the event that no network is expected. Under a general set of conditions,[9] it is possible to show that the fulfilled expectation demand curve is single-peaked and that the price that the last consumer is willing to pay ($n = 1$) is necessarily zero because there are no further gains in utility from joining a network as big as the whole population in the economy (Economides and Himmelberg, 1995).

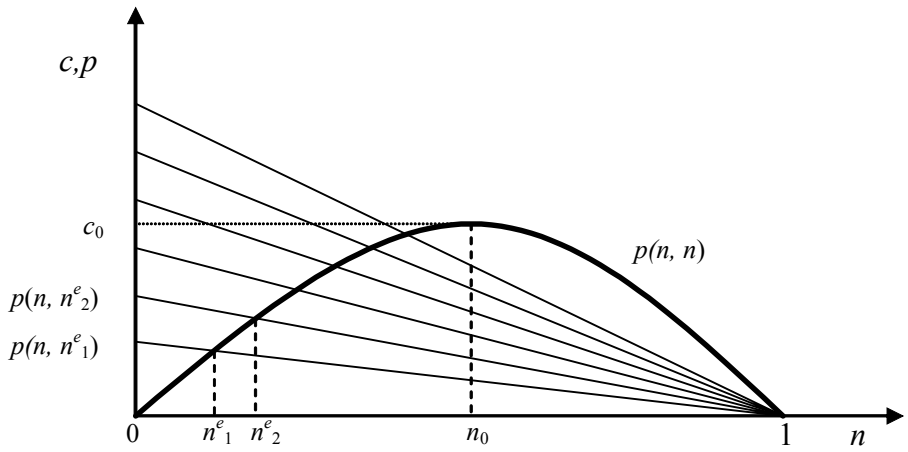
---

[7] However, the value of the network and, consequently, the value of the network good depend on the probability that customers switch from one network to another. This means that the network externality might have an indirect impact on another network.

[8] For example, nobody will buy a telephone if he or she is the only owner.

[9] The inverse demand curve is derived from a utility function that depends on the stand-alone value of the good and that is increasing, at a decreasing rate, with respect to the number of network participants (Economides and Himmelberg, 1995).

Figure 2. The Fulfilled Expectation Demand Curve



Furthermore, the equilibrium demand schedule is increasing for small n if one of the following conditions holds: (i) the utility of every consumer in a network of zero is zero; (ii) there are immediate and large external benefits to network expansion for very small networks; and (iii) there is a significant density of high willingness-to-pay consumers who are just indifferent on joining a network of approximately zero size (Economides, 1996).

In the case of perfect competition, the equilibrium in the market for the network good presents a critical mass point, corresponding to the minimal non-zero equilibrium size of the network. This point is represented by n_0 in the diagram. For marginal costs (MC) greater than c_0 the optimal size of the network is zero, while for MC smaller than c_0 multiple equilibria exist: zero network size and the points on the x-axis correspondent to the first and the last intersection of the MC with the demand schedule. Only the outer intersection is a stable Pareto-efficient equilibrium (Van Hove, 1999).

Does e-money present the characteristics considered sufficient to reach a critical mass point? Realistically, e-money has no value as a stand-alone good (condition i), if it is not used for transactions. The demand for e-money can be justified by the relevance of new forms of commerce and financial transactions (e-commerce and e-finance), which are carried out in virtual markets, thanks to advances in information technology (IT) (Prinz, 1999). Given technological advances and the functions satisfied by different forms of money, the decrease in the cost of use of e-money could generate enough demand to reach a critical mass (conditions ii and iii).

Even though e-money could generate an initial equilibrium while its network grows larger, the issue of e-money under perfect competition is inefficient because the marginal social benefit of network expansion is greater than the benefit that accrues to the single participant. Prinz (1999) shows that, under perfect competition, the demand for e-money is less than socially optimal.

Economides (1996) demonstrates that the presence of a single private issuer of e-money leads to an even smaller network than in the case of perfect competition.

In the case of oligopoly, Economides (1996) shows that a social optimum could be reached if issuers adopt a compatible technology that supports the networks. Issuers will agree to cooperate if the profits deriving from a bigger network are not offset by the increased level of competition in the market for e-money. As a result, the chances to develop sustainable networks depend on the balances of multiple conditions.

According to Van Hove (1999), e-money networks must satisfy six conditions to develop. First, production of e-money must present increasing economies of scale, so that few large issuers will constitute the market. Second, network effects must be strong for consumers to pay higher prices for larger networks. Third, network effects must not weaken too quickly; thus small incompatible networks are not economically sustainable. Fourth, e-money must offer uniform services in order to reinforce the importance of the network dimension for the utility of consumers. Fifth, the installed base must be fairly visible, so that consumers are able to choose which network to join on the basis of their expectations. And sixth, the network must have a minimum geographical scale to avoid the possibility of excessive supply of local e-money.

The first condition refers to technological constraints and the second to the demand for network products. The remaining conditions assure that neither consumers nor issuers demand or produce too many incompatible forms of e-money. The numerous conditions that e-money must fulfill to create the sufficient size of the network to be accepted as a medium of exchange and store of value are a delicate balance between compatibility and competition.

Each form of e-money competes with other forms of e-money and with traditional money, which, as legal tender, maximizes network benefits. Competition limits the diffusion of e-money because networks will not reach socially optimal sizes and more issuers are less likely to agree upon technological standards. Notwithstanding all of these limitations, demand for e-money could increase with the size of new forms of e-markets for goods and services. The problem of compatibility of e-money argues for the intervention of national regulators (Prinz, 1999): central banks and financial sector regulators could address the compatibility problem by making e-money legal tender and supervising its issuers.

Alternatively, e-money could develop efficient network sizes only in a limited number of sectors of the economy. Even in this scenario, the subsequent reduction of the use of traditional banks' money might have consequences for the functioning of the payment and settlement system and the conduct of monetary policy, as we shall see in Sections IV and VI.

IV. Payment and Settlement

Regarding the payment and settlement system, we now turn to the effect of e-money generated within the financial system.

The primary liabilities on the balance sheet of a central bank are currency and bank reserves. The latter are balances held by banks with the central bank to fulfill reserve requirements (where they exist) and to settle transactions with other banks and institutions.

E-money in the form of e-purses and stored-value cards (e-cash) competes directly with traditional currency for payments in small transactions. This raises concerns that currency in circulation might actually disappear, with complete currency substitution. This outcome, although not entirely implausible in the long run, is highly implausible in the medium term. The reason is that there are still substantial differences between bank notes and coins and e-cash. The range of services rendered by traditional currency is not a subset of the services offered by e-money.

Specifically, e-cash can be used for very small payments, does not grant anonymity to the parties involved, and bears a higher risk for the holder than central bank notes, since the issuer is not a risk-free issuer. On the other side, the purchasing power of e-purses or stored value cards (SVC) is infinitely divisible and can be marketed as less vulnerable against inflation (BIS, 2001b). Neither of the instruments involves any bank record when used.

Therefore, e-money in the form of SVCs or e-purses is only a partial substitute for currency, since there is no reason why agents should give up some of the characteristics of currency not offered by the alternative instrument. At the same time, the market for e-money will expand in parallel with the supply of new and better services offered by this instrument. Throughout this process, currency and e-money will coexist, without either of them totally replacing the other.

More complex is the situation with network money. In a network-based system, all transactions are recorded by the issuer and can be settled within the system. Why is this relevant? In general, banks transfer claims to each other to conduct business during daytime and settle end-of-day net imbalances with balances held at the central bank (net system).[10] Therefore, settlement takes place on the books of the central bank and gives rise to positive demand for central bank reserve money.

---

[10]Alternatively, banks could reach final settlement continuously (gross system). Net systems limit the need for settlement balances; however, the standards adopted by private clearinghouses (Lamfalussy standards) require a high level of collateral and multiple intra-day settlements. Therefore, the difference between the two systems is blurred (Hankel, Ize, and Kovanen, 1999).

The central bank is the most suitable institution for final settlement of imbalances for reasons that are important at individual bank level and at system level. First of all, the central bank cannot fail. Second, it is the lender of last resort for any financial institution that might run into liquidity problems. Since the central bank is the monopolistic issuer of base money, it can always supply liquidity in the amounts deemed necessary for the banking sector.

From a systemic point of view, these features eliminate the risk of impossibility of settlement from the settlement system (systemic risk): an individual institution can still fail, but the central bank can provide liquidity to any of them to guarantee the smooth functioning of the financial markets and an orderly recovery of claims by other banks. Therefore, the central bank can help increase the stability and efficiency in the market even if we consider solely its role as part of the market infrastructure, abstracting from policy consideration.

Conversely, no private institution in a private settlement system is risk free, and even if a large member were to emerge to settle other members' transactions, the other institutions would have to release to this pivotal competitor very valuable information. This sounds quite unlikely. Last but not least, no private institution can play the lender-of-last-resort function because of balance sheet constraints and profitability considerations. These characteristics make it rather unlikely that central banks will be supplanted in the foreseeable future as the centerpiece of the settlement system.

However, the demand for reserve money could be considerably reduced. Advances in IT improve the ability of banks to manage their cash flow and reduce their need to hold prudential settlement balances to avoid liquidity constraints. Real-time settlements can be reached by borrowing and lending funds at the precise time of settlement. In this case, demand for real balances for settlement purposes would approach zero and be highly volatile.

Such a reduction in the demand for central bank reserves has profound consequences on the way central banks implement their monetary policy and on its effectiveness to control prices and real activities (see Section VI).

V. Financial Development Issues

In the previous section we analyzed the effects of e-money generated within the financial system; in this section we analyze the possible impact of e-money—in the form of network money—generated outside the financial system, on the real economy and on monetary aggregates.

The issue is whether purchasing power (PP) generated by the consumption of goods and services (e.g., airline, hotels, car rental, and credit card points) outside the books of any financial institutions poses a threat to the control of money supply by the central bank and other financial institutions. The creation of PP is driven by the consumption of goods and services (G&S) and constitutes a liability on the books of the issuer. These points can be considered network money, in the sense that they can be spent or transferred by customers within the issuer's network to purchase a predefined set of services. So far, the usage of these points has increased for two reasons: first, the growing dimensions of the networks owing to

global alliances; second, the increased number of G&S that can be obtained with these points. Network growth and increased availability of G&S means that calling these points money is just a matter of degree (extension of the network and quantity of G&S). Other recent evolutions are the (limited) transferability across networks and extended or no expiration dates.

If points that can be used in a specific network gain transferability across networks, these points could be considered quasi-money, except that they can buy only a limited amount of G&S. However, this is also a matter of degree, since even national currencies can only buy a limited amount of G&S, and whatever is not available in the country must be bought with another currency, which in turn must be bought in the market or from the issuer. In this sense it is not difficult to foresee the possible rise of exchange rates among network points. A limiting factor to considering them money is the expiration date, when it does exist.

The issuer creates points like a central bank and, unlike any central bank, still retains the power to set the price of the G&S it supplies in the network. Therefore, it has control over "points inflation." If the supply of points has been too high, so that demand for its own G&S starts straining supply, it can redefine the "points price" to reduce the points' PP. Therefore, one entity coordinates the functions of suppliers of G&S and that of the supplier of PP. This coordination does not happen through the market, but at the level of the institution, under the constraint of its balance sheet.[11] However, if the points issued by an issuer can be used to buy the G&S of several providers, the coordination function might be lost or severely diminished. This can put some members of the network under strain, because demand might concentrate on specific G&S, while supply of PP can derive from several uncoordinated sources.

The impact of PP generated outside of the financial system is not worrisome, because its role is still too limited: these points do not have fungibility and transferability, except in an extremely limited sense. Moreover, they could be time limited, and become worthless should the issuer go bankrupt.[12] In this sense, this kind of financial development does not pose any systemic risk.

This additional PP might make sectoral demand more pro-cyclical, since additional consumption of G&S is based on the underlying sectoral dynamics, increasing (decreasing) in periods of expansion (recession). It might have a somewhat positive effect on aggregate

---

[11] For prudential concerns, the liability arising from the issuance of points should be recorded on the balance sheet of the issuer. This, however, will not prevent customers from spending points issued by a member of the network on G&S supplied by another member.

[12] This is not necessarily the case: in the recent example of United Airlines' (UA) Chapter 11 bankruptcy arrangement (filing), UA points could be used on the network partners' routes, especially on the closest substitute, Lufthansa. Considering the two airlines were rewarding different routes and classes differently, UA being the most generous, it must have been quite burdensome for Lufthansa to satisfy the additional demand coming from UA customers at price zero.

demand, since it tends to stimulate consumption. However, it could lead to a reduction in the stability of the relationships between real activity and monetary aggregates used by central banks to fine tune money supply.

VI. THE TRANSMISSION OF MONETARY POLICY

Can central banks still influence monetary policy in the presence of competing forms of e-money? In the extreme case of complete substitution of base money, e-money represents a threat to the way monetary policy is implemented, to the ability of the central bank to carry out its monetary policy, and to the standard effect of monetary policy on output and prices. With extensive use of e-money the monetary authority might not expect to have the same sort of command over changes in interest rates as it has otherwise, depending on different circumstances.

To address the question above, we need to look at various possible scenarios. Demand for base money[13] in percent of GDP has declined over the years in most advanced economies (Hankel, Ize, and Kovanen, 1999) because of advances in payment technology that have reduced the liquidity needs for daily transactions. E-money is part of these developments and competes directly with central bank money.

As shown in Section IV, e-money and currency are not perfect substitutes, so there will be positive demand for both. However, to address the question asked at the beginning of the section, we could even consider the extreme case of the disappearance of currency. Would that matter? The answer is negative. Demand for currency is part of the demand for central bank money (base money). Elimination of currency would not by itself eliminate demand for base money. It would merely reduce it.

Also, the ability to conduct monetary policy is not altered even if reserve requirements are eliminated. Reserve requirements are part of the demand for central bank reserves, but not the only component, the other part being for settlement balances (as long as settlement takes place on the books of the central bank). Therefore eliminating reserve requirements reduces but does not eliminate banks' demand for central bank money.

As long as settlement takes place on the books of the central bank, there will be a positive demand for central bank money. This is what allows central banks to retain control over short-term interest rates. By varying the interest rate on these overnight balances, the whole structure of interest rates is affected. This, in turn, affects aggregate spending, the level of prices, and real variables. Financial institutions will also have to consider risks inherent to their liquidity positions and their ability to minimize settlement balances by buying or

[13] Demand for reserves arises from five sources: (i) reserve requirements on banks; (ii) the nonbank public's demand for liquidity, especially in the form of currency; (iii) banks' demand for settlement balances; (iv) payment of tax obligations; and (v) international interbank settlements.

selling funds in the interbank market, considering the rewards and punishment structure set up by the central bank. The central bank will also have to take into account financial institutions' expectations regarding the availability of settlement balances, the functioning of the interbank market, and the behavior of the central bank itself. The reduction in the demand for base money and its higher instability increases the degree of uncertainty agents' face, which in turn increases the degree of risk reflected in the structure of interest rates.

The demise of currency and reserves for the purpose of both reserve requirements and settlement balances does not reduce to zero the demand for central bank money because governments could require taxes to be paid in central bank money. Also, traditional reserves might be held to carry out international transactions (Palley, 2002).

However, the residual demand for central bank liabilities could be to small and too unstable to allow the central bank to target a short-term interest rate through open market operations, so that banks are willing to hold the remaining supply of reserves at the target rate of the central bank (Friedman, 2000; Woodford, 2000). [14]

Banks can introduce network money with the purpose of saving in transaction and settlement costs. The adoption of e-money (fully backed by assets held by issuers—e.g., short-term government bonds) in a private clearing system challenges the monopoly of the central bank in the supply of the medium of exchange and settlement. Information technology can support either net or real-time gross settlement (RTGS) systems operated by private banks, where e-money is used for final settlement. In such a system, the central bank would lose the monopoly power on the issues of liabilities used as settlement balances from the banking

---

[14] The central bank can directly target an overnight rate and then provide a "band," with the targeted rate at the center. The ceiling and the floor are the two standing facilities (this is the case for the Reserve Bank of Australia, the Bank of Canada, and the Bank of New Zealand). The ceiling is determined by the commitment of the central bank to offer an infinite amount of settlement balances at the specified interest rate, the lending rate, above the target interest rate. Nobody would have the incentive to borrow at a higher rate in the interbank market, since the central bank would provide all the necessary liquidity. Below the central bank lending rate, banks are encouraged to borrow and lend among themselves.

Similarly, the floor of the band is determined by the decision of the central bank to accept any amount of deposits, for which the central bank pays a deposit rate. Nobody would have any incentive to lend at an interest rate below the central bank deposit rate. Above the deposit rate, banks are encouraged to trade among themselves. The deposit rate and the lending rate, fixed by the central bank, determine the short-term interest rate "band"—usually determined as fixed and symmetric basis points above and below the target overnight rate.

Alternatively, the central bank can announce the lending rate, as in Canada, and determine the deposit rate as a certain number of basis points below the lending rate. The target overnight rate is derived by calculating the center of the band. The result is identical, as long as it is announced that the target rate is the center of the band.

system. Costa Storti and De Grauwe (2001) define the situation above as a cashless society. In a cashless environment, a possible solution for the central bank to retain control over short-term interest rates would be to impose legal requirements on the financial system as outlined, for instance, by Henckel, Ize, and Kovanen (1999). If the authorities do not resort to their regulatory powers, a cashless society has important implications for the effectiveness of monetary policy.

If the central bank can no longer create liabilities with the stroke of the pen, it must borrow them on the market, as any other bank. The targeting of an operative rate as the midpoint of a band defined by the lending and deposit rate would still be possible, but with consequences for the independence of the conduct of the central bank's monetary policy.

As considered in Figure 3 (Costa Storti and De Grauwe, 2001; used by permission), the market for overnight balances in a cashless society requires that the central bank borrows the funds necessary to enforce the band represented by the lending rate (LR) and the deposit rate (DR). If the demand for overnight balances shifts from DD to D'D', the central bank must borrow the funds needed to enforce the band. The equilibrium shifts from point A to point B, where there is an excess demand of reserves with respect to the market supply SS. To finance the excess demand, the central bank borrows reserves in the market from other banks at the market rate MR and lends it at LR, the rate the central bank enforces. The losses of the central bank are the counterpart of this arbitrage.[15]

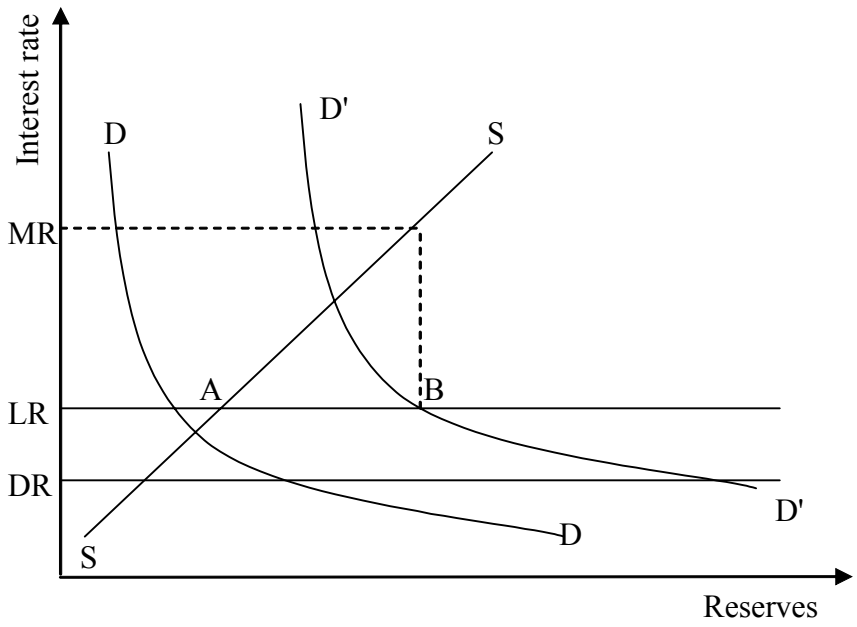
In a cashless society, the central bank has lost its seigniorage (i.e., the power to create ultimate means of payment), and it becomes a player in the market. To borrow the necessary reserves to enforce its monetary policy, the central bank must have sufficient collateral. According to current practice, the collateral used in loans and repurchase agreements in the interbank market is constituted by liquid government securities (e.g., treasury bills and government bonds).

Therefore, the treasury must be willing to supply large amounts of risk-free securities to the central bank, which subsequently becomes a sizable player in the financial market.

---

[15] Costa Storti and De Grauwe (2001) point out that the arbitrage opportunities give the commercial banks a strong incentive to borrow cheaply from the central bank and to lend the funds back to the same central bank at a higher price, resulting in the bank being burdened by unsustainable large losses. However, Woodford (2000) remarks that in monetary systems without reserve requirements the amount of settlement balances demanded by banks is limited. Occasionally, spikes occur and the central banks must be ready to supply large amounts of reserves for a limited period of time, while engaging in liquidity operations to maintain the stability of the market for settlement cash.

Figure 3. The Market for Overnight Balances in a Cashless Society



The ability of the central bank to implement its monetary policy will depend upon the size of its balance sheet. Therefore, the effect of central bank operations will no longer affect the private sector behavior at the margin, independently of the size of these operations (Friedman, 2000). The dependence on the treasury threatens in several ways the independence of the central bank, whose ability to play its role in the financial system is related to the indebtedness of the government (Hankel, Ize, and Kovanen, 1999).

First, central bank dependence on the treasury raises the issue of fiscal solvency. Were the government considered not able to repay its securities, the price of treasury bills would collapse, and the central bank could not back with the government's obligation its monetary policy and its function of lender of last resort. In a cashless economy, the central bank cannot monetize the public debt and therefore adjust the real value of public debt to a sustainable level.

Second, a government that maintains a balanced budget (or even a fiscal surplus) would not provide the financial system with the usual collateral. In the absence of treasury bills, banks would need to use private paper as collateral for interbank transactions or central bank-issued bills. In this scenario, the supply of e-money could grow unstable and pro-cyclical, mainly because the assets backing e-money supplied (and demanded) by the financial system would be endogenously determined by the expectations over the price of market assets and ultimately by expectations of development of economic activity.[16] The issue of

[16] This is a consequence of the price indeterminacy problem considered by Fama (1980).

interest-bearing central bank bills presents once again the problem of central bank profitability without seigniorage. Unless the central bank is well capitalized, concerns over the interest cost of its bills could discourage a central bank from following a tight monetary policy or could lead to rollover problems (Hankel, Ize, and Kovanen, 1999).

The introduction of e-money might lead to changes in the framework of monetary policy and instruments for its implementation; consequently it requires well-coordinated fiscal and monetary policies.

In a financial system where transactions and final settlements are implemented with network money,[17] Palley (2002) considers the introduction of asset-based reserve requirements (ABRR) across the financial system, as opposed to the traditional liability-based reserve requirements. ABRR allow the central bank to selectively target undesirable asset allocations and exercise a counter-cyclical monetary control. With ABRR the central bank maintains control over the overnight interest rate, broadens the definition of monetary base relevant for the conduct of monetary policy, and discriminately targets specific assets instead of the bulk of deposits.[18]

In a cashless society with asset-backed e-money as a medium of exchange and store of value, the central bank can retain control over monetary policy if the central bank is a big player in the market and can credibly enforce a band determined by the lending and deposit rate. The central bank will act mainly as a broker, occasionally intervening in the market to enforce its monetary policy.

If the central bank cannot be a sizable player in the market and finds limitations in the enforcement of its monetary policy, its control over short-term interest rates and the financial system might be severely hampered. However, improvements in the effectiveness of monetary policy can be achieved through broader regulation of the financial system; also IT applied to money and payment systems might lead to a redefinition of the size of an optimal monetary area.

---

[17] Palley (2002) defines network money as mutual fund e-settlement money, where the value of assets held by financial institutions (not necessarily banks) backs the deposits, which constitute e-money.

[18] However, for a clear note of caution on ABBR see Marston (1996, p. 6): "There have been rare cases where reserves have been defined in relation to bank assets. Primarily the technique has been used to affect credit distribution. From the standpoint of monetary control, the weakness of the approach is the failure of required assets to fall in the face of simultaneous deposit and reserve losses. When deposits decline, no reserves are freed from the reserve requirement until, or unless, banks are able to reduce their earning assets."

Broader regulation includes at least four types of measures: (i) reintroducing reserve requirements; (ii) tightly supervising e-money issuers;[19] (iii) limiting the types of assets with which issuers are allowed to back the supply of e-money; and (iv) maintaining sources of demand for central bank money.[20] However, broader regulation could trigger a regulatory race between national authorities and issuers of e-money: the former seeking to contain e-money supply within their control, and the latter trying to escape such regulation through innovations (Friedman, 1999).

Alternatively, IT could lead to a redefinition of existing monetary areas and induce national authorities to adjust their policies to the new systems. Central banks could resize themselves with respect to the markets that they ought to regulate: national authorities could reshape monetary systems, leading in some cases to wider monetary areas, as shown in Section VII.

VII. E-MONEY AND MONETARY AREAS

E-money affects the boundaries of existing national monetary areas. Network externalities modify the optimal size of monetary unions in the presence of e-money. This modification has implications for the effectiveness of monetary policy.

Money can be defined in terms of the number of functions fulfilled and its monetary space. E-money will not replace traditional central bank money, since it cannot improve upon every function of traditional money; also, most likely, e-money will create new or sub-monetary spaces. A monetary space is a spatial or virtual domain in which money serves all or some of its functions (OECD, 2002); for instance, the euro area defines a territorial space that uses the euro, while the oil market is a virtual space that uses U.S. dollars.

The presence of outside money (defined as money competing with the legal tender in an economy) weakens the ability of the central bank to control monetary aggregates and the real economy, since advances in IT facilitate the exchange of traditional currencies across borders, the development of new forms of money, and new payment and settlement systems independent from central bank systems (Costa Storti and De Grauwe, 2002).

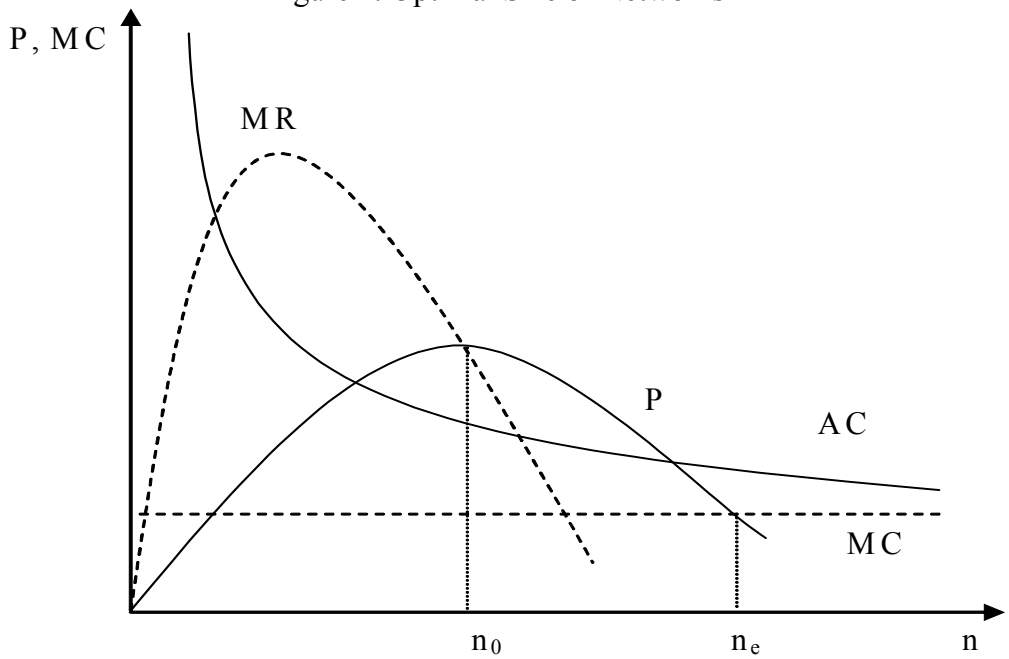
---

[19] The European Central Bank (ECB), for example, has taken a strong stance with regard to competing private e-monies. In addition to requiring that e-money must conform to existing banking supervision, including reserve requirements, the issuers of e-money are, if requested, to be legally obliged to redeem it at par against central bank euros (ECB, 1998). In other words, it is the ECB's intention that any new issuers of private e-money become part of the existing banking system. Out of concern for the United States' lead in e-commerce, the Federal Reserve is, as yet, more tolerant of e-money. However, the U.S. Internal Revenue Service has opposed the part payment of income in "frequent flier miles" that were potentially negotiable (OECD, 2002). For an assessment of the use of "frequent flier miles," see Section V.

[20] For example, requiring tax payments to be made with central bank money (Palley, 2002).

The optimal size of monetary areas can be derived theoretically from the properties of money as network good (Economides, 1996; and Van Hove, 1999). Figure 4 (Costa Storti and De Grauwe, 2002; used by permission) shows the optimal size of monetary networks. The willingness to pay (P) corresponds to the fulfilled expectation demand curve derived in Section III. Money generates network externalities because the utility of money for any individual increases with the number of users. An optimal monetary area fully internalizes the positive effect of network externalities. The cost structure of a monetary network is characterized by high fixed costs and constant marginal costs (MC). Thus economies of scale in the supply of the means of payment are very high, as represented by the AC curve in Figure 4. The Pareto-optimal size of the network is obtained in point n_e, where price equals marginal cost.

Figure 4. Optimal Size of Networks



E-money and IT can have different effects on monetary unions. On the one hand, the diffusion of e-money increases the risk of strong currencies replacing weaker ones and creating a world hierarchy of monies. This increases the incentive to join a monetary union because the central bank that loses control over its monetary policy can either transfer its power to another organization able to control the monetary system or merge its monetary system with a better managed one. This tends to shift the MC schedule downward, thus leading to an increase in the optimal size of a monetary union.

On the other hand, IT increases the compatibility of existing monetary systems. The higher accessibility of different networks reduces the incentive to join a full monetary union, thus shifting the willingness-to-pay curve downward. However, a partial loss of control over the national monetary system could lead countries to enhance their collaboration beyond national borders.

Once e-money has reached its critical mass point, it will replace traditional money in a few sectors of the monetary system. If banks and other financial institutions create a new network money that efficiently replaces central bank money in the final settlement of claims, this new form of money will have lower marginal costs for network participants. Since IT facilitates transactions among network participants and provides better connections to other networks, the demand for network money (i.e., the price consumers are willing to pay to join the network) will increase. In Figure 4, lower marginal costs and higher prices correspond to a downward shift of the MC curve accompanied by an upward shift of the demand schedule, leading to a greater optimal size of the network.

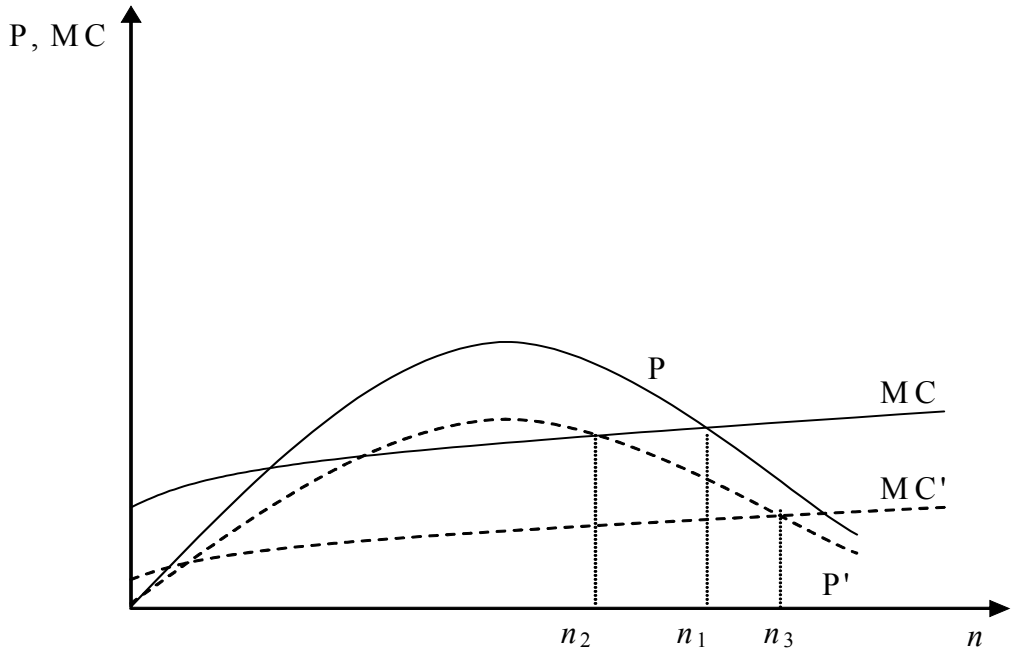
E-money could contribute to the creation of larger currency areas that bypass traditional payment systems based on central bank money. The new networks overcome national boundaries and require a coordination effort among country authorities to manage the monetary developments of new areas.[21] IT facilitates compatibility among monetary networks; this increases the benefit of agents in joining compatible monetary networks and their respective network benefits, sustaining the diffusion of e-money in its region and improving the efficiency of existing national payment systems.

Increased compatibility of monetary networks has an ambiguous effect on monetary unions. IT could decrease the willingness to pay for joining a monetary union because it improves technical compatibility among existing monetary networks, thereby reducing the advantage of joining a monetary union. In Figure 5 (Costa Storti and De Grauwe, 2002; used by permission), the number of monetary systems that merge in a monetary union is represented on the horizontal axis (n). In the diagram, increased compatibility of monetary networks is represented by the shift of the P schedule to P'. The marginal cost (MC) countries face in joining a monetary union increases with the number of participants, since the greater is the size of the union, the lower is the influence each member can exercise on the monetary policy of the union as a whole. The marginal cost of joining faced by each country is represented by the intercept of the MC schedule with the vertical axis. The possibility that outside money reduces the power of national authorities over the monetary system—owing to an increase in the size of capital movements—decreases the cost of joining a monetary union. In Figure 5 this is represented by a downward shift of the MC schedule to MC'. According to the different characteristics of national monetary systems (e.g., exchange rate regime and size of the central bank as player in the monetary area), the opportunity cost of joining a monetary union varies greatly across countries. In equilibrium, IT could lead either to an increase in the size of the monetary union, as represented by point n_3, or to a smaller monetary union, where different networks are better integrated (n_2). Costa Storti and De Grauwe (2002) argue that a downward shift in the willingness to pay curve could be of second order relative to a

[21] These developments could include the issue of the currency of denomination of e-money, and possible e-money exchange rates, if a reference currency for new e-money issues has not been identified within the currency union.

downward movements of the MC curve, leading to an increase in the optimal size of a monetary union.

Figure 5. The Effect of Information Technology on the Optimal Size of Monetary Unions



In conclusion, e-money could lead to the creation of new monetary regions where the central banks' authority is expanded to cover broader monetary areas than before. New forms of money (e-money) could increase the size of monetary unions thanks to IT and economies of scale. Also in a monetary area as discussed above, e-money could reach such a diffusion as to require substantial adjustments in the way monetary policy is run. In this situation the arguments presented in Section VI for a single-country analysis apply. At present, however, this case is highly unlikely even in the long run.

VIII. CONCLUSIONS

The innovations in the payment and settlement system are important processes, but not so much so that they require radically new institutions and instruments. Disappearance of central bank notes is possible, but highly unlikely, and the central bank role in the payment and settlement system is not seriously challenged.

Two other general conclusions can be drawn at this point. The first is that the innovations in payment and settlement technology are increasing the speed of financial transactions, and possibly the efficiency in the use of liquid resources, and this should only be welcomed. The second is that these innovations are unlikely to deprive the central bank of its ability to determine short-term interest rates and therefore to steer monetary policy and influence real economic variables.

However, the loss of seigniorage requires a change in the way monetary policy is carried out. In an e-money environment, instead of operating from liquidity-based open market operations central banks will be altering monetary policy by targeting an intervention band. In this way, the policy intention of the central bank will be directly signaled to the market. Another point is that the size of the central bank balance sheet would matter for the central bank policy to be credible.

Central banks that cannot credibly enforce monetary policy decisions will be forced to reform—either by introducing additional regulation with respect to the issuers of e-money or by creating new institutions more apt to cope with the different characteristics of the monetary systems or by merging existing monetary systems in wider monetary unions.

If the role of central banks can be safely reasserted even in this new environment, a serious challenge comes from a regulatory point of view. This has not been the object of these notes but requires authorities to take regulatory measures at the domestic level and to coordinate regulations at the international level.

This paper also continues the theoretical debate about the consequences of the introduction of e-money in the financial system. It also explores the effect of the creation of purchasing power (PP) outside the monetary system on aggregated demand and on control of money supply by the central bank.

The question concerns the issue of whether PP generated by the consumption of goods and services (e.g., airline points) outside the books of any financial institutions threatens the control of the money supply by the central bank and other financial institutions. Again, the short answer is negative because the role of PP is too limited: these points do not have fungibility and transferability, except in an extremely limited sense. Moreover, they are as yet time limited, and bankruptcy of the issuer might make them worthless. Still, PP might have a positive, but limited, effect on aggregate demand, while making sectoral demand more pro-cyclical.

Table 1. System Design Features

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
Western Europe																
Austria	Quick	Card-based	145.35	400	No	No	No	No	Yes (launch 2001)	Yes	No	No	No	Yes	Yes	Yes
	Paysafecard	Network-based	-	100	-	-	No	-	-	Yes	-	-	No	-	-	No
Belgium	Proton	Card-based	105.00	145	No	No	No	Piloted	Piloted	No	No	No	No	Yes	Yes	Yes (debit card function and ATM access)
Denmark	Danmønt	Card-based	n.a.	32	-	No	No	-	No	No	-	No	No	-	No	No
Finland	Avant	Card-based	311.00	400	No	No	No	Yes	Yes	Piloted	No	No	No	Yes	Yes	Yes (debit, credit, ATM use options on a single card)
	Matkahuolto	Card-based	n.a.	n.a.	No	No	No	No	No	No	No	No	No	Yes	No	No
	Rovaniemi Citycard	Card-based	150.00	n.a.	No	No	No	No	No	No	No	No	No	Yes	No	No
	Seinäjoki Citycard	Card-based	n.a.	n.a.	No	No	No	No	No	No	No	No	No	Yes	No	No
	Waasa Card	Card-based	155.00	150	No	No	No	No	No	Yes	No	No	No	Yes	No	Yes
	Espoo Citycard	Card-based	311.00	-	-	No	-	-	No	-	-	No	-	-	Yes	-
	Pori Citycard	Card-based	311.00	-	-	No	-	-	No	-	-	No	-	-	Yes	-
	Vantaa Citycard	Card-based	311.00	-	-	No	-	-	No	-	-	No	-	-	Yes	-
	UniCard	Card-based	155.00	-	No	No	-	No	No	-	No	No	-	Yes	No	-
France	Monéo	Card-based	n.a.	100	-	No	No	-	No	No	-	No	No	-	Yes, debit card function	Yes (debit card function)
	Mondex France	Card-based	n.a.	-	-	Yes	-	-	No	-	-	No	-	-	Yes, debit card function	-
	MinutePay	Network-based	670.00	-	-	Yes	-	-	Yes	-	-	No	-	-	No	-
Germany	GeldKarte	Card-based	400 (DM)	200	No	No	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes
Greece	egnatiaPrepay	Software-based	-	No	-	-	No	-	-	Yes	-	-	No	-	-	No
Italy	MINIpay	Card-based	180.00	262	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No

Table 1. System Design Features (continued)

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
Italy	Omnipay Prepagato	Network-based	143.00	157	-	No	No	-	Yes (onlyfor internet)	Yes (onlyfor internet)	-	Considered	Considered	-	Considered	Considered
	Moneta On Line	Network-based	185.00	524	-	No	No	-	Yes (onlyfor internet)	Yes (only for internet)	-	No	No	-	No	No
	Kalibra (and Other initiatives)	Card-based	-	3,146	-	-	No	-	-	Yes	-	-	No	-	-	Yes (ATM)
	PagoBancomat Prepagato	Card-based	-	Nominative: no limits; Anonymous 524	-	-	No	-	-	No	-	-	No	-	-	Yes
	CartaFacile	Network-based	-	524	-	-	No (considered)	-	-	Yes (onlyfor internet)	-	-	No	-	-	No
	Carta Chiara	Card-based	-	3,146	-	-	No	-	-	Yes	-	-	No	-	-	Piloted (debit card and ATM)
	Sella Money	Card-based	-	524	-	-	No	-	-	Yes	-	-	No	-	-	Yes (ATM, POS
	Sella-Planet	Card-based	-	524	-	-	No	-	-	Yes	-	-	No	-	-	Yes (ATM, POS
Luxembourg	miniCASH	Card-based	-	131	-	-	No	-	-	No	-	-	No	-	-	Yes (debit card and ATM)
Netherlands	Chipknip	Card-based	226 or 4,521	450	No	No	No	No	Yes	No	n.a.	No	No	Debit card	Debit card	> 70% issued on debit card
	Chipper	Card-based	226.00	-	No	No	-	No	Yes	-	n.a.	No	-	Debit card	Debit card	-
Norway	Buypass	Card-based	-	Card: 2,500 Net account: 9,500	-	-	Yes	-	-	Yes	-	-	Yes	-	-	Yes
	Payex	Network-based	-	1,000	-	-	Yes	-	-	Yes	-	-	No	-	-	No
	Contopronto	Network-based	-	10,000	-	-	Yes	-	-	Yes	-	-	No	-	-	No
	KOPEK	Network-based	-	1,000	-	-	Yes	-	-	Yes	-	-	No	-	-	No
	SmartPay	Network-based	-	10,000	-	-	Yes	-	-	Yes	-	-	No	-	-	No

Table 1. System Design Features (continued)

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability AmongEnd-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
Portugal	PMB (Porta Moedas Multibanco)	Card-based	341.00	233.4 (max. daily loadable value)	No	No	No	No	No	No	No	No	No	Debit and/or credit card; ATM access	Debit and/or credit card; ATM access	Debit and/or credit card functions; ATM access
Spain	Monedero 4B	Card-based	170.72	170.72	No	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
	Visa Cash	Card-based	170.72	170.72	No	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
	Euro 6000	Card-based	204.86	204.86	No	No	No	Piloted	Piloted	Piloted	No	No	No	Yes	Yes	Yes
	Virtual C@sh+	Network-based	239.01	239.01	No	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	No
	Cybertarjeta La Caixa	Network-based	1,707.20	1,707.20	-	No	No	-	Yes	Yes	-	No	No	-	Yes	No
	CybertarjetaBanco Herrero	Network-based	1,707.20	-	-	No	-	-	Yes	-	-	No	-	-	Yes	-
	Virtual BBVA clic-e	Network-based	-	681.82	-	-	No	-	-	Yes	-	-	No	-	-	No
Sweden	Cash Card	Card-based	150.00	n.a.	-	No	No	-	No	No	-	No	No	-	Yes (debit card and ATM access)	Yes (debit cards and ATM access)
Switzerland	CASH	Card-based	204 per card (680 per day)	193 per card	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
	e-cashTM	n.a.	3,401 per month	n.a.	No	No	-	Yes	Yes	-	No	No	-	No	No	-
United Kingdom	Mondex	Network/ Card	165 (GBP 100, i.e., unchanged, but in USD)	-	Yes	Yes	-	Limited	Limited	-	No (although planned later)	No (although planned later)	-	ID and access control. No other payment function at present, but planned later	ID and access control. No other payment function at present, but planned later	-
	Visa Cash	Card-based	83 (GBP 50, i.e., unchanged, but in USD)	-	No	No	-	No	No	-	No (although planned later)	No (although planned later)	-	Debit/credit /check guarantee/ ATM card	Debit/credit/check guarantee/ ATM card	-

Table 1. System Design Features (continued)

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2000	2001	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
United Kingdom	Magex Wallet	Network-based	n.a.	n.a.	No	No	-	Yes	Yes	-	No	No	-	-	–	-
		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Central and Eastern Europe																
Czech Republic	FUNCHIP	Card-based	-	-	-	-	No	-	-	No	-	-	No	-	-	No
Lithuania	eLitoCard	Card-based	No limit	No limit	No	No	No	Piloted	Considered	No	Yes	Yes	LTL, USD, EUR	Yes	Yes	Yes (debit card, identity card)
Moldova	MoldCard system	Card-based	2,413.00	2,413.00	-	No	-	-	No	-	-	No	-	-	Yes	-
Russia	PayCash	Network-based	No limit	No limit	-	Yes	Yes	-	Yes	Yes	-	No	No	-	No	No
Slovak Republic	MicroPay1	Network-based	Small values	Small values	-	n.a.	-	-	Yes	-	-	No	-	-	No	-
	mKonto1	Network-based	Small values	Small values	-	n.a.	-	-	Yes	-	-	No	-	-	No	-
Turkey	Kampüs Karti (Campus Card)	Card-based	n.a.	n.a.	-	No	No	-	No	No	-	No	No	-	Yes	Debit card functionality
	ODTU Akilli Kart Sistemi (METU Campus Smartcard System)	Card-based	-	-	-	-	No	-	-	No	-	-	No	-	-	No
North America																
Canada	Visa Cash	Card-based	335.00	335.00	No	No	No	Considered	Considered	No	No	No	No	Yes	Yes	Yes
	Mondex Canada Sherbrooke, Quebec	Card-based	335.00 (average)	335.00 (average)	Yes	Yes	-	Considered	Considered	-	No	No	-	Yes	Yes	-
United States	Buxx (Visa reloadable)	Network-based	1,500.00	1,500.00	-	n.a.	No	-	Yes	Yes	-	Yes	Yes	-	ATM	ATM
	Travel (Visa reloadable)	Network-based	-	-	-	-	No	-	-	Yes	-	-	Yes	-	-	ATM
	Payroll (Visa reloadable)	Network-based	-	-	-	-	No	-	-	Yes	-	-	n.a.	-	-	ATM

Table 1. System Design Features (continued)

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
United States	Non-payroll (Mastercard reloadable)	Network-based	-	500–5,000	-	-	No	-	-	Yes	-	-	Yes	-	-	ATM
	Payroll (Mastercard reloadable)	Network-based	-	n.a.	-	-	No	-	-	Yes	-	-	n.a.	-	-	ATM
	Travel (Amrerican Express reloadable	Network-based	-	2,750	-	-	No	-	-	Yes	-	-	Yes	-	-	ATM
	Gift cards (Visa non-reloadable)	Network-based	-	10–1,000	-	-	No	-	-	Yes	-	-	n.a.	-	-	ATM
	Gift cards (Mastercard non-reloadable)	Network-based	-	25–2,500	-	-	No	-	-	Yes	-	-	n.a.	-	-	ATM
	Gift cards (American Express non-reloadable)	Network-based	-	25–500	-	-	No	-	-	Yes	-	-	n.a.	-	-	ATM
	Starbucks Duetto	Network-based/ card-based	-	n.a.	-	-	No	-	-	Yes	-	-	n.a.	-	-	Credit card
	Visa Cash 1, 2 (New York)	Card-based	500.00	-	n.a.	n.a.	-	n.a.	n.a.	-	No	No	-	ATM	ATM	-
	Mondex 1,3 (New York)	Card-based	200.00	-	n.a.	n.a.	-	n.a.	n.a.	-	No	No	-	ATM	ATM	-
	American Express Cobaltcard4	Network-based	2,000.00	-	-	n.a.	-	-	Yes	-	-	Yes	-	-	ATM	-
	MasterCard Ecount4	Network-based	500.00	-	-	n.a.	-	-	Yes	-	-	Yes	-	-	ATM	-

Table 1. System Design Features (continued)

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
Central, South America and the Caribbean																
Brazil	Visa Cash	Card-based	45–136	n.a.	No	No	No	Considered	Considered	Considered	No	No	No	Yes	Yes	No
Honduras	FUTURA 3000	Card-based	3.00	-	-	Between banking institutions only	-	-	Electronic clearing	-	-	Yes,Central American currencies and USD	-	-	No	-
Jamaica	Pay Plus Card	Card-based	-	Being considered	-	-	Being considered	-	-	Being considered	-	-	Yes - phase 3 of the project is intended to include this feature	-	-	Yes (combined credit card features)
	Pay Cash Link	Network-Based	-	Being considered	-	-	Being considered	-	-	Being considered	-	-	Yes - phase 3 of the project is intended to include this feature	-	-	n.a.
Venezuela	Mondex	ePurse card	200.00	-	-	Yes. Currently restricted among merchants	-	-	Yes	-	-	Up to 5 currencies. Currently restricted to local currency	-	-	Yes (ID card, debit/credit cards)	-
	Visa Travel	Prepaid card	250.00	-	-	No	-	n.a.	No	-	-	No	-	-	No	-
	Visa Cash	ePurse card	n.a.	-	-	Yes	-	-	Yes	-	-	Yes	-	-	n.a.	-
	eCard	Virtual Credit Card	Credit limit on main credit card	-	-	No	-	-	Yes	-	-	Yes	-	-	No	-
	Pasaporte Digital	Virtual Credit Card	Credit limit on main credit card	-	-	No	-	-	Yes	-	-	Yes	-	-	No	-
	P-Cash	Virtual prepaid	1,400.00	-	-	Yes	-	-	Yes	-	-	No	-	-	No	-
Asia																
Hong Kong	Octopus	Card-based	129.00	Approx. 130	No	No		No	No	No	No	No	No	No	No	No
	Yahoo! PayDirect with HSBC	Network-Based	-	Approx. 640	-	-		-	-	Yes	-	-	No	-	-	No

Table 1. System Design Features (continued)

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
Hong Kong	Mondex	Card-based	385.00	-	Yes	Yes	-	Yes	Yes	-	Available but not currently used	Available but not currently used	-	Available but not currently used	Available but not currently used	-
	Visa Cash	Card-based	385.00	-	No	No	-	No	Piloted	-	No	Piloted	-	Yes	Piloted	-
India	State Bank of India (bank)	Prepaid foreign travel card	-	10,000	-	-	-	-	-	n.a.	-	-	USD and EUR	-	-	Used at ATMs and merchant establishments
	Oriental Bank of Commerce	Prepaid	-	20,000	-	-	-	-	-	n.a.	-	-	INR-denominated	-	-	Used at ATMs and merchant establishments
	ICICI Bank	Prepaid	-	15,000 for non-travel cards and 50,000 for travel cards	-	-	-	-	-	n.a.	-	-	INR-denominated	-	-	Used at ATMs and merchant establishments
	HDFC Bank	Prepaid	-	The bank is asked to fix a limit	-	-	-	-	-	n.a.	-	-	International card	-	-	Used at ATMs and merchant establishments
	UTI Bank	Prepaid international travel card	-	10,000 as per BTQ	-	-	-	-	-	n.a.	-	-	USD	-	-	Used at ATMs and merchant establishments
	IDBI Bank	Prepaid multiutility gift card	-	25,000	-	-	-	-	-	n.a.	-	-	INR-denominated	-	-	Only at merchant establishments
	Citibank	Prepaid Dollar card	-	As per BTQ	-	-	-	-	-	n.a.	-	-	USD	-	-	Used at ATMs and merchant establishments
Korea	K-Cash	Card-based and network based	-	429	-	-	No	-	-	Yes	-	-	Considered	-	-	ID card, saving public authentication file, credit card, debit card, etc.
	Mybi	Card-based and network based	-	429	-	-	No	-	-	Yes	-	-	Considered	-	-	ID card, saving public authentication file, credit card, debit card, etc.
	A-Cash	Card-based	-	429	-	-	No	-	-	No	-	-	No	-	-	ID card, credit card
	Mondex	Card-based and network based	-	429	-	-	No	-	-	Yes	-	-	Piloted	-	-	Credit card

Table 1. System Design Features (continued)

Country	Name of System	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000-	2001	2002	2000	2001	2002
Korea	Visa Cash	Card-based and network based	-	429	-	-	No	-	-	Yes	-	-	Considered	-	-	Credit card, saving public authentication file
	Nemo	Network-based	-	429	-	-	No	-	-	Yes	No	-	No		-	No
Malaysia	MEPS Cash	Card-based	131.58	2.000	-	No	No	-	Yes	Considered	-	No	No		No	Yes (with Bankcard, MyKad)
	Touch 'n Go	Card-based	-	500	-	-	No	-	-	No	-	-	No		-	No
Philippines	Master Electronic	Card-based	-	180-900	-	-	No	-	-	No	-	-	No		-	Yes (can be used as ATM card, purchase card and discount card)
	Visa Electronic	Card-based	-	180-900	-	-	No	-	-	No	-	-	No		-	Yes (can be used as ATM card, purchase card and discount card)
	Ace Arizona	Card-based	-	180-1.800	-	-	No	-	-	No	-	-	No		-	Yes (can be used as ATM card, purchase card and discount card)
Singapore	CashCard	Card-based	289	287.94	No	No	No	Yes	Yes	Yes	No	No	No	ATM and debit cards	ATM and debit cards	ATM and debit cards
	Ez-link card	Card-based	-	57.59	-	-	No	-	-	No	-	-	No		-	No
	eNETS VCard	Server-based	-	287.94	-	-	Yes	-	-	Yes	-	-	No		-	No
Taiwan, China	FISC-IC Card	Card-based	15.2 lower limit 303 upper limit	15-295	-	No	No	-	No	No	No	No	No		Yes (ATM, debit and phone cards)	Yes (ATM, credit, debit, phone card)
	FISC-E-bank	Network-Based	60,600 upper limit 90,900 (per day)	-	-	No	-	-	Yes	-	-	No	-		No	-

Table 1. System Design Features (continued)

Country	Name of Systems	Type of System	Value Limit on Card or Consumer Software (in USD)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2000
Taiwan, China	Mondex Taiwan	Card-Based	63 per card 1,563 per month	Upper limit 295	-	No (piloted)	No	-	Yes (considered)	Yes	-	Yes (up to 5 currencies can be stored)	No	-	Yes. Credit card.	Yes (creditcard and debit card)
Thailand	SCB Smart Card	Card based	250	465	No	No	No	No	No	No	No	No	No	2 types: e-purse; ATM/ e-purse	2 types: e-purse; ATM/e-purse	E-purse, ATM, Staff ID
	MicroCash	Card-based	125	-	No	No	-	No	No	-	No	No	-	2 types: e-purse; ATM/ e-purse	e-purse only	-
Africa																
Ghana	Sika Card	Card-based	-	No limit	-	-	No	-	-	No	-	-	No	-	-	No
	Mondex	Card-based	-	No limit	-	-	Yes	-	-	Yes	-	-	Yes, but currently using only local currency	-	-	No
Malawi	Smartcash	Card-based	-	No limit	-	-	Scheduled for end-October 2003	-	-	No	-	-	No	-	-	Yes (debit card and ATM)
	Sparrow	Card-based	-	200,000	-	-	n.a.	-	-	No	-	-	No	-	-	Yes (debit card and ATM)
Nigeria	Valucard	Card-based	Varies with each issuing bank, but capable of carrying up to NGN 16m	Varies with each issuing bank, but capable of carrying up to 16 m1	-	No	No	-	No	No	-	No	No	-	Yes	Yes
	Smartpay	Card-based	n.a.	Varies with each issuing bank, butcapable of carrying up16m	-	No	No	-	No	No	-	No	No	-	Yes	Yes

Table 1. System Design Features (concluded)

Country	Name of Systems	Type of System	Value Limit on Card or Consumer Software (in U.S. dollars)		Transferability Among End-Users			Adapted for Network Payments			Multicurrency Features			Multifunctional Payment Systems		
			2001	2003	2000	2001	2003	2000	2001	2002	2000	2001	2002	2000	2001	2002
Nigeria	Esca	Card-based	Up to NGN 16m	Up to 16ml	-	No	No	-	No	No	-	No	No	-	No	Yes
	Paycard	Card-based	-	Up to 16ml	-	-	No	-	-	No	-	-	No	-	-	Yes
	MasterCard (local version)	Card-based	-	Not indicated	-	-	n.a.	-	-	n.a.	-	-	No	-	-	Yes
	MasterCard (international version)	Card-based	-	Not indicated	-	-	-	-	-	-	-	-	Yes	-	-	n.a.
Tanzania	Tembo Card	Card-based	-	5,000 for non-account holders 10,000 for account holders	-	-	No	-	-	No	-	-	No	-	-	No

Source: Bank for International Settlements (2000, 2001a, and 2004).

1/ "-" indicates either that a system has been discontinued before the survey or that the sytem has not been launched yet.

Table 2. Data on Use of E-Money

Country	Name of System	Number of Cards Issuedor Home PC Used				Volume of Daily (purchase) Transactions				Average Value of (purchase) Transactions (in U.S. dollars unless otherwise specified)				Float Outstanding (in millions of U.S. dollars)				Launch Product Date
		1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	
Western Europe																		
Austria	Quick	48,000,000	55,000,000	56,000,000	6,000,000	5,800	8,400	12,500	47,123	6.00	4.17	4.95	7.70	3.30	3.90	4.30	14.11	
	Paysafecard	-	-	-	40,000	-	-	-	n.a.	-	-	-	n.a.	-	-	-	1.05	1995
Belgium	Proton	7,000,000	n.a.	8,500,000	2,500,000	149,261	n.a.	156,357	300,445	4.00	n.a.	3.17	5.90	44.40	n.a.	43.43	129.00	Nov. 00
Denmark	Danmønt	n.a.	593,000	n.a.	896,000	n.a.	21,685	n.a.	20,731	n.a.	1.10	n.a.	1.16	n.a.	2.74	n.a.	3.00	Feb. 95
Finland	Avant	n.a.	n.a.	n.a.	1,000,000	n.a.	n.a.	n.a.	2,500	n.a.	n.a.	n.a.	2.00	n.a.	n.a.	n.a.	1.40	1994
	Matkahuolto	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Mar. 97
	Rovaniemi Citycard	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Seinäjoki Citycard	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Waasa Card	n.a.	n.a.	n.a.	153	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.89	n.a.
	Espoo Citycard	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1995
	Pori Citycard	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Vantaa Citycard	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	UniCard	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
France	Monéo	15,000	n.a.	60,000	1,110,000	266	n.a.	4000	53,700	1.20	n.a.	3.00	3.70	n.a.	n.a.	n.a.	21.01	n.a.
	Mondex France	n.a.	n.a.	110,000	n.a.	n.a.	n.a.	1,500	n.a.	n.a.	n.a.	2.50	n.a.	n.a.	n.a.	0.23	n.a.	2000–03
	MinutePay	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Sep. 99
Germany	GeldKarte	60,000,000	n.a.	60,000,000	62,000,000	58,000	n.a.	75,000	107,547	3.60	n.a.	2.21	1.95	70.80	n.a.	58.00	75.00	Jul. 01
Greece	egnatiaPrepay	-	-	-	128	-	-	-	1	-	-	-	36.00	-	-	-	0.01	1996
Italy	MINIpay	442,000	40,712	n.a.	11,362	846	798	n.a.	466	6.20	1.60	n.a.	2.01	0.77	0.49	n.a.	0.27	2002
	Omnipay Prepagato	n.a.	n.a.	97	20,276	n.a.	n.a.	3	84	n.a.	n.a.	10.00	11.28	n.a.	n.a.	0.00	0.38	1996
	Moneta On Line	n.a.	n.a.	4,002	12,632	n.a.	n.a.	32	66	23.40	n.a.	57.00	41.34	n.a.	n.a.	0.14	0.61	Oct. 00
	Kalibra (and other initiatives)	-	-	-	62,492	-	-	-	1,303	-	-	-	54.10	-	-	-	7.89	Dec. 00
	PagoBancomat Prepagato	-	-	-	20,5000	-	-	-	40,000	-	-	-	71.08	-	-	-	n.a.	Jul. 01
	CartaFacile	-	-	-	2,035	-	-	-	7	-	-	-	40.74	-	-	-	0.19	Dec. 01
	Carta Chiara	-	-	-	750	-	-	-	125	-	-	-	42.44	-	-	-	0.06	Jun. 02
	Sella Money	-	-	-	9,388	-	-	-	302	-	-	-	41.24	-	-	-	0.04	Jun. 02
	Sella-Planet	-	-	-	5,199	-	-	-	3	-	-	-	37.01	-	-	-	n.a.	Dec. 02

Table 2. Data on Use of E-Money (continued)

Country	Name of System	Number of Cards Issuedor Home PC Used				Volume of Daily (purchase) Transactions				Average Value of (purchase) Transactions (in U.S. dollars unless otherwise specified)				Float Outstanding (in millions of U.S. dollars)				Launch Product Date
		1999	2000	2001	1999	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	
Luxembourg	miniCASH	-	-	-	383,720	-	-	-	7718	-	-	-	3.06	-	-	-	3.57	Mar. 03
Netherlands	Chipknip	13,000,000	n.a.	14,500,000	17,200,00	n.a.	n.a.	n.a.	238,356	8.00	n.a.	8.00	2.71	28.00	n.a.	25.90	60.00	Feb. 99
	Chipper	7,000,000	n.a.	7,000,000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Oct. 96
Norway	Buypass	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Jun. 97
	Payex	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Contopronto	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	KOPEK	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	SmartPay	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
Portugal	PMB (Porta Moedas Multibanco)	3,433,679	3,500,357	n.a.	3,700,545	13,060	13,090	n.a.	977	1.30	0.86	n.a.	2.36	1.50	0.82	n.a.	0.18	n.a.
Spain	Monedero 4B	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Apr. 95
	Visa Cash	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	End-1996
	Euro 6000	n.a.	n.a.	n.a.	10,150,949	n.a.	n.a.	n.a.	3,084	n.a.	n.a.	n.a.	2.35	n.a.	n.a.	n.a.	21.57	1996
	Virtual C@sh+	5,690,036	8,802,825	n.a.	n.a.	6,112	5,545	n.a.	n.a.	3.12	2.07	n.a.	n.a.	10.63	27.34	n.a.	n.a.	Mid-2000
	Cybertarjeta La Caixa	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	End-1996
	CybertarjetaBanco Herrero	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Mid-2000
	Virtual BBVA clic-e	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Mid-2000
Sweden	Cash Card	n.a.	3,000,000	n.a.	4,200,000	n.a.	16,700	n.a.	2,337	n.a.	7.00	n.a.	4.20	n.a.	40.00	n.a.	0.01	Mid-2000
Switzerland	CASH	3,000,000	n.a.	3,600,000	3,692,000	n.a.	n.a.	n.a.	54,795	n.a.	n.a.	2.22	2.35	n.a.	n.a.	n.a.	n.a.	1998
	e-cashTM	3400	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Jan. 97
United Kingdom	Mondex	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Visa Cash	140,000	1,60,000	n.a.	n.a.	507	507	n.a.	n.a.	16.34	16.34	n.a.	n.a.	0.26	0.26	n.a.	n.a.	Jul. 1995
	Magex Wallet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Oct. 1997
Central and Eastern Europe																		
Czech Republic	FUNCHIP	-	-	-	800,481	-	-	-	15,092	-	-		27.38	-	-	-	0.11·	
Lithuania	eLitoCard	53,000	n.a.	105,000	143,000	937	n.a.	3,025	3,020	23.40	n.a	6.51	9.40	3.60.	n.a	12.45	27.00	Feb. 98
Moldova	MoldCard system	n.a.	3,944	n.a.	n.a.	n.a.	211	n.a.	n.a.	n.a	21.00	n.a	n.a	n.a.	0.04	n.a.	n.a	1996
Russia	PayCash	n.a.	n.a.	n.a.	47	n.a.	n.a.	n.a.	1	n.a	n.a	n.a	30.33	n.a.	n.a.	n.a	2.04	1998
Slovak Republic	MicroPay1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a	n.a	n.a	n.a	n.a.	n.a.	n.a.	n.a	Aug. 03

Table 2. Data on Use of E-Money (continued)

Country	Name of System	Number of Cards Issued or Home PC Used				Volume of Daily (purchase) Transactions				Average Value of (purchase) Transactions (in U.S. dollars unless otherwise specified)				Float Outstanding (in millions of U.S. dollars)				Launch Product Date
		1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	
Slovak Republic	mKonto1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Turkey	Kampüs Karti (Campus Card)	3,359	n.a.	950	50,000	3	n.a.	30	n.a.	102.90	n.a.	3.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	ODTU Akilli Kart Sistemi (METU Campus Smartcard System)	-	-	-	27,500	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Autumn 2003
North America																		
Canada	Visa Cash	48,000	61,503	n.a.	77,358	n.a.	n.a.	n.a.	n.a.	2.85	1.68	n.a.	1.50	0.03	0.03	n.a.	0.01	
	Mondex Canada Sherbrooke,Quebec	30,000	25,108	n.a.	n.a.	n.a.	679	n.a.	n.a.	4.00	4.42	n.a.	n.a.	0.09	0.11	n.a.	n.a.	Oct. 97
United States	Buxx (Visa reloadable)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	na	n.a.	na	n.a.	Nov. 97
	Travel (Visa reloadable)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Aug. 00
	Payroll (Visa reloadable)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Non-payroll (Mastercard reloadable)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Jul. 01
	Payroll (Mastercard reloadable)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Travel (Amrerican Express reloadable	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Gift cards (Visa non-reloadable)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Oct. 03
	Gift cards (Mastercard non-reloadable)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Gift cards (American Express non-reloadable)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Starbucks Duetto	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Oct. 02
	Visa Cash 1, 2 (New York)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	na	n.a.	na	n.a.	Oct. 03
	Mondex1, 3 (New York)	96,000	96,000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	na	n.a.	na	n.a.	Oct. 97
	American ExpressCobaltcard4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	na	n.a.	na	n.a.	Oct. 97
	MasterCardEcount4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	na	n.a.	na	n.a.	Oct. 00
Brazil	Visa Cash	95,000	n.a.	95,000	50,000	334	n.a.	334	7,233	4.42	n.a.	3.77	6.02	67.80	n.a.	37.70	n.a.	
Honduras	FUTURA 3000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Oct. 96
Jamaica	Pay Plus Card	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Pay Cash Link	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.

Table 2. Data on Use of E-Money (continued)

Country	Name of System	Number of Cards Issuedor Home PC Used				Volume of Daily (purchase) Transactions				Average Value of (purchase) Transactions (in U.S. dollars unless otherwise specified)				Float Outstanding (in millions of U.S. dollars)				Launch Product Date
		1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	
Venezuela	Mondex	n.a.	n.a	250	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3,500.00	n.a.	n.a.
	Visa Travel	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Jan. 2001
	Visa Cash	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Oct. 2001
	eCard	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	To be announced
	Pasaporte Digital	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Mar. 2001
	P-Cash	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Jun. 2001
Asia																		
Hong Kong	Octopus	5,600,000	n.a.	7,000,000	9,000,000	390,0000	n.a.	6,000,00	7,000,000	0.94	n.a.	0.89	1.00	n.a.	n.a.	n.a.	Confidenti	
	Yahoo! PayDirect with HSBC	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Sep. 97
	Mondex	200,000	n.a.	243,000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	4.00	n.a.	4.00	n.a.	2002 Q4
	Visa Cash	310,000	n.a.	340,000	n.a.	n.a.	n.a.	n.a.	n.a.	2.55	n.a.	5.90	n.a.	n.a.	n.a.	n.a.	n.a.	Nov. 1997
India	State Bank of India (bank)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Aug. 96
	Oriental Bank of Commerce	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	ICICI Bank	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	HDFC Bank	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	UTI Bank	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	IDBI Bank	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	Citibank	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
Korea	K-Cash	-	-	-	554,260	-	-	-	12,858	-	-	-	0.59	-	-	-	0.49	n.a.
	MYbi	-	-	-	2,057,500	-	-	-	501,020	-	-	-	0.62	-	-	-	3.72	Jul. 00
	A-Cash	-	-	-	400,000	-	-	-	80,000	-	-	-	0.59	-	-	-	0.34	Sep. 02
	Mondex	-	-	-	700,000	-	-	-	n.a.	-	-	-	n.a.	-	-	-	0.08	Jun. 01
	Visa Cash	-	-	-	860,000	-	-	-	n.a.	-	-	-	n.a.	-	-	-	0.02	Jun. 00
	Nemo	-	-	-	3,000,000	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Oct. 01
Malaysia	MEPS Cash	n.a.	n.a.	53,534	9,200,000	n.a.	n.a.	8	42	n.a.	n.a.	1.81	1.12	n.a.	n.a.	0.06	0.45	Nov. 01
	Touch 'n Go	-	-	-	2,400,000	-	-	-	80,615	-	-	-	3.24	-	-	-	12.29	1996
Philippines	Master Electronic	-	-	-	530,000	-	-	-	54,298	-	-	-	0.00	-	-	-	0.64	1997
	Visa Electronic	-	-	-	19,886	-	-	-	36	-	-	-	n.a.	-	-	-	0.01	2000
	Ace Arizona	-	-	-	50,000	-	-	-	17,510	-	-	-	0.05	-	-	-	0.30	Mar. 03
Singapore	CashCard	3,156,637	4,696,861	n.a.	6,000,000	276,133	36,4198	n.a.	317,808	0.62	0.75	n.a.	1.19	15.46	19.63	n.a.	26.30	Dec. 02
	ez-link card	-	-	-	4,000,000	-	-	-	2,565,000	-	-	-	0.47	-	-	-	29.77	Nov. 96
	eNETS Vcard	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Apr. 02

Table 2. Data on Use of E-Money (concluded)

Country	Name of System	Number of Cards Issued or Home PC Used				Volume of Daily (purchase) Transactions				Average Value of (purchase) Transactions (in U.S. dollars unless otherwise specified)				Float Outstanding (in millions of U.S. dollars)				Launch Product Date
		1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	1999	2000	2001	2002	
Taiwan, China	FISC-IC Card	n.a.	n.a.	2,100,000	2,030,000	n.a.	n.a.	1,200	152	n.a.	n.a.	2.43	3.38	n.a.	n.a.	n.a.	n.a.	n.a.
	FISC-E-bank	n.a.	n.a.	38,000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Feb. 98
	Mondex Taiwan	n.a.	2,000	n.a.	250,000	n.a.	n.a.	n.a.	215	n.a.	n.a.	n.a.	7.00	n.a.	n.a.	n.a.	0.41	Feb. 99
	E-SUN e-Coin	-	-	-	88,000	-	-	-	350	-	-	-	4.20	-	-	-	0.12	Jun. 02
Thailand	SCB Smart Card	17,000	17,000	n.a.	50,000	750	n.a.	n.a.	700	330.00	330.00	n.a.	2.01	n.a.	n.a.	n.a.	0.01	Jan. 02
	MicroCash	58,710	58,710	n.a.	n.a.	413	n.a.	n.a.	n.a.	4.00	4.00	n.a.	n.a.	0.18	n.a.	n.a.	n.a.	1999 Nov. 96
Africa																		
Ghana	Sika Card	-	-	-	82,636	-	-	-	130	-	-	-	n.a.	-	-	-	n.a.	
	Mondex	-	-	-	3,637	-	-	-	70	-	-	-	2.00	-	-	-	95.00	1997
Malawi	Smartcash	-	-	-	18,900	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	Apr. 03
	Sparrow	-	-	-	n.a.	-	-	-	11	-	-	-	3,209.00	-	-	-	0.01	2001
Nigeria	Valucard	n.a.	n.a.	72,306	1,84,924	n.a.	n.a.		n.a.	n.a.	n.a.	0.06	0.88	n.a.	n.a.	3.52	17.85	2001
	Smartpay	n.a.	n.a.	31,345	78,266	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.01	n.a.	n.a.	0.07	0.33	n.a.
	Esca	n.a.	n.a.	5,818	17,500	n.a.	n.a.	n.a.	411	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	na	n.a.	n.a.
	Paycard	-	-	-	n.a.	-	-	-	n.a.	-	-	-	0.06	-	-	-	n.a.	n.a.
	MasterCard (local version)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
	MasterCard (international version)	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.
Tanzania	Tembo Card	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	-	-	-	n.a.	n.a.

Source: Bank for International Settlements (2000, 2001a, and 2004).

1/ "-" indicates either that a system has been discontinued before the survey or that the sytem has not been launched yet.

Table 3. Characteristics and Utilization of E-Money Products, 2000–2003

	Number of E-money Systems			New Systems		Discontinued Systems		Technological Features (in percent of total supply): Transferability Among Users Adapted for Network Payments		Adapted for Network Payments		Multicurrency Features		Multifunctional Payment System	
	2000	2001	2003	2003	2001	2003	2001	2003	2001	2003	2001	2003	2001	2003	2001
Western Europe	26	34	37	15	12	12	4	13.5	8.8	54.1	47.1	2.7	0.0	54.1	64.7
Central and Eastern Europe 1/	3	6	5	2	5	3	2	20.0	16.7	20.0	50.0	20.0	16.7	40.0	50.0
North America	7	7	11	9	2	5	2	0.0	14.3	90.9	42.9	45.5	42.9	100.0	28.6
Central, South America, and the Caribbean	6	8	3	2	6	7	4	0.0	25.0	0.0	62.5	66.7	62.5	33.3	25.0
Asia	7	10	27	21	3	4	0	5.0	10.0	37.0	40.0	25.9	10.0	74.1	40.0
Africa	0	3	11	8	3	0	0	10.0	0.0	10.0	0.0	18.2	0.0	63.6	66.7
Total	49	68	94	57	31	31	12	9.3	11.8	48.8	45.6	19.1	14.7	65.6	51.5

	Cards Issued (in thousands)			Float Outstanding (in millions of U.S. dollars)			Purchase Volume (in thousands)			Average Payment (in U.S. dollars)		
	2000	2001	2003	2000	2001	2003	2000	2001	2003	2000	2001	2003
Western Europe	140,816.7	158,374.0	122,005.5	1,59.7	200.9	343.2		2,33.9		4.7	3.8	881.7
Central and Eastern Europe 1/	56.4	109.9	1,021.0	3.6	12.5	29.1		0.9		13.6	7.0	18.1
North America	1,26.0	121.1	77.4	n.a.	n.a.	n.a.		n.a.		1.7	1.8	n.a.
Central, South America, and the Caribbean	95.0	95.3	50.0	67.8	41.2	37.7		0.3		3.8	3.8	7.2
Asia	3,409.6	9,774.5	41,189.6	19.6	23.7	74.9		4,177.3		6.7	2.4	10,630.6
Africa	-	109.5	385.9	-	3.5	1,13.2		-		-	0.0	0.6
Total	144,503.7	168,584.2	164,729.3	250.7	281.8	5,98.2		4,412.4		4.7	3.7	11,538.2 2/

Sources: Bank of International Settlement (2000, 2001a and 2004); and own calculations.
1/ Includes Turkey.
2/ Total average excludes Africa.

Table 4. Changes in Characteristics and Utilization of E-Money Products, 2000–2003

(Percentage change with respect to the previous reporting period; unless otherwise specified)

	E-money Systems		System Turnover 1/ (in percent)		Technological Innovations 2/ (in units)		Card Issued		Float Outstanding		Purchase Volume		Average Payment	
	2001	2003	2001	2003	2001	2003	2001	2003	2001	2003	2001	2003	2001	2003
Western Europe	30.8	8.8	61.5	79.4	2	2	12.5	-23.0	25.8	70.8	31.6	186.5	-18.6	-32.6
Central and Eastern Europe 3/	100.0	-16.7	233.3	83.3	0	0	95.0	829.1	247.0	133.4	247.4	454.6	-48.7	225.5
North America	0.0	57.1	57.1	200.0	0	0	-3.9	-36.1	n.a.	n.a.	n.a.	n.a.	4.0	-15.2
Central, South America, and the Caribbean	33.3	-62.5	166.7	112.5	0	0	0.3	-47.5	-39.2	-8.5	0.0	2065.6	-.03	60.0
Asia	42.9	170.0	42.9	250.0	0	1	186.7	321.4	20.6	216.3	52.4	67.0	-64.1	-52.5
Africa	n.a.	266.7	n.a.	266.7	0	1	n.a.	252.5	n.a.	3117.3	n.a.	n.a.	n.a.	1022.9
Total 4/	38.8	38.2	87.8	129.4	2	4	16.7	-2.3	12.4	112.3	51.3	72.8	-20.4	-37.4

Sources: Bank of International Settlement (2000, 2001a, and 2004); and own calculations.

1/ Number of new and discontinued systems devided by number of systems in the previous survey year.

2/ Introduction of users transferability, network payments abilitation, multicurrency features, and multifunctional payment systems between the two reporting periods.

3/ Includes Turkey.

References

Arnone, Marco, 2001, "E-Money and the Transmission of Monetary Policy," paper presented at the Second Monetary Conference, "Electronic Banking: Challenges and Opportunities for Central Banks," organized by the Central Bank of Philippines, Manila, Feb. 26, 2001.

Arnone, Marco and Luca Bandiera, 2003, "E-Money: Chances of Success and Consequences for Monetary Policy," *Kiel Institute for World Economics Working Paper* No. 401 (Kiel, Germany: Kiel Institute).

Bank for International Settlements, 1990, *Report of the Committee on Interbank Netting Schemes of the Central Banks of the Group of Ten Countries* (Basel).

———, 1996, *Implications for Central Banks of the Development of Electronic Money* (Basel).

———, 2000, *Survey of Electronic Money Developments*, Committee on Payments and Settlement Systems (Basel).

———, 2001a, *Survey of Electronic Money Developments*, Committee on Payments and Settlement Systems (Basel).

———, 2001b, "Electronic Finance: A New Perspective and Challenges," *BIS Papers* No. 7, Monetary and Economic Department (Basel).

———, 2004, *Survey of Developments in Electronic Money and Internet and Mobile Payments*, Committee on Payments and Settlement Systems (Basel).

Beck, Hanno, 2001, "Banking is Essential, Banks are Not. The Future of Financial Intermediation in the Age of the Internet," *Netnomics*, Vol. 3, pp. 7–22.

Berk, Jonathan M., 2002, "Central Banking and Financial Innovation. A Survey of the Modern Literature," *Banca Nazionale del Lavoro Quarterly Review* No. 222, September.

Bootle, Roger, 2001, "The Future of Electronic Money - Why the Nok Will Not Replace the Dollar," *The Business Economist*, Vol. 32, No. 1, pp. 7–15.

Borio, Claudio E.V., 1997, "Monetary Policy Operating Procedures in Industrial Countries," *BIS Economic Papers* No. 47, July (Basel: Bank for International Settlements).

Bullard, James and Bruce D. Smith, 2000, "The Value of Inside and Outside Money," *Federal Reserve Bank of St. Louis Working Paper Series* No. 2000–027B, November.

Cohen, Benjamin J., 2001, "Electronic Money: New Day or False Dawn?" *Review of International Political Economy*, Vol. 8, No. 2, pp. 197–225, Summer.

Costa Storti, Claudia and Paul De Grauwe, 2002, "Electronic Money and Optimal Size of Monetary Union," *CEPR Discussion Paper Series,* No. 3391, May (London: Centre for Economic Policy Research).

———, 2001, "Monetary Policy in a Cashless Society," *CEPR Discussion Paper Series,* No. 2696, February (London: Centre for Economic Policy Research).

Economides, Nicholas, 1996, "The Economics of Networks," *International Journal of Industrial Organization*, Vol. 14, pp. 673–699.

Economides, Nicholas and Charles Himmelberg, 1995, "Critical Mass and Network Evolution in Telecommunications," pp. 47–63, in *Toward a Competitive Telecommunication Industry: Selected Papers for the 1994 Telecommunications Policy Research Conference,* ed. by Gerard Brock (Mahwah, NJ: Lawrence Erlbaum).

European Central Bank, 1998, *Report on Electronic Money*, Frankfurt, August.

Fama, Eugene F., 1980, "Banking in the Theory of Finance," *Journal of Monetary Economics*, Vol. 6, pp. 39–57.

Freedman, Charles, 2000, "Monetary Policy Implementation: Past, Present and Future-Will Electronic Money Lead to the Eventual Demise of Central Banking?" *International Finance*, Vol. 3, No. 2, pp. 211–227.

Friedman, Benjamin M., 2000, "Decoupling at the Margins: the Threat to Monetary Policy from the Electronic Revolution in Banking," *NBER Working Paper,* No. 7955, (Cambridge, Mass: National Bureau of Economic Research).

———, 1999, "The Future of Monetary Policy: the Central Bank as an Army with only a Signal Corps," *NBER Working Paper* No. 7420, (Cambridge, Mass: National Bureau of Economic Research).

Goodhart, Charles, 2000 "Can Central Banks Survive the IT Revolution?" *International Finance*, Vol. 3, No. 2, pp. 189–209.

Hankel, Timo, Alain Ize, and Arto Kovanen, 1999, "Central Banking without a Central Bank," *IMF Working Paper* No. 99/92 (Washington: International Monetary Fund).

Hawkins, John, 2001, "Electronic Finance and Monetary Policy," in *Electronic Finance: A New Perspective and Challenges, BIS Papers,* No. 7, (Basel: Bank for International Settlements).

Katz, Michael L. and Carl Shapiro, 1985, "Network Externalities, Competition and Compatibility," *American Economic Review*, Vol. 75, No.3, pp. 424–440.

King, Mervyn, 1999, "Challenges for Monetary Policy: New and Old," *Bank of England Quarterly Bulletin*, Vol. 39, pp. 397–415, November.

Marston, David, 1996, "The Use of Reserve Requirements in Monetary Control— Operational Features and Country Practices," *IMF/Monetary and Financial Systems Department Operational Paper* No. 96/1 (Washington: International Monetary Fund).

Mesonnier, Jean-Stéphane, 2001, "Monnaie Électronique et Politique Monétaire," *Bulletin de la Banque de France,* No. 91, July.

Mundell, Robert A., 1961, "A Theory of Optimum Currency Areas," *American Economic Review*, Vol. 51, (September) pp. 657–665.

Organization for Economic Cooperation and Development, 2002, *The Future of Money* (Paris).

Palley, Thomas, 2002, "The E-Money Revolution: Challenges and Implications for Monetary Policy," *Journal of Post Keynesian Economics*, Vol. 24, No. 2, pp. 217–233.

Prinz. Aloys, 1999, "Money in the Real and Virtual World: E-money, C-money and the Demand for Cb-money," *Netnomics*, Vol. 1, pp. 11–35.

Sato, Setsuya. and John Hawkins, 2001, "Electronic Finance: an Overview of the Issues," in "Electronic Finance: a New Perspective and Challenges," *BIS Paper* No. 7, November (Basel: Bank for International Settlements).

Shy, Oz and Juha Tarkka, 2002, "The Market for Electronic Cash Cards," *Journal of Money, Credit and Banking*, Vol. 34, No. 2, May.

Spencer, Peter, 2001, "E-money: Will it Take Off?" *World Economics*, Vol. 2, No.1, (January–March) pp.121–136.

Van Hove, Leo, 1999, "Electronic Money and the Network Externalities Theory: Lessons for Real Life," *Netnomics*, Vol. 1, pp. 137–171.

White, Lawrence. H., 1984, "Competitive Payments Systems and the Unit of Account," *American Economic Review*, Vol. 74, No. 4, (September) pp. 699–712.

Woodford, Michael, 1997, "Doing without Money: Controlling Inflation in a Post-Monetary World," *NBER Working Paper* No. 6188, (Cambridge, Mass: National Bureau of Economic Research), September.

———, 2000, "Monetary Policy in a World without Money," *International Finance*, Vol. 3. No. 2, pp. 229–260.

———, 2003, *Interest and Prices: Foundations of a Theory of Monetary Policy*, (Princeton, NJ: Princeton University Press).