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Central Banking Without Central Bank Money

Prepared by Timo Henckel, Alain Ize, and Arto Kovanen[1]

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Abstract

Given the rapidly declining demand for *central bank reserves* and their gradual replacement in wholesale payments by alternative forms of money—*clearinghouse money* and *treasury money*—this paper discusses whether the complete extinction of base money could undermine monetary control. It argues that such concerns are misplaced since central banks can target interest rates and inflation even in the absence of base money. The paper explores implications for current and future central banking, including monetary and foreign exchange operations, lender of last resort, coordination between public debt and monetary management, and design of operating rules in currency boards.

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I. INTRODUCTION: TRENDS AND ISSUES

In the textbook monetary paradigm, central banks influence interest rates through controlling monetary aggregates, which are linked to the supply of central bank liabilities through a money multiplier. Hence, central banks' ability to control the supply of their monetary liabilities is considered to be critical. However, central bank (base) money, relative to other means of payment or monetary aggregates, has declined steadily over the last three decades, to the point where its existence and relevance for monetary policy in the future has become an open question. The velocity of reserve money in the G-10 countries has risen by about 60 percent since the beginning of the 1970s (Figure 1).[2] At the same time, money multipliers have more than doubled (Figure 2). Both components of base money, banks' reserves and currency in circulation, have declined sharply during the last two decades as a proportion of GDP (Figures 3 and 4). Indeed, in some cases, the demand for settlement balances has fallen to the point where both central banks and commercial banks regularly adopt zero (or near zero) reserves as their day-to-day operational target.[3]

In part, these trends reflect changes in the use of monetary policy instruments, particularly large reductions in (or outright elimination of) mandatory reserve requirements.[4] Thus, during the 1990s Germany, France, Japan, and the U.S.A reduced their reserve requirements, while Canada switched to a zero reserve requirements regime in 1994. At the same time, payments system innovations, both in gross and net clearing systems, have increased the efficiency and safety with which banks clear and settle interbank transactions, resulting in a rapid increase in both the value and the volume of such transactions, relative to the underlying volume of settlement balances (Table 1). In particular, the expanded use of netting has allowed banks to substitute inside *clearinghouse money* for outside *central bank money*. In turn, the increased liquidity and depth of the securities markets has played an important facilitating role in this process, particularly in the case of repurchase operations with treasury bills. By providing the bulk of the collateral base for daily interbank money market operations, treasury bills have effectively become *treasury money*, i.e., near money substitutes for settlement balances (Figure 5 and Table 2).

Of course, neither the supply of clearinghouse money nor that of treasury money is under central bank control. Thus, this paper focuses on the implications that the continued reduction in base money, and indeed its possible extinction, could have for the conduct of monetary policy. The paper first investigates whether, in view of payments developments and developments in monetary instruments, a world without central bank money is likely to

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[2]Velocity is calculated as the ratio of nominal GDP to base money. Money multipliers are calculated as the ratio of broad money to base money.

[3]Some of the countries that are presently very close to targeting zero reserves include Australia, Belgium, Canada, Mexico, the U.K., and Sweden.

[4]See Borio (1997) and Sellon and Weiner (1996).

Figure 1. The Velocity of Reserve Money 1/
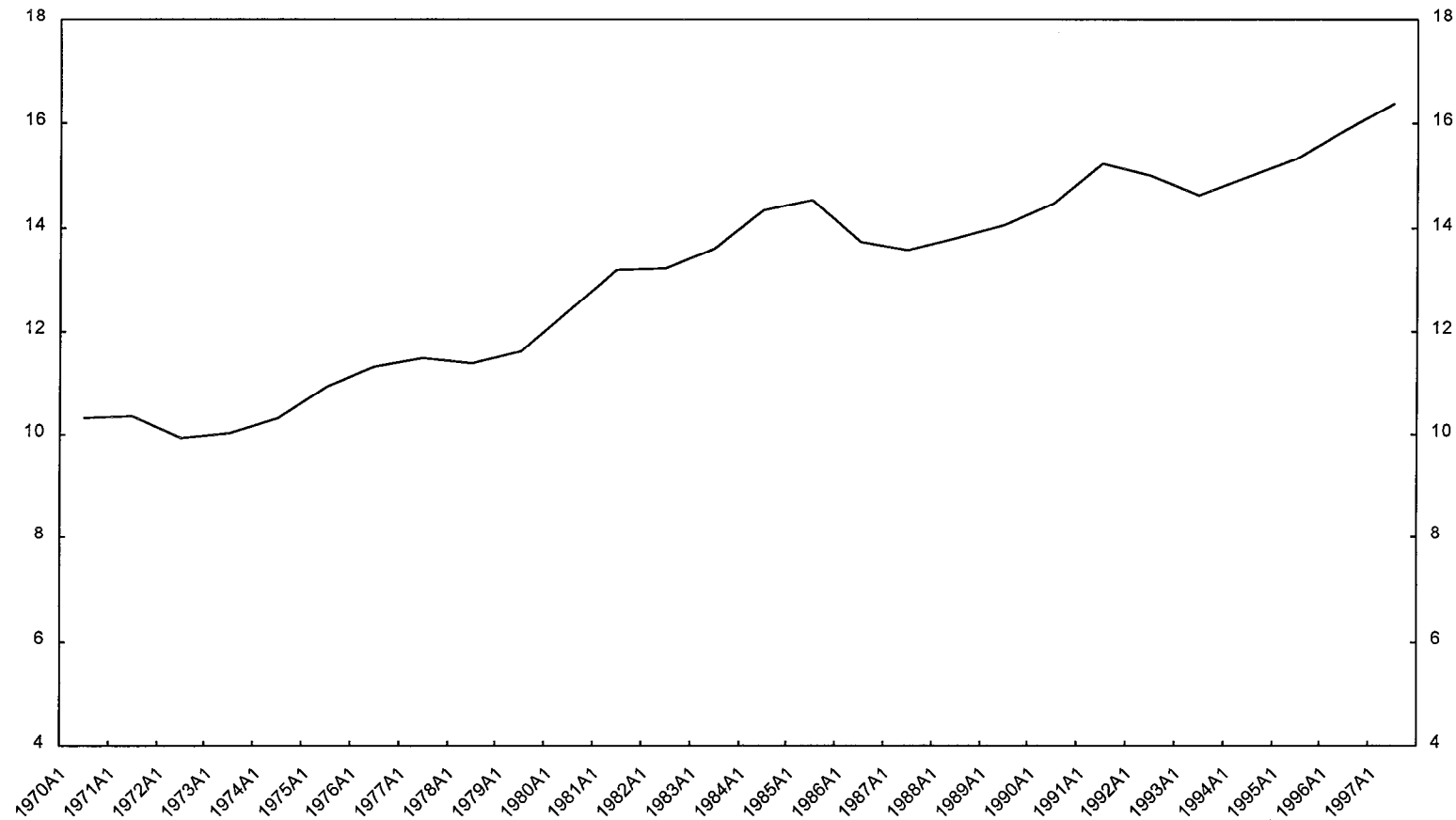
Source: IMF, International Financial Statistics.

1/ Calculated as the ratio of nominal GDP to reserve money; annual averages for the following countries: Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, and the United States.

Figure 2. Money Multiplier 1/
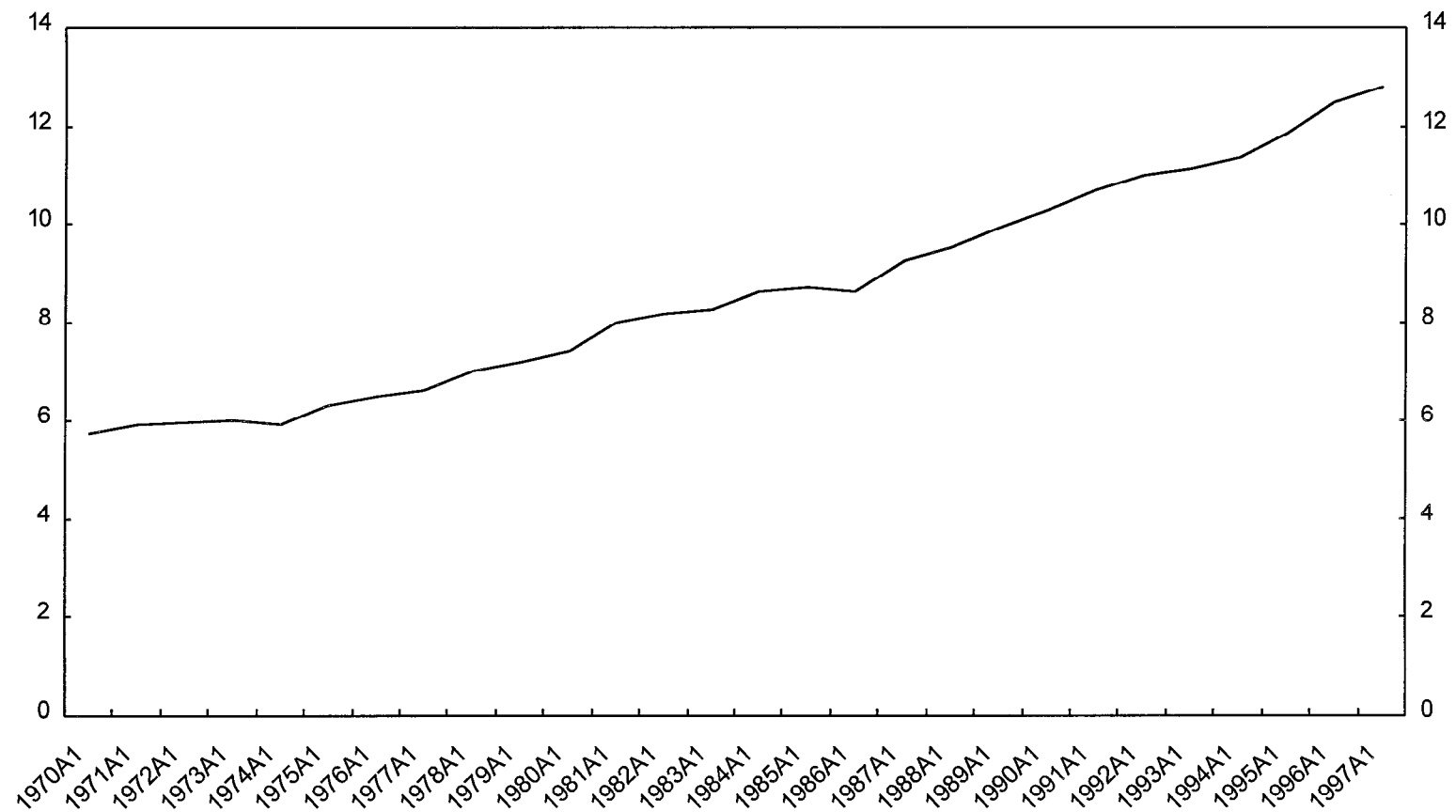
Source: IMF, International Financial Statistics.

1/ Calculated as the ratio of broad money to reserve money; annual averages for the following countries: Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, and the United States.

Figure 3. Bank Reserves
(In percent of GDP)
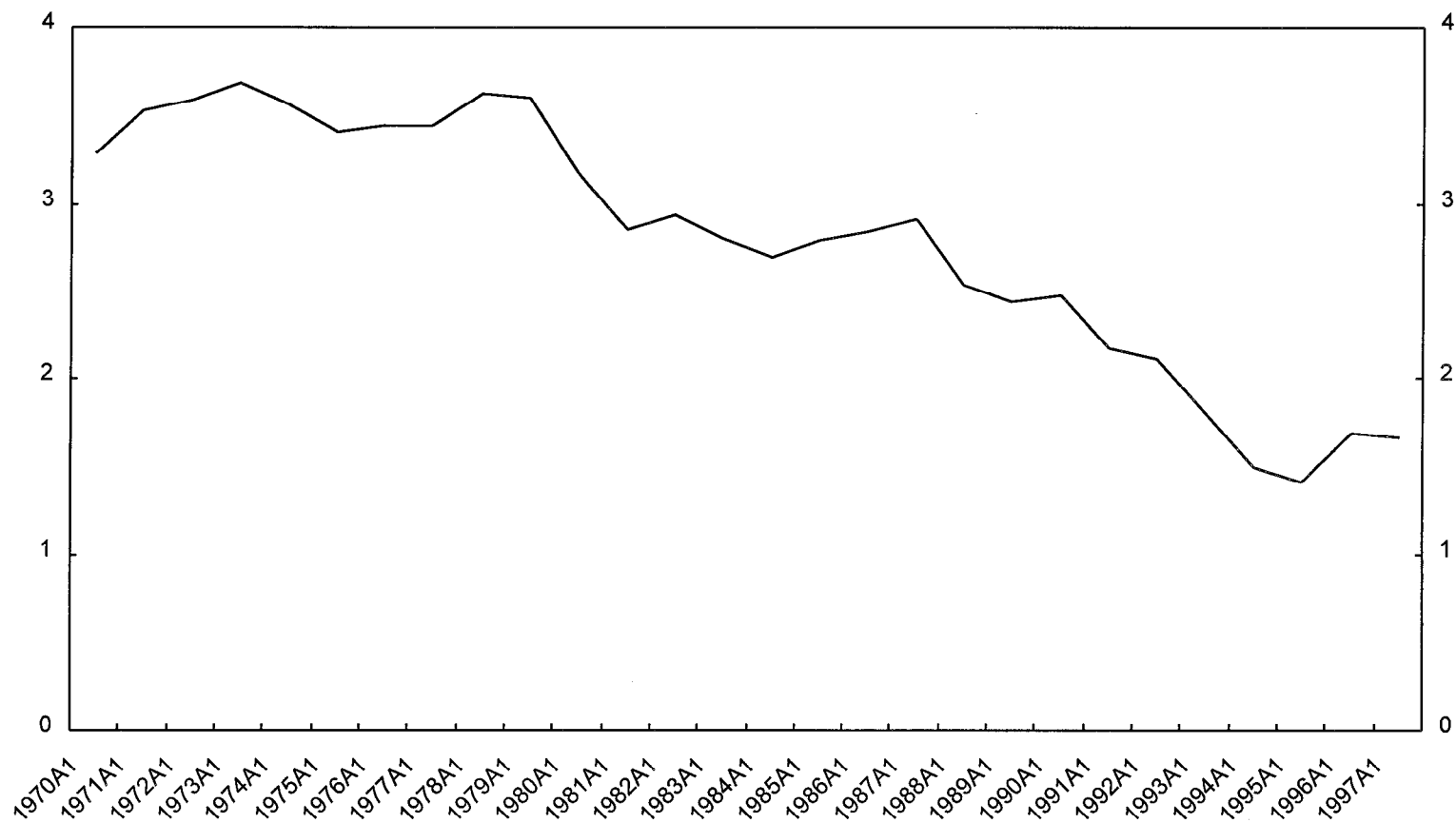
Source: IMF, International Financial Statistics.

1/ Calculated as the ratio of reserves to nominal GDP; annual averages for the following countries: Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, and the United States.

Figure 4. Currency Held by the Public
(In percent of GDP)
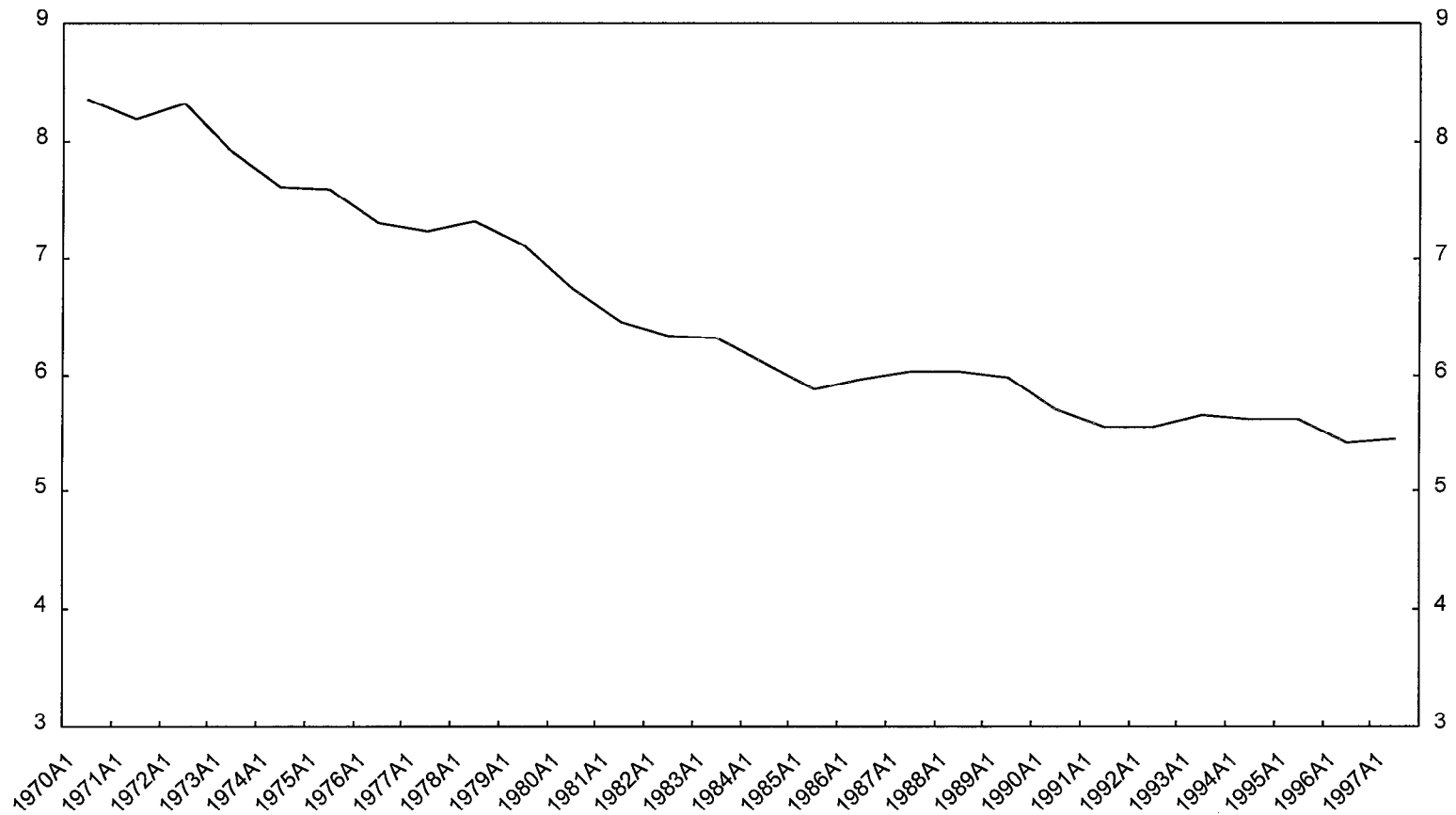
Source: IMF, International Financial Statistics.

1/ Calculated as a percentage of currency to nominal GDP; annual averages for the following countries: Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, and the United States.

Figure 5. United States: Bank Holdings of Treasury Securities and the Size of the Repo Market

——— Overnight and Term Repos (Left scale)

········· Bank Holdings of Treasury Securities to Bank Reserves (Right scale)
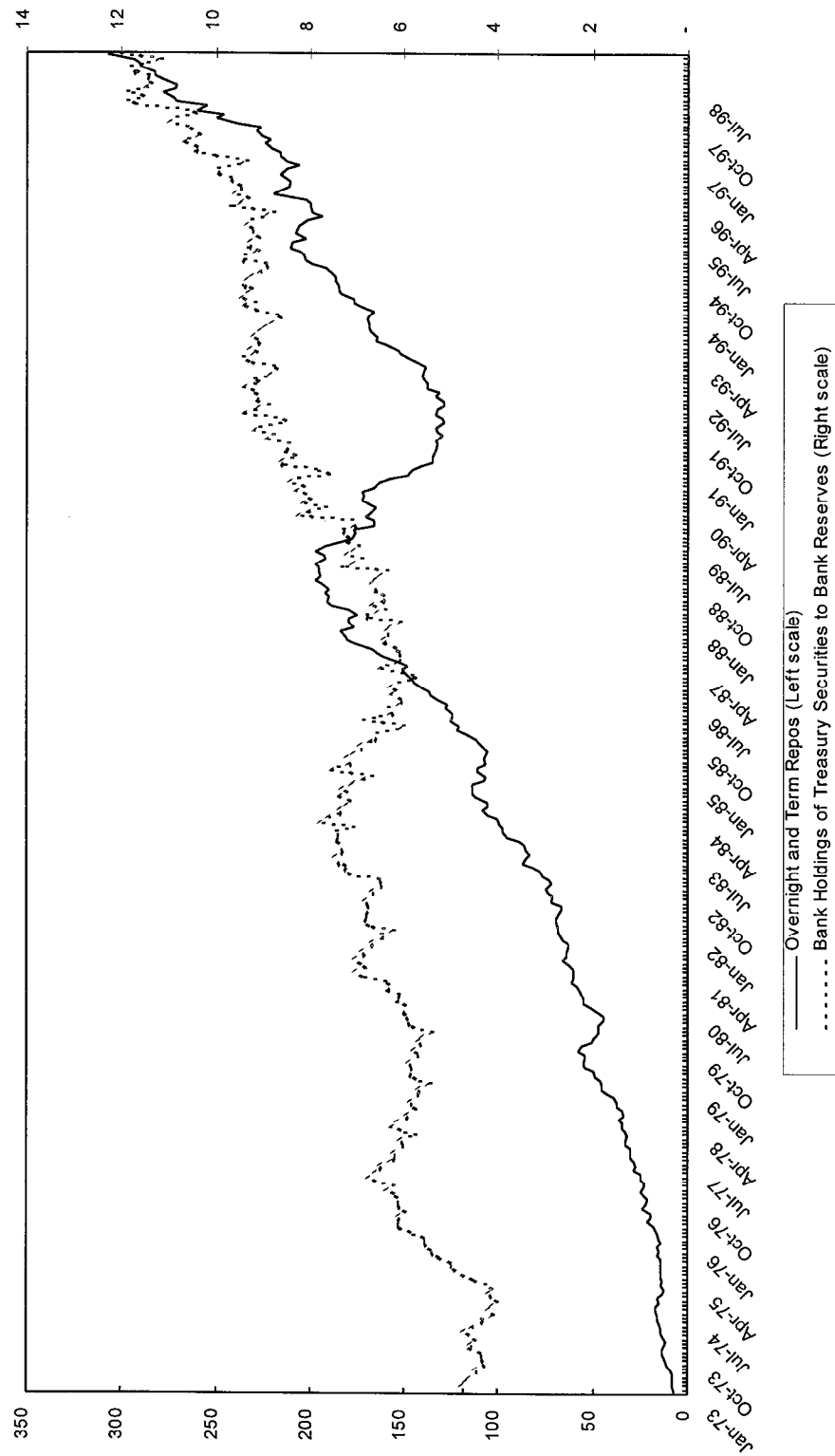
Source: U.S. Federal Reserve Bank of New York.

Table 1: Turnover in Selected Large-Value Payment Systems
(Billion of U.S. dollars, at annual rate)

Country		1996	Rate of Growth (in percent)	
			Since: 1988	1992
Canada:	IIP (Net)	11,309	340.1	52.7
France:	SAGITTAIRE (Net)	21,722	777.6	92.4
Germany:	EAF/EAF2 (Net)	98,669	513.8 1/	84.4
	IL-ZV (RTGS)	18,487	554.5	110.0
Japan:	FEYCS (Net)	78,788	128.2	38.1
	BOJ-NET (RTGS)	357,336	75.1	8.3
Sweden:	RIX (RTGS)	10,146	723.0	75.7
Switzerland:	SIC (RTGS)	28,658	50.7	13.8
U.K.:	CHAPS (RTGS)	45,104	155.8	38.0
U.S.A.:	CHIPS (Net)	331,541	100.4	39.1
	Fedwire (RTGS)	249,140	55.7	25.1

Source: Statistics on Payment Systems in the Group of Ten Countries, BIS, December 1993 and 1997, and staff calculations.

1/ The figure refers to 1990.

Table 2: Turnover in Securities Settlement Systems
(Value of transactions/GDP ratio, at annual rate)

Country	1992	1996	Growth (%)
Belgium	2.5	11.3	352
Canada	18.9[93]	45.5	141
France	3.2	13.2	313
Germany	1.5	4.5	200
Italy	2.8	15.9	468
Japan	6.2	9.4	52
Netherlands	0.5	1.1	120
Sweden	29.3[94]	39.6	35
Switzerland	1.1	3.2	191
U.K.	14.9	37.4	151
U.S.A.	25.7	27.8	8

Source: Statistics on Payment Systems in the Group of Ten Countries, BIS, December 1993 and 1997, and staff calculations.

materialize in the foreseeable future. It then examines how central banks would conduct monetary policy in such a world, both in terms of achieving their final targets and conducting their day-to-day monetary operations. The paper concludes by drawing some lessons about current central bank operations and possible insights about ways in which these are likely to evolve.

The paper exclusively focuses on the demand for reserves by financial intermediaries (i.e., the wholesale side of the payments system), which is at the core of the monetary transmission mechanism in modern economies. A similar process of innovations in payment technology is leading to the gradual substitution of currency by noncash means of payment, including electronic money (Tables 3 and 4).[5] This trend is likely to continue and may accelerate as financial transfers are increasingly conducted electronically, including through direct debits and Internet transactions.[6] Thus, in the long run, it is likely that currency will disappear altogether or only constitute a minute fraction of total money. However, even if a small residual demand for currency continues to exist, it is unlikely to play a substantial role in the formulation or conduct of monetary policy.[7] Indeed, in developed financial systems, currency is not a useful operational or intermediate target, nor does it constitute a relevant channel of transmission of monetary policy.

The paper is structured as follows. Section II discusses the demand for reserves by commercial banks. It first reviews the demand for intraday reserves in the context of recent payments system and risk management innovations. It then reviews the factors affecting the demand for overnight reserves and presents a simple model of demand for bank reserves which illustrates linkages with monetary operations. Section III looks ahead and examines how monetary policy might be conducted in a world without central bank reserves. It assesses how central banks might control their operational target (the interest rate) and final target (inflation). Section IV reviews the implications for a central bank's balance sheet of a paradigm without base money and examines how other central bank functions—lender of last resort and foreign exchange market interventions—can be performed in this paradigm. Section V concludes by drawing some lessons for present-day central banking. Starting from some reflections on what makes a central bank unique, it draws inferences on the design of monetary instruments, the coordination between monetary and public debt issues, and the design of currency board arrangements in a world in which the conventional monetary approach to the balance of payments no longer applies.

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[5]For a discussion of the impact of electronic money on central bank operations, see BIS (1996)

[6]See Norbert (1996).

[7]Note that, although wholesale payment systems have undergone important changes, the retail sector has been relatively slow to adopt new technologies. For example, the far-sweeping reforms and changes which many people predicted in the 1960's and 1970's did not take place. See Flannery (1996).

Table 3: Use of Various Cashless Payment Instruments 1/
(Value of transactions per GDP)

Country	1988	1992	1996
Belgium	22.7	28.3	36.9
Canada	29.1	31.6	20.2
France	30.6	35.5	38.5
Germany	49.5	61.3	63.6
Italy	9.4	21.2	34.6
Japan	N/A	92.6	99.3
Netherlands	37.2	33.6	35.1
Sweden	4.4	4.4	4.2
Switzerland	97.3	100.9	108.8
U.K.	50.0	42.4	43.2
U.S.A.	79.1	82.1	87.9

Source: Statistics on Payment Systems in the Group of Ten Countries, BIS, December 1997, and staff calculations.

1/ These include cheques, debit and credit cards, credit transfers, direct debits, and others.

Table 4: Relative Importance of Transfers (Credits and Direct Debits) as Means
of Cashless Payment Instruments
(Percent of total cashless payments, 1996)

Country	Volume	Value
Belgium	69.2	96.0
Canada	14.3	2.0
France	27.5	93.7
Germany	89.4	98.2
Italy	50.5	95.6
Japan	N/A	N/A
Netherlands	76.4	99.7
Sweden	85.2	98.5
Switzerland	77.7	99.9
U.K.	38.0	95.5
U.S.A.	3.7	88.6

Source: Statistics on Payment Systems in the Group of Ten Countries, BIS, December 1997,
and staff calculations.

II. THE DEMAND FOR BANK RESERVES

A. Payments System Developments and the Demand for Intraday Reserves

There are three main ways to effect interbank payments. Payments can be cleared bilaterally (through correspondent accounts), with net end-of-day balances being settled centrally on the books of the central bank.[8] Alternatively, banks can channel their payments through a clearinghouse, their accounts at the clearinghouse being debited and credited throughout the day as incoming or outgoing payments are registered. Intra-day net debit/credit positions remain provisional until the end-of-day multilateral clearing when banks settle their "net-net" positions through their accounts with the central bank. Third, banks may settle individual payments in real-time through their accounts at the central bank if a real-time gross settlement (RTGS) system is available.

From a risk management perspective, the main difference between net and gross payments systems is that only a gross system can ensure "finality," i.e., a payment that has been processed through an RTGS system is final and irreversible. Instead, in a netting system, payments may be reversed due to the inability of a net debtor bank to settle its end-of-day obligations. The latter can occur due to "technical" failures, short-term liquidity difficulties, or outright bankruptcy. Settlement failures may require an unwinding of transactions, with possible domino effects on other banks. Thus, gross settlement systems are safer than netting systems.

The main benefit of netting, of course, is that it limits the need for (unremunerated) settlement balances. In a netting system, inside (or "credit") money is created continually as banks with net credit positions provide implicit intraday credits to banks with net debit positions. Clearinghouse money is strictly endogenous; it expands or contracts as needed to accommodate the volume of transactions and the changes in the distribution of net debit positions among participants. At the same time, clearinghouse money is only needed as an information device that keeps track of who owes what to whom. It is a *process*, rather than a *stock*.

Total transactions volume in a clearinghouse can thus reach staggering levels in proportion to final settlements. In the case of CHIPS, the New York-based large value clearinghouse, the daily value of payments is well over a trillion dollars while net-net

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[8]This is often feasible when the total number of banks is small and the electronic payments clearing between banks is well-developed. The payment instructions are processed centrally at each bank and sent to other banks usually in the form of batch transfers several times each day. Banks establish bilateral credit lines to one another to cover intraday shortfalls in liquidity. Intraday credits may or may not be collaterized.

settlements generally reach a few billion dollars.[9] As each payment must be cleared separately, gross settlement systems are clearly more "reserve-intensive." For example, in the case of the U.S. Fedwire system, the ratio of the total volume of daily transactions to the average daily overdraft (as a proxy for settlement balances) is comparatively much smaller (around 16 in 1994) than the ratio of the daily transactions volume to daily final settlements in CHIPS.

However, under the twin pressure of regulators for limiting settlement risk and market forces for limiting settlement costs, differences between gross and net systems have tended to wither away. On the one hand, observance of Lamfalussy standards for netting systems has considerably reduced settlement risk in such systems.[10] In particular, clearinghouses have been required to: (i) introduce bilateral or multilateral caps that limit the exposure of clearinghouse participants to any member with large net debit balances; (ii) form common pools of securities that can be used as collateral to obtain liquidity support; and (iii) formulate loss sharing arrangements which ensure that settlement can be successfully completed in all but the most extreme cases. In addition, clearinghouses are advised to settle more often.[11] On occasion, clearinghouses have been requested to adopt fail-proof standards, for example individual net debit caps which limit the net debit any participant can have at any time to the liquid collateral it has deposited with the clearinghouse or the central bank.[12]

At the same time, to reduce the need for intraday liquidity, some RTGS systems provide sophisticated queueing algorithms. In other cases, central banks provide intraday liquidity to banks with debit positions, sometimes at a cost and usually against appropriate collateral. Thus, when the provision of intraday liquidity is automatic, payments are cleared on the central bank's books in much the same way as they would in a private clearinghouse with fully collateralized individual net debit caps. Banks' net clearing position can fluctuate freely as long as it remains within the debit cap limit.

Moreover, if there are no reserves leakages outside the banking system (i.e., no unsterilized operations between banks and the central bank or the treasury), for every bank with a credit balance on its central bank account, there must be another bank with a debit balance. As in the case of a private clearinghouse, changes in day-to-day settlement balances in the central bank's books must sum up to zero (the sum of all "due to's" and all "due from's" is identically zero). Thus, provided that an efficient interbank market for central bank money exists, debtor banks can borrow from creditor banks the reserves they need to close

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[9]In 1998, average daily transactions reached US$1.2 trillion while net end-of-day settlements amounted to only US$7 billion, i.e., a ratio of 171. See Richards (1995).

[10]See Bank of International Settlements (1990).

[11]In the extreme case of continuous settlement, net clearing systems become gross systems.

[12]This is the case, for example, of Argentine clearinghouses.

their positions at the end of the day or at any time during the day. In particular, when clearing and settlement times are set to allow for the existence of a pre-settlement money market, banks with a net debit position can obtain in the interbank market the reserves they need to close their end-of-day balances.

In addition, when debtors and creditors do not find each other or can not agree on a reasonable price, central banks can act as "brokers" to recycle the missing reserves from creditors to debtors. Creditor banks can deposit their surplus reserves in a deposit facility at the central bank and those reserves can be borrowed back by debtor banks, with some intermediation spread, through a Lombard-type collateralized credit facility. Hence, the banking system as a whole can, in principle, clear and settle with little or no reserve balances, even when payments are made on a gross, rather than net, basis.

At the same time, *treasury money* is rapidly becoming an alternative monetary unit to central bank money as a liquid reserve asset. Paralleling the developments in the interbank market, the turnover of securities settlement systems, primarily with treasury bills, has grown extremely rapidly (Table 2). Banks can obtain funds in the money market by conducting repurchase operations with treasury bills, which have same-day settlement, or by selling treasury bills for liquidity. Progress in book-entry and payment systems that allow delivery-versus-payment of securities in real time and electronic broker systems that allow banks to find market counterparts nearly instantaneously have greatly reduced transaction costs, thereby contributing to the creation of a deep and liquid market for government securities.

The increased liquidity of securities has thus provided banks with a superior substitute for central bank reserves. Instead of holding unremunerated settlement balances, banks hold liquid securities which they can use at any time to borrow the settlement balances that they exactly need to avoid end-of-day overdrafts in their current account at the central bank. As a result, the volume of treasury securities held in the books of commercial banks in the U.S. (hence available for repurchase operations) has increased very rapidly and is now twelve times their reserve money balances.[13] At the same time, the growth of the treasury bill repo market in the U.S. has been spectacular, particularly in the 1990s (Figure 5).

Since it is the unit of account, central bank money has an intrinsic advantage over treasury money in that its nominal value does not fluctuate over time. In contrast, the market value of other securities (such as treasury bills) fluctuates, reflecting changes in market conditions. Should banks be obliged to engage in outright purchases or sales of securities for settlement purposes, price volatility would limit the liquidity of securities compared to settlement balances. Repurchase operations are not subject to such constraints, however. The risk associated with price volatility, which is small in the case of short-term bills, can be

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[13]The stock of treasury securities held by banks in the U.S. at the end of 1973 was 91 billion U.S. dollars, compared to central bank reserves of 38 billion U.S. dollars, a ratio slightly over 2:1. Comparable figures for 1998 were 790 billion U.S. dollars and 65 billion U.S. dollars, respectively, i.e., a ratio of 12:1.

factored in the repurchase contracts through the use of margins (haircuts). Thus, the only cost to a bank of holding treasury bills rather than central bank balances is the opportunity cost of the additional bills that are needed to constitute the margins. This cost—particularly in the case of short-term bills (less than a year)—is clearly of a second order of importance compared to the opportunity cost of holding fully unremunerated settlement balances instead of remunerated treasury bills.

B. Monetary Operations and the Demand for Overnight Reserves

Banks demand overnight reserves partly because they are required to. In most countries depository institutions are still required to hold a (usually small) fraction of certain deposits as vault cash or as a reserve balance with the central bank.[14] While the *heavy duty* monetary regulation capacity of reserve requirements provided the traditional justification for their use, the residual role of reserve requirements in the most advanced market economies is derived instead from their use as *liquidity buffers*.[15] [16] When required reserves are averaged over a holding cycle, banks can absorb both idiosyncratic and systemic liquidity shocks by allowing their reserves to fall below (rise above) the required average level in the case of liquidity shortfalls (surpluses). By raising the interest rate elasticity of the demand for reserves, this reduces the impact of daily liquidity shocks on interest rate volatility during the holding cycle.[17]

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[14]Readers interested in analyses of reserve requirements are referred to Borio (1997), Hardy (1993), and Kuosmanen (1997).

[15]When banks must meet their settlement obligations by the end of the day, the demand for settlement balances is typically very insensitive to changes in the overnight rate over its typical range of variation, which implies that the overnight rate can become more volatile when reserve requirements are not binding. Recent experiences seem to confirm this prediction. For example, the volatility of the Federal funds rate rose sharply at the end of 1990 around the time of the Federal Reserve's cut of reserve requirements.

[16]In countries with unsound banking systems and weak bank supervision, the use of reserve requirements has also been advocated on prudential grounds, i.e., to ensure that banks hold a minimum liquidity that can be used to avoid undermining the payments system when a bank becomes illiquid or bankrupt. In some cases, the use of unremunerated reserve requirements has also been advocated as an additional source of seignorage revenue. However, if the aim of reserve requirements is strictly to generate quasi-fiscal revenue, a better targeted—hence more efficient—alternative would consist in directly taxing banks in proportion to their liabilities, without freezing their deposits. The seignorage issue, which is relevant to a central bank which no longer issues monetary liabilities—hence loses its seignorage on currency emission—is briefly addressed in Section III-C.

[17]Under an averaging system, the demand for reserves becomes very elastic around the level

At the same time, however, reserve averaging usually increases end-of-holding-period volatility, as banks need to make up for unexpected accumulated reserve imbalances.[18] Moreover, averaging makes the demand for reserves more responsive with respect to *expected* changes in interest rates, which may also raise daily interest rate volatility, particularly when central banks allow the supply of liquidity to fluctuate during the holding cycle.[19] In addition, higher required reserves can reduce the depth and liquidity of the money market by limiting incentives for trading in this market, thereby hampering the conduct of open market operations. These difficulties, together with the high cost to banks of unremunerated reserve requirements—and the incentives this provides for circumventing the regulations—have led most countries to steadily reduce reserve requirements. As the buffer capacity of reserve requirements depends on the characteristics of averaging rules rather than on the level of reserve requirements, zero reserve requirement regimes have been introduced in some countries. In other countries, reserve requirements have been eliminated altogether.[20]

In the absence of reserve requirements, banks' residual demand for overnight settlement balances is mainly precautionary. Without uncertainty about payment transactions, a bank could plan perfectly ahead and always have the exact amount of reserves necessary.[21] However, with uncertainty, a bank needs to minimize the risk of incurring a penalty over the ongoing market rate when unable to meet settlement obligations by the end of the day.

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[17](...continued)
of the rate expected to prevail in the immediate future.

[18]These theoretical predictions are confirmed by a number of empirical studies. Poole (1968) investigates the U.S. Federal funds market and finds that, "the standard deviation of the Federal funds rate increases day by day over the [reserve averaging period]." Spindt and Hoffmeister (1988) also find evidence that the variance of the overnight rate is higher towards the end of each business day and is highest near the end of settlement days. See also Borio (1997) and Sellon and Weiner (1996, 1997).

[19]An interesting illustration of this effect for Finland can be found in Valimaki (1998).

[20]Countries which currently do not have reserve requirements in place are Belgium, Kuwait, Norway, Switzerland, and the United Kingdom (see Fry et al., 1999). Canada and Mexico have introduced zero reserve requirement regimes.

[21]There exists a wealth of papers analyzing a bank's reserve management problem under payments uncertainty. Prominent among these are Orr and Mellon (1961), Poole (1968), Baltensperger (1974), Baltensperger and Milde (1976), and Stanhouse (1986). A dynamic treatment of the problem is presented in Ravalo (1995). Baltensperger (1974, p. 205) argues that, "in many instances the degree of 'knowledge' or 'certainty' about reserve changes is, to a certain extent, subject to the control of the decision maker. One of the main functions of precautionary reserves is, therefore, to save on planning and information costs."

The extent of uncertainty depends on the institutional and operational characteristics of payments and settlements and the depth and liquidity of the interbank money market. Indeed, as noted earlier, when the settlement system provides for a period of borrowing and lending among money market participants after the final positions of the day become known, the need for holding precautionary reserves is much reduced. Nevertheless, even in this case, some residual demand for reserves may exist due to market imperfections. Debtor banks may be unable to locate a potential lender in time or lenders may not offer loans at suitable conditions. This may be in part due to strategic considerations. When the last remaining creditor bank in the market must negotiate a price at which to lend resources to the last remaining debtor bank, a game situation arises in which the creditor bank may adopt a noncooperative behavior (i.e., be tempted to corner the debtor bank), rather than a cooperative behavior (under the understanding that the borrowing bank will later reciprocate when the roles become inversed).[22]

Uncertainty is also affected by the quality of the central bank's day-to-day liquidity management, i.e., the extent to which it systematically offsets through open market operations the liquidity shocks caused by its own operations (such as exchange market interventions or rollovers of outstanding obligations with the market), fluctuations in the treasury's account at the central bank, or day-to-day fluctuations in demand for currency. A central bank that injects or contracts liquidity erratically on a day-to-day basis induces banks to maintain higher precautionary balances because it increases the likelihood that debtor banks will be unable to locate in the market the funds needed to square their position at the end of the day. Instead, a well-behaved central bank is just like any other participant in the interbank market: to avoid introducing noise in the market, it must pay for all its regular operations (including those it conducts for the treasury) by borrowing in the market, rather than by creating new money; similarly, it must systematically reinject the funds it receives in payment from other banks, rather than allowing money to leak out of the system.

While banks' demand for reserves is, thus, a reflection of central banks' skills in limiting market noise, it also ultimately depends on central banks' willingness to cover end-of-day imbalances at low cost to the banks, i.e., on the *reward-penalty structure* of the central bank standing facilities that are designed to deal with end-of-day reserve shortfalls or surpluses. Banks demand higher reserves if this structure is biased towards penalties rather than rewards, i.e., if the rate on reserve shortfalls is highly penal in relation to market rates while the remuneration on reserve surpluses is at close to market rates.

At the same time, central banks can induce money market participants to demand higher reserves—and money market rates to rise—by conducting intraday borrowing so as to leave the market short of liquidity by the end of the day. When this is known to market

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[22]The literature has very little to say about such strategic issues affecting bank behavior, how they relate to the demand for reserves, and how payment system developments fit into the picture.

participants, the perceived probability that some of them will be forced to access—at penalty rates—the central bank's end-of-day liquidity support increases. Banks' attempt to avoid such penalties can induce an immediate increase in the money market rate. The simple model of demand for bank reserves under payments uncertainty which is developed in the next section illustrates these points. At the same time, it can be used to infer a number of useful implications for the conduct of monetary policy.

C. Simple Model Of Demand for Bank Reserves

Suppose that the representative risk-neutral bank has beginning of day settlement balances (i.e., deposits net of long-term loans), D, and needs to decide at the beginning of the day how much to invest in the overnight money market at the interest rate r^* and how much to maintain as excess reserves, R^d, knowing that, in case of shortfalls, it must access a central bank discount window, at a rate r', and in the case of surplus reserves, it can deposit them in a central bank deposit facility at a rate r''.[23] In the absence of expected liquidity leakages or injections by the central bank, end-of-day settlement needs are symmetrically distributed around zero for the representative bank, i.e., a bank has equal probability of ending the day with a surplus or a shortfall. However, with liquidity leakages (injections), the representative bank would expect the end-of-day distribution of settlement balances to be skewed toward a net debit (credit) position. Hence, assuming for simplicity a uniform distribution, end-of-day clearing positions are distributed between $-v+u$ and $v+u$, with $u < 0$ if net liquidity leakages are expected, and $u > 0$ in the case of net injections. For end-of-day clearing positions comprised between $-R^d$ and $v + u$, the bank has excess balances to deposit; for clearing positions between $-v + u$ and $-R^d$, the bank must borrow from the credit facility. Thus, the bank chooses its reserves to maximize profits, P, such that:

$$P = r^*(D-R^d) + \frac{r''}{2v} \int_{-R^d}^{v+u} (R^d + x)dx + \frac{r'}{2v} \int_{-v+u}^{-R^d} (R^d + x)dx \qquad (1)$$

which, after integration, becomes:

$$P = r^* (D-R^d) + \frac{r''}{2v} \left[R^d x + \frac{x^2}{2} \right]_{-R^d}^{v+u} + \frac{r'}{2v} \left[R^d x + \frac{x^2}{2} \right]_{-v+u}^{-R^d} \qquad (2)$$

and simplifies further to:

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[23]The model developed in this section is in the tradition of the models of demand for bank reserves under payments uncertainty that were first proposed by Poole (1968).

$$P = r^* (D - R^d) + r'' \frac{(R^d + u + v)^2}{4v} - r' \frac{(R^d + u - v)^2}{4v} \qquad (3)$$

The bank expects to deposit $(R^d + u + v)^2 / 4v$ and to borrow $(R^d + u - v)^2 / 4v$. Since the inequalities that are implicit in the maximization problem, $-v + u < -R^d < v + u$, can also be written $-v < R^d + u < v$, it follows that a bank *ex-ante* always expects to borrow *and* deposit settlement funds. However, it expects to be a net depositor of funds (i.e., to deposit more than it borrows) when it expects to hold positive balances by the end of the day, i.e., $R^d + u > 0$, and to be a net borrower otherwise.

The first-order condition of this maximization problem is:

$$-r^* + \frac{r''}{2v} (R^d + u + v) - \frac{r'}{2v} (R^d + u - v) = 0 \qquad (4)$$

or, rearranging terms:

$$R^d + u = 2v \left(\frac{r' + r''}{2} - r^* \right) / (r' - r'') \qquad (5)$$

Thus, the demand for reserves increases when the central bank is expected to leave the market short by the end of the day ($u < 0$). It also rises with the uncertainty associated with daily settlements (parameter v in the model). Factors that reduce payment uncertainty such as an efficient interbank market (including a deep T-bill market that effectively eliminates credit risk), suitable clearing and settlement arrangements (i.e., the existence of a pre-settlement market in which banks can actively trade *after* end-of-day net positions become known), and a neutral and reliable central bank liquidity management (which systematically offsets the monetary impact of its own operations and usually avoids leaving the market short or long in the aggregate) ought to reduce the demand for reserves.

The demand for reserves is also a function of the central bank standing facilities' penalty/reward structure. Banks demand positive reserves, including the end-of-day expected reserve injections, if the mid-point of the central bank's intervention band, $(r' + r'')/2$, is above the money market rate, hence if the penalty associated with a reserve shortfall is higher

than that (i.e., the opportunity cost) associated with surplus reserves.[24] Provided there are no quantitative limits on accessing the central bank lending window or non-pecuniary costs associated with such borrowing, a penalty-reward structure which is symmetric around the interbank rate eliminates the need for reserves.[25] In this case, the central bank remains in a neutral position with respect to the market. On a net basis, it neither borrows nor lends end-of-day settlement funds from or to market participants. Its role is instead limited to occasionally recycling funds from net debtors to net creditors when they are unable to do it in the market.

In equilibrium, the demand for bank reserves, R^d, must equal the supply of reserves, R^s, as determined by the central bank's monetary policy. Setting $R^d=R^s=R$, (5) can be solved to give r^* as a function of R:

$$ r^* = \frac{r' + r''}{2} - \frac{(r' - r'')}{2v} (R + u) \tag{6} $$

This expression leads to a number of interesting conclusions. First, the model is consistent with the existence of a liquidity effect, in the sense that an actual contraction (R) or expected contraction (u) of liquidity by the central bank leads to an increase in the money market rate.[26] In particular, the central bank can induce an increase in the money market rate by announcing it will leave the market short. In addition, day-to-day monetary disturbances, due to stochastic changes in u, are reflected in day-to-day interest rate volatility, with the variance of the money market rate linked to the variance of the monetary disturbances through the following expression:

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[24]Note that the central bank's discount rate can be lower than the money market rate, as in the case of the U.S., when there are significant non-pecuniary costs to accessing the discount window. For more on the use of Federal funds versus the discount window as a borrowing source, see Ho and Saunders (1985) and Smirlock and Yawitz (1985).

[25]When excess reserves are not remunerated, symmetry leads to the familiar result that the central bank's lending rate must equal twice the money market rate.

[26]The existence of a liquidity effect has been on the research agenda for some time and experienced a strong revival in the 1990's. While not always conclusive, the evidence is generally in favor of the existence of a liquidity effect, that is, additional reserves do lower the interbank interest rate. Empirical results were not satisfying until researchers distinguished between non-borrowed and borrowed reserves and accounted for the endogeneity of borrowed reserves. For key papers in this area, see Leeper and Gordon (1994), Chari, Christiano, and Eichenbaum (1995), and Hamilton (1997).

$$var \ r^* = \frac{(r' - r'')^2}{4v^2} \ var \ u \tag{7}$$

From this expression, it can be noted that while interest rate volatility can be reduced through a narrower intervention band, it is not affected by the positioning of the band with respect to the market rate (i.e., by the penalty/reward structure). In particular, inducing banks to hold larger reserves, through accentuating the penalty bias, does not result in lower interest rate volatility. At the same time, however, a reduction in uncertainty (as reflected in a lower v) would result in higher interest rate volatility, unless offset by a narrowing of the band, r' - r", or a more effective day-to-day liquidity management by the central bank that limits the variance of monetary disturbances, var u. Thus, more effective payment arrangements and deeper money markets must go at a par with a more careful liquidity management by the central bank.

The central bank can induce a change in the interbank rate by directly moving its intervention band, rather than affecting liquidity. An upward shift in the band, at the initial money market rate, gives rise to a contraction of interbank lending, as banks strive to increase their end-of-day expected reserves. When the penalty-reward structure is symmetric (i.e., when $R^d+u=0$), the interbank rate rises by the same amount as the central bank's intervention rates. While this looks like pure signaling (there is no measurable liquidity effect), the underlying adjustment is nevertheless based on liquidity: the increase in the central bank's intervention rates discourages banks, at the initial money market rate, from accessing the central bank overnight lending window, thereby reducing the supply of loanable funds in the interbank market and raising the money market rate.[27] Thus, signaling and liquidity effects should be viewed as *complements*, rather than *alternative* interpretations of the monetary transmission mechanism, as sometimes depicted in the literature.

Thus, this model of demand for bank reserves suggests that monetary policy functions in a way that bears little resemblance with the traditional quantity theory framework. A positive stock of central bank money is not needed for monetary policy to be effective. The central bank can affect the interest rate irrespective of the level of reserves. Moreover, the central bank can control the demand for reserves through its standing facilities. Targeting zero reserves is attractive in that it normally leaves the central bank out of the market for settlement balances and limits its role to that of a *broker of last resort,* i.e., to recycling reserves between market participants when they are unable to find a mutually agreeable price at which to trade in the market. In addition, central banks can affect interest rates without

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[27]For discussions on signaling see Borio (1997), and Hardy (1997, 1998).

actually changing the stock of outside money; instead, they can do so by announcing changes to their intervention bands, i.e., through pure signaling.[28]

These features seem to be well corroborated by emerging trends. Central banks' capacity to control money market rates does not seem to have been affected by the steady reduction in bank reserves, as illustrated by the observation that there is a very large dispersion in the magnitude of bank reserves held by central banks in industrial countries (Table 5). Indeed, European central banks that operate with minute bank reserves appear to be at least as successful in limiting daily interest rate volatility as those that operate with large reserves (Figure 6). To limit interest rate volatility and guide interest rates, the use of symmetric interest rate intervention bands is on the rise, with a number of central banks, including the Bank of Canada, the European Central Bank, and others, having opted for such a system. The importance of signaling and the ability of central banks to "talk" the market into accepting rate changes through a variety of signals but without conducting a single monetary operation, has also been well documented by a number of observers.[29]

III. Looking Ahead: Conducting Monetary Policy Without Base Money

A. Operational Targeting

How then can central banks conduct monetary policy in a moneyless world? In terms of operational targeting—i.e., the central bank's capacity to affect short-term interest rates—the key is that the central bank remains the uncontested broker/lender of last resort in the case of settlement difficulties, and controls the rates at which it engages in such operations. Should the money market always clear at the end of the day as a closed system (i.e., without net liquidity injections or contractions by the central bank), a private broker—rather than a central bank—could, in principle, facilitate the recycling of liquidity and post for such transactions an interest rate band that might differ from that of the central bank. Conceivably, a situation could even arise in which settlement brokers would freely compete in the money market. In this case, there could be several competing monetary policy "directors." The broker with the lower intermediation spread (i.e., the more efficient), or a

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[28]The model presented here is a gross simplification of reality and can be extended in many ways. In particular, transaction costs, non-pecuniary costs to accessing the central bank's lending window, limits on access, or non-linear schedules for borrowing from this window can be introduced, as in Poole (1968), Baltensperger (1974), Baltensperger and Milde (1976), and Stanhouse (1986). However, these more complete analyses do not yield substantially more insight.

[29]For example, the Swiss central bank uses a deactivated discount window facility to provide guidance on interest rates. For details, see Borio (1997).

Table 5: Banks Reserves Held at the Central Bank
(Percent of narrow money)

Country	1988	1992	1996
Belgium	N/A	0.16	0.13
Canada	5.57	2.60	0.65
France	4.54	0.46	0.40
Germany	13.37	12.90	4.30
Italy	25.75	23.90	11.60
Japan	3.45	2.10	1.80
Netherlands	N/A	13.00	8.30
Sweden 1/	3.95	1.40	0.20
Switzerland	7.09	3.60	3.30
U.K. 2/	0.38	0.40	0.50
U.S.A.	4.92	3.10	2.20

Source: Statistics on Payment Systems in the Group of Ten Countries, BIS, December 1997, and staff calculations.

1/ The monetary aggregate used is M3.
2/ The monetary aggregate used is M2.

Figure 6. European Union: Overnight Interest Rate Volatility and the Level of Reserves
(Dec. 1993-Dec. 1994)
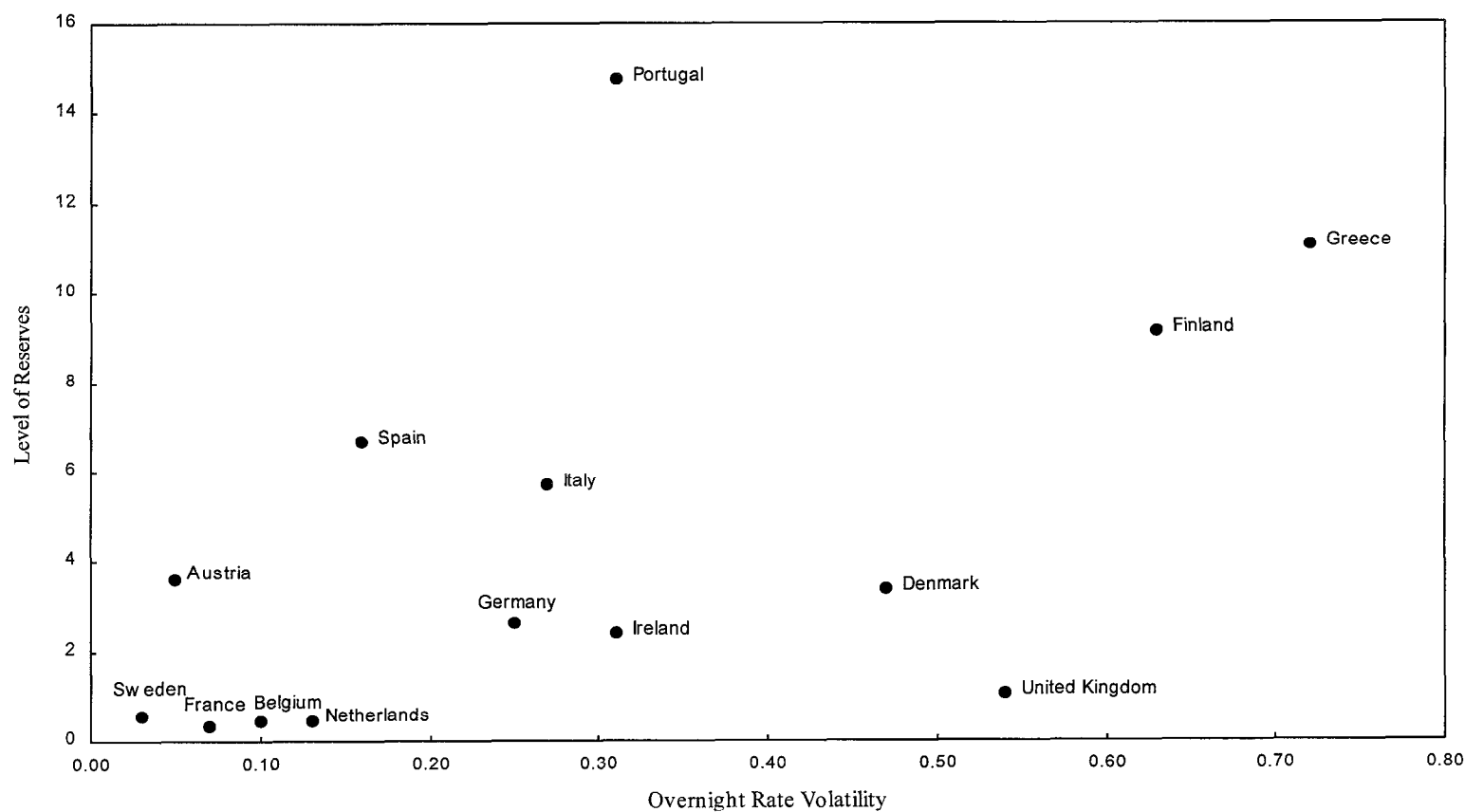
Sources: IMF, International Financial Statistics; and Escrivá and Fagan (1996).

Note: *Overnight interest rate volatility*: daily standard deviation of deviation of overnight market rates from official rates. *Level of reserves*: reserves as a percentage of GDP.

more "credible" interest rate (i.e., a rate which is viewed by the market as more consistent with prevailing macroeconomic conditions), could well take over monetary policy from the central bank.

This will not happen, however, as long as settlement occurs as a two-stage process. In the first stage, all end-of-day net credit positions in the clearinghouse *must be lent overnight* to the central bank at the rate it chooses to set. In the second stage, the central bank on-lends these balances to the participants with net debit positions, thereby securing final settlement with zero balances for all participants. Thus, no entity but the central bank can create an artificial shortage (surplus) of settlement money by borrowing (lending) intra-day and accumulating end-of-day credits (debits) on its clearinghouse account. For this, whether banks effect their final settlement on the books of the central bank or on those of a private clearinghouse is immaterial.

What matters is that the central bank remains, by law or regulation, the *only entity which is allowed to "corner" the market for settlement balances* by forcing participants to lend or borrow from its end-of-day settlement facilities at the rates it chooses to impose on the market. By taking positions in the intra-day market, a central bank acquires a unique "disciplining" capacity which bolsters the credibility of its interest rate announcements and ensures that no alternative private broker takes its place. In well developed markets, there should not even be a need for actually using this monopoly power. As the market learns to interact with the central bank, the threat of using this power should be sufficient to ensure the credibility of the monetary signals.

Thus, one could conceive a system in which private clearinghouses settle automatically, net creditors earning overnight interest on their balances and net debtors paying overnight interest on theirs.[30] This would de facto amount to automatic recycling of settlement funds at rates set by the central bank. All such transactions would need to be covered by automatic repo operations with treasury bills and duly secured by central bank lender of last resort support, in the way described in the next section. Finality would thus be insured through exchanging ownership of treasury bills in the book-entry system, rather than settlement balances on the central bank's books. In this way, the netting process would extend indefinitely, subject to the availability of collateral (e.g., treasury bills), but without any central bank money.

In such a paradigm, should the central bank narrow down its intervention spread sufficiently, the settlement market would eventually vanish as incentives to find counterparts in the market—rather than relying on the automatic end-of-day adjustments at the central bank windows—would disappear. At the same time as it would ease banks' day-to-day liquidity management, this procedure would allow the central bank to control the overnight interest rate in the simplest possible manner.

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[30]A settlement system with such characteristics has been recently introduced in Malaysia.

One potential drawback of the disappearance of the overnight money market is that it might hinder the central bank's ability to detect changes in financial conditions or market sentiment at an early stage. However, when a deep short-term interbank repo market exists, it is not clear that the overnight money market provides much additional useful information which is not already reflected in the repo market. Moreover, day-to-day variations in the spread between the overnight rate and the slightly longer repo rates mostly reflect noise associated with random liquidity disturbances, rather than useful signals of changes in market fundamentals. Hence, even when the changes in this spread are actually caused by underlying shifts in market fundamentals, they may be difficult to isolate from the background noise.

Another possible objection to the concept of a simple narrow-band system with little or no overnight settlement market is that it might oversimplify the signaling process and, hence, limit the breath of communication between the central bank and market participants. For example, before changing their keynote interest rate, central banks sometimes like to "test the waters," i.e., to conduct transactions at tentative interest rates in order to test the market's reactions, including that of the foreign exchange market. Also, at times of market upheaval, central banks may wish to let overnight rates deviate sharply from their keynote rate.[31] While this objection is potentially relevant, it is not necessarily unsurmountable. Other channels of communication may be established, through limited intervention in alternative markets—such as the repo market—or alternative ways to "talk to the market," such as purely signal-oriented facilities or through direct communication. Indeed, recent trends towards greater policy transparency and immediate "explanation" of policy decisions are important steps in this direction.

Summing up the discussion so far, it is thus fair to say that the scope for eliminating the market for settlement funds—which is the next logical step after eliminating central bank money—still appears at this point somewhat uncertain. Nevertheless, in terms of achieving the central bank's operational target, the presence or absence of central bank money should not, by itself, be a significant issue. The next question, to which we turn now, is whether a central bank can achieve its final target, inflation, in the absence of central bank money.

B. Inflation Targeting

With purely endogenous money, the price level becomes in principle indeterminate: any expected or actual price increase can be accommodated by an endogenous increase in money. However, the direct targeting in many central banks of inflation instead of monetary aggregates and the broad use of Taylor-type operating rules—i.e., the direct management of short-term interest rates to achieve longer-term inflation targets—provides prima facie

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[31]For example, in the context of an attack on the currency, central banks may wish to communicate that while they are ready to let short-term rates rise sharply, they view this increase as strictly transitory (i.e., interest rates should return to their "normal" level in the near future).

evidence that this concern is misplaced. The following bare-bones inflation targeting model illustrates why:

$$P = E(P) + v(Y - Y^*) \tag{8}$$

$$Y - Y^* = a(r^* - r) \tag{9}$$

$$R = r + P \tag{10}$$

$$R^* = r^* + P^* \tag{11}$$

$$R = R^* + b(P - P^*) \tag{12}$$

Equation (8) is the usual expectations-augmented Phillips curve, where P and $E(P)$ are actual and expected inflation, respectively, and Y and Y^* are actual and potential output. (9) is the IS schedule, where r is the current real rate of interest and r^* the Wicksellian "natural" rate of interest. (10) and (11) are standard Fisher equations which define the nominal rates of interest and (12) is a Taylor-type central bank reaction function, where P^* is the inflation target.

Substituting (9) in (8) and (10) and (11) in (12) leads to:

$$P - E(P) = av(r^* - r) \tag{13}$$

$$r - r^* = (b - 1)(P - P^*) \tag{14}$$

In turn, substituting (14) into (13):

$$P - E(P) = av(b-1)(P^* - P) \tag{15}$$

This equation shows that the targeted inflation is the only possible steady state equilibrium for which rational expectations hold (i.e., expected inflation equals actual inflation). While this does not prove that this equilibrium is globally stable, suppose that there is an inertial element in expectations (or in price formation), so that $\dot{P} = P - E(P)$. Then:

$$\dot{P} = av(b - 1)(P^* - P) \tag{16}$$

It is obvious that this dynamic equation is globally stable if $b > 1$, i.e., if the central bank raises the *nominal* real interest rate in response to an increase in inflation by enough to ensure that the *real* rate of interest rises as well, which is a familiar result of the inflation targeting literature.[32]

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[32]See Clarida, Gali, and Gertler (1997) and Bernanke et al. (1998).

Thus, what matters is that there is an appropriate monetary rule. The quantity theory equation, which, for a given money supply level, is the traditional monetary rule, is replaced by an alternative Taylor-type rule which directly links the interest rate to (expected) inflation. In terms of the traditional IS/LM model, the positively sloped LM curve is replaced by a direct policy determination of the interest rate, i.e., a horizontal line.

While the model above is too rudimentary to be anything more than suggestive, there is a growing literature that discusses the uniqueness and stability of equilibria in such general equilibrium Wicksellian models.[33] At the same time, while the operational applicability of such a framework requires some minimum preconditions, including central bank independence, adequate coordination with the fiscal authorities, and the existence of a somewhat predictable monetary transmission mechanism, its spread in recent years from industrial economies to emerging economies suggests that it is destined to rapidly become the norm rather than the exception.

IV. OTHER CENTRAL BANK FUNCTIONS

A. Central Banks' Balance Sheet in a Paradigm without Base Money

In a paradigm where a central bank does not issue or withdraw money (except perhaps marginally to strengthen monetary signals, as explained above), its balance sheet would look quite different from that of a conventional central bank. Consider, to clarify the argument, the case of a "bare-bones" closed-economy central bank in which settlements take place on the books of one (or several) private clearinghouse(s). Suppose, in addition, that the central bank has divested the management of treasury accounts to commercial banks.[34] In this case, all the central bank's traditional monetary liabilities, currency, required reserves, and excess reserves disappear from the liability side of its balance sheet (Figure 7-A and B). The central bank's only remaining liability is its capital, and its normal assets are claims on government, in the form of treasury bills or other securities. In addition, the central bank may have occasional claims on banks resulting from its "structural" lender-of-last resort operations (see below).

As any other clearinghouse participant, the central bank also has an intraday account with the clearinghouse. This account may deviate from zero during the first phase of

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[33]See in particular the path-breaking analysis in Woodford (1997), which shows that in a model where money vanishes a stable local equilibrium continues to exist for the rate of inflation even when money balances are zero.

[34]While central banks can continue to manage treasury accounts even if they do not issue their own money (these two functions are totally unrelated), the trend is towards the treasuries taking increasing responsibility for managing their liquidity in accounts with commercial banks.

settlement, when the central bank wishes to leave the system short or long in order to reinforce its policy signals. However, it always closes the day at zero. Thus, when the central bank wishes to reinforce the signal of a monetary policy tightening, it may do so by borrowing in the interbank market during the day, thereby leaving the market short and forcing banks to borrow from its lending facility at the end of the day. If the end-of-day lending is itself conducted through repo operations with treasury bills, the central bank's total claims on government remain unchanged. Thus, a tightening takes the form of a reduction in treasury bills repoed during the day, offset by an increase in treasury bills repoed through the lending facility. Once rates have risen, the central bank can gradually return towards a neutral policy stance in which it neither borrows nor lends at the end of the day.[35]

B. Lending of Last Resort

In addition to its monetary function, a central bank may provide lender of last resort support to secure settlements. It may do so in three ways. It may act as an end-of-day broker, in which case it acquires a claim on the debtor bank, collateralized by a treasury bill repo, and a liability towards the creditor bank, collateralized by a reverse repo operation. It may also leave the market short during the day and lend the missing funds through its end-of-day facilities when it wishes to reinforce its monetary policy signals, in the fashion described above. In both of these cases, which correspond to regular payments system support operations, its total treasury bill holdings and net claims on banks remain unchanged. Or it may provide "structural" liquidity support when a bank runs out of treasury bills to exchange against clearinghouse money at settlement time or to transact in the RTGS system. In this case, it swaps treasury bills from its portfolio against unsecured claims on a bank or against relatively illiquid collateral, such as commercial loans. The treasury bills can then be used by the commercial bank to continue operating in the payments system.[36] [37]

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[35]Notice that the debate as to whether central banks should conduct their monetary operations on the liability side or asset side of their balance sheet (i.e., leaving the system structurally long or structurally short) can be reinterpreted in the context of a moneyless economy as a preference for leaving banks usually dependent on the end-of-day borrowing facility. However, the potential benefit of leaving the market short on a routine basis is essentially an empirical issue which, to our knowledge, remains to be fully substantiated.

[36]Such lender of last resort support can only be justified when banks are unable to borrow in the interbank market due to widespread "market failure." This may occur in particular in the case of a systemic crisis when, due to asymmetric information and a large systemic increase in credit risk, the interbank market becomes fragmented or breaks down altogether. See Holmstrom and Tirole (1998).

[37]This is similar in spirit to what Timberlake (1984) refers to as a Treasury open-market operation.

Figure 7. Central Bank Balance Sheets

A. A Traditional Central Bank

Liabilities	Assets
Currency	Claim on Government
Required Reserves	Claim on Banks
Excess Reserves	Foreign Assets
Capital	

B. A Central Bank Without Money

Liabilities	Assets
Intra-Day Clearing Account	Claims on Government o/w *-Securities obtained through intra-day repos* *- Securities obtained through end-of-day repos*
Capital	Claim on Banks
	Foreign Assets

C. A Central Bank Without Money, LLR or Forex Interventions (Intra-day)

Liabilities	Assets
Intra-Day Clearing Account	-Securities obtained through intra-day repos

While under the first two types of liquidity support, the central bank's role is limited to recycling liquidity, in the second case it assumes (and ultimately socializes) an implicit credit risk which the market can not effectively assume (or price at interest rates which can be afforded by the borrowing bank without undermining its solvency). Notice also that, even without currency, a systemic run on the banking system could take the form of a massive asset shift from bank deposits into claims on government (treasury bills). Indeed, the central bank *does not need to issue money* to be a lender of last resort. What matters instead is that its portfolio of treasury bills—*treasury money*—should be sufficient to restore the liquidity of banks in difficulty, or that a smooth arrangement exists that allows the central bank to issue for this purpose sufficient treasury bills at any time on account of the treasury.[38]

Fiscal solvency is of course required for such *fiscalization* of lender of last resort to be possible. Should there be an expectation of default on the government's obligations, the price of the treasury bills would collapse. This could create a severe payments crisis by reducing the market value of treasury money relative to underlying payment transactions. At the same time, the risk premium on treasury bills could rise up to the point where the demand for such instruments could become totally inelastic, thereby preventing the rollover of the debt. In a conventional monetary economy, equilibrium would be restored through *monetizing* the public debt, i.e., by paying off maturing obligations with central bank money (or, equivalently, by allowing the central bank to acquire more treasury obligations), thereby raising the price level until the real value of public debt has fallen to a fiscally sustainable level.[39] In an economy without central bank money, debt monetization is of course not possible. Nevertheless, the central bank can achieve a similar result—i.e., cause an inflationary bubble that reduces the real value of public debt—by relaxing nominal interest rates until real interest rates become negative.[40]

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[38]The central bank can then deposit the "proceeds" of the treasury bill issues in a frozen remunerated account on the liability side of its balance sheet. Arrangements of this type have been introduced in several central banks, including in Mexico.

[39]On the "fiscal" theory of the price level, see Woodford (1997). An early analysis of underlying linkages between fiscal and monetary theories can be found in Sargent and Wallace (1981). See Ize (1987) for a related interpretation of exchange rate theory.

[40]However, the scope for inflating away the domestic debt in a non monetary economy is limited by the level of nominal interest rates. Thus, if nominal interest rates are initially very close to zero (as in the current Japanese "liquidity trap"), liquidating the public debt through negative real interest rates could become altogether impractical or impossible. In an open economy, a more effective liquidation of public debt can be obtained through a demand shift to foreign securities, away from domestic securities, which leads to price increases through an exchange rate depreciation. See Ize (1987).

The opposite extreme of a government which maintains a fiscal surplus or balanced budget at all times—hence, does not issue *treasury money*—raises an interesting set of alternative issues.[41] In the absence of treasury bills, participants in the payments system (including the central bank) would need to use private paper as collateral for interbank settlement loans; or else the central bank would need to issue means of payment in the form of central bank bills. While the rapidly growing securitization of bank assets suggests that the use of the first option may expand, the dependence of the payments system on assets whose market value is strongly procyclical and may contract sharply under systemic crises raises obvious concerns.

In the absence of *seignorage revenue*, the second option requires that proper arrangements are in place to secure the profitability of the central bank. While in a conventional central bank the money base constitutes, de facto, a substantial shadow capital, this no longer holds for a central bank that does not issue currency.[42] Thus, unless the central bank is strongly capitalized, concerns over the interest cost of its bills could discourage the central bank from following a tight monetary policy or lead to rollover problems. While the central bank would be independent in a traditional sense (i.e., able to avoid financing the fiscal deficit), its independence could nevertheless become undermined by its inability to assume the cost of its monetary policy.

Moreover, even when well capitalized, the central bank would need to find a way to put its bills in circulation and accumulate matching assets. In the absence of domestic public debt and a public deficit, the only suitable mechanism would consist in swapping foreign treasury bills brought in by market participants against domestic central bank bills, i.e., through a currency board-type mechanism. This brings us to the next issue, the case of a moneyless open economy.

C. The Case of an Open Economy: Foreign Exchange Market Interventions

In an open economy, central banks' additional role is to smooth out short-term portfolio shifts between domestic and foreign currency—or domestic and foreign bonds—through changes in international reserves rather than exchange rate adjustments. Indeed, in the conventional monetary approach to the balance of payments, central banks allow, through *unsterilized* foreign exchange intervention, changes in the demand for base money to be matched by fluctuations in external supply. This is also the basis of the monetary adjustment mechanism in pure currency boards: a shift into (from) domestic assets

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[41]While this discussion goes beyond the scope of this paper, it is worth noticing that even governments that do not face systematic financing requirements may find it advantageous to develop a treasury bill market, either to cover short-term cashflow imbalances or to facilitate intergenerational wealth transfers.

[42]On the issue of whether central banks need capital, see Stella (1997).

is self-adjusting because it leads to an expansion (contraction) of domestic money which lowers (raises) interest rates and lowers (increases) the return on domestic assets compared to that on foreign assets.

In an economy without central bank money, intraday foreign exchange intervention could take the same traditional form. The central bank could sell foreign exchange by accumulating a net debit position in the foreign clearinghouse while accumulating a net creditor position in the domestic clearing house. By the end of the day, however, it would need to settle its position in both clearinghouses through a repo (and a reverse repo) of domestic (and foreign) treasury bills. As all interventions would thus be *sterilized,* this would effectively amount to a sale of *domestic treasury money* against *foreign treasury money.* However, with ample supply of treasury money, a currency board-type adjustment of interest rates would fail to take place automatically. Thus, to protect its foreign reserves and prevent an exchange rate collapse, the central bank would need to tighten its monetary policy in the case of a large shift away from domestic assets. Unlike in a currency board, the monetary tightening would need to be specifically incorporated in the monetary policy rule.

A currency board-type automatic adjustment could still take place, however, if the supply of treasury bills (or central bank bills) is limited to that needed for securing transactions in the interbank market. In this case, a shortage of treasury money (or central bank bills) would constrain the liquidity of the payments system. This might induce banks to bring in liquidity from abroad in the form of foreign treasury bills which could be converted by the central bank in domestic bills, thereby expanding domestic liquidity as under a currency board. However, in a financially well integrated economy, it is also conceivable that banks might directly use foreign treasury bills as collateral for domestic interbank operations. In this case, foreign means of payments would directly make up for the scarcity of domestic means of payment.

V. SOME LESSONS FOR PRESENT-DAY CENTRAL BANKING

A. What Makes a Central Bank Unique?

This paper took the view that while central bank money is rapidly vanishing, due to payments system developments and the evolution of monetary instruments, its demise should not be a matter of concern for the effectiveness of monetary policy. Neither the capacity of the central bank to reach its operational (interest rate) target nor that of reaching its final (inflation) target should be at risk. Instead, as long as it follows a sensible monetary policy (in the sense of being broadly consistent with what market participants view as conducive to inflation and output stability), the increased transparency of monetary policy should enhance its effectiveness.

However, the disappearance of base money raises a more fundamental question: what makes a central bank *unique* and distinguishes it from any other institution? The paper

suggested three defining features. The first of these features, which may be the only one that will truly survive in the longer run, is that the central bank is the only entity that has the capacity to conduct monetary policy and provide a stable nominal anchor. For this purpose, central banks must be able to target short-term interest rates. The key requirement is not that banks clear and settle with central bank money on the central bank's books. Instead, the central bank should be the only participant in any private clearinghouse that has the power to force banks to borrow from its end-of-day lending facility at a rate it chooses to set, or else settlements should be conducted automatically, with any end-of-day net debit position financed at the central bank-determined rate.

Second, central banks traditionally assume responsibility for lender of last resort operations. In a conventional setting with base money, this is justified by the fact that a central bank supports illiquid commercial banks through issuing its own liabilities and subsequently using monetary policy to mop up the resulting excess liquidity. In a moneyless economy, the paper argued that central banks can still provide lender of last resort support by swapping liquid treasury bills against illiquid bank assets at a moderately penal rate. In principle, a central bank has an advantage over any other specialized public institution in that its proximity to the payments system enables it to make a wiser and more timely use of "constructive ambiguity" in deciding whether and when to provide liquidity support.

However, it should preferably not be the institution that directly assumes the credit risk on its balance sheet. The loan can instead be placed on the books of a public agency responsible for dealing with problem banks. Indeed, such specialized agencies, which have become increasingly popular in the wake of recent banking crises, are probably most capable of socializing the risk involved in such operations and recovering the assets at best value. In addition, with a strong bank supervision and well designed prudential norms that ensure that only banks with a sufficient margin of reported solvency are allowed to operate in the payments system, the risks associated with lending of last resort activities may become sufficiently circumscribed that the loans can be provided, up to some limit, on an automatic basis. If so, the primary responsibility for deciding whether an institution is eligible for lender of last resort support should be assigned to the supervisory agency rather than the central bank. Indeed, such decisions should be consistent with the prudential rules that allow a bank to operate. Thus, in such a paradigm, the lender of last resort role of central banks becomes blurred or irrelevant.

The central bank is also, in principle, the only entity that can moderate exchange rate fluctuations by swapping domestic treasury bills against foreign treasury bills. These operations imply risks and costs which only a public entity can assume. However, the scope for (and benefits of) sterilized foreign exchange intervention has increasingly been shown to be limited in the case of advanced market economies with floating exchange rates and deep foreign exchange markets. Thus, unless a country chooses to peg its exchange rate, the need and justification for a central bank that holds foreign exchange reserves and intervenes in the foreign exchange market has also increasingly become an open question.

If one is willing, then, to conceive a central bank devoid of lender of last resort and foreign exchange intervention responsibilities, the logical conclusion is that the central bank of the future would not need to have a balance sheet at all. It would only hold intra-day positions in private clearinghouses and its single responsibility would be that of a *monetary policy coordinator (*Figure 7-C*)*. While such a paradigm might still, of course, be somewhat distant, it is important to understanding current trends, conceiving the design of current central bank operations and instruments, and comprehending the linkages between fiscal and monetary issues and the role of treasury debt instruments in monetary policy.

B. Monetary Instruments

In terms of monetary instruments, the trend away from reserve requirements and towards the introduction of symmetric interest rate intervention bands appears to be here to stay. The benefits in terms of smoother interest rates of reserve requirements with averaging provisions seem to be surpassed by those of an interest rate intervention band. At the same time, the latter provides much clearer signaling.

While open market operations constitute at this time the clearly dominant monetary instrument measured in terms of transaction volumes, as compared to operations conducted at the central bank windows, this measure is misleading in that open market operations are mostly conducted to offset central bank (and treasury) day-to-day operations in the interbank market, rather than used as an active tool of monetary policy. In fact, it is likely that central banks will behave increasingly as any other interbank market participant that must "settle" its day-to-day net "due to" or "due from" payment obligations through open market operations, while signaling their monetary policy through the intervention band. In this framework, actual transactions at the central bank windows should only take place occasionally, for example when the central bank wishes to reinforce the signaling effect of a change in the band or is testing the market for an interest rate change ahead of a possible change in the band.

It is well possible that in the future central banks' monetary policy task could be limited to setting the interest rate at which banks settle their end-of-day clearinghouse obligations, settlements being conducted automatically by the clearinghouses. While this would effectively terminate the market for settlement funds, the resulting potential informational loss to the central bank might not be very relevant relative to the potential efficiency gains for commercial banks in their day-to-day liquidity management.

C. Coordination Between Public Debt and Monetary Issues

The enhanced use in payments of treasury money suggests that book-entry registries for treasury bills should be viewed as equally crucial components of the payments system as an RTGS system, or indeed, as a central bank accounting system. While it is difficult to argue that book-entry registries should be developed and maintained by central banks if one simultaneously argues that banks can settle on the books of private clearinghouses rather than

on those of the central bank, it does follow that central banks should guard and regulate with similar care the operation of book-entry systems as those of other key elements of the payments system.

The use of treasury money also underlines the increasingly crucial linkages between a prudent fiscal policy and a sound payments system. A loose fiscal policy that undermines the value for payments of local treasury bills is likely to result in the substitution of domestic means of payments by foreign means of payments (i.e., domestic as well as cross-border clearing and settlement with foreign treasury bills). On the other hand, the increasingly important role of treasury bills as a means of payment implies that the development of the treasury bill market should respond to monetary as well as fiscal objectives. This argues for adequate coordination between central banks, treasuries, and, possibly, specialized bank resolution agencies, in ensuring that the supply of debt instruments remains within a range which is broadly consistent with their use in the payments system and in designing appropriate lender of last resort arrangements (see, for instance, Fry (1997)).

It also raises the more general issue of how to provide adequate means of payment in economies that run systematic fiscal balances or fiscal surpluses, or whose fiscal deficits are entirely financed from abroad. While this issue also arises in a traditional monetary setting—the scope for expanding central banks' net domestic assets, hence base money, is constrained in the absence of domestic government securities—it acquires further relevance in an economy without base money. In the latter case, the lack of treasury bills affects *both* the availability of the means of payment *and* the scope for putting them in circulation. While these issues could be in principle addressed through issuing central bank bills and allowing their supply to expand as under a currency board, the typical narrowness of central bank bill markets and the increasing financial globalization suggest that foreign treasury bills with deeper and more liquid markets might become instead the preferred means of payment.

D. Currency Boards and The Monetary Approach to the Balance of Payments

The vanishing central bank money also suggests that the traditional monetary programming framework will become increasingly outdated. The impact of this on Fund program design and monitoring has already been noticed in the context of the rapid development of inflation targeting.[43] But it is also likely that the conventional monetary approach to the balance of payments will gradually lose its relevance, which has important implications for conventional currency boards. In particular, as central bank settlement balances become an increasingly small fraction of total payment transactions, interest rate instability in pure currency boards which abstain altogether from engaging in monetary

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[43]See Savastano (1997) and Masson et al. (1998)

operations—particularly lending operations—is likely to increase.[44] Thus, currency boards will probably need to provide at least some kind of end-of-day liquidity support.[45]

This, in turn, raises the risk that the rate set by the monetary authority for its lending operations might not adequately reflect market sentiment, thereby undermining its international reserves position. At the same time, as central bank money (i.e., currency and settlement balances) shrinks, the fact that it is fully covered by international reserves becomes increasingly irrelevant in supporting the credibility of the exchange rate regime.[46] Instead, the international reserves backing—held either by the currency board authority or by market participants in the form of foreign liquidity requirements—needs to be expanded to cover broader monetary aggregates. Thus, currency boards will need to address the issue of how to substitute their conventional automatic-pilot operating rule (i.e., limit money creation to that arising from currency conversions) by an alternative limited-discretion rule that links the setting of interest rates to the international reserves position in a way that provides an adequate trade-off between flexibility and credibility in the implementation of monetary policy.

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[44]The interest rate instability results from the fact that with very limited settlement balances it becomes easy for clearinghouse participants to "corner" the market, i.e., to borrow intra-day and leave the money market short. When such activities occur towards the end of the trading day, it becomes difficult for foreign interest rate arbitraging to undo such activities on a timely basis, even with a fully open economy. In Hong Kong, for example, speculators were able during 1998 to manipulate stock prices by forcing money market rates to rise, which led the monetary authorities to intervene directly in the stock market to stabilize it.

[45]One possible solution consists in expanding the definition of the monetary base to include other (fully backed) central bank liabilities with banks (such as required reserves or central bank bills) that can be used flexibly to obtain settlement balances at a repo rate set by the central bank. Thus, the Hong Kong monetary authorities have recently broadened the definition of the monetary base to include (fully backed) central bank bills that banks can use for daily settlements through automatic repo operations with the central bank at a pre-determined rate. Another solution could follow the route suggested earlier in this paper of a two-stage settlement process which obliges clearinghouse participants with long end-of-day positions to lend these resources to the monetary authority so that they can be on-lent to participants that are short, at central bank-determined interest rates.

[46]Indeed, in the limiting case of a currency board with zero base money, the absurd conclusion could be reached that zero international reserves backing is needed to make it credible.

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