

**Can Central Banking Survive
the IT Revolution?**

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Can Central Banking Survive the IT Revolution?¹

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I. Introduction

The liabilities of Central Banks, in the shape of currency outstanding and the deposits held with them by commercial banks, provide the monetary base for the banking system. By means of their monopoly control of this monetary base,² the Central Bank in each country is able to fix the level of the nominal short-

¹ I have benefited greatly from discussions, and correspondence, with Ingemar Bengtsson, Roger Clews, Brian Doyle, Kevin Dowd, Ed Green, David Humphrey, Mervyn King, Adam Posen, Ken Rogoff, Jim Thomas, John Tsoucalas (General Manager, Currency Consulting International), John Vickers and Michael Woodford. Mathias Drehmann provided most helpful and enthusiastic research assistance. Nevertheless I remain responsible for all the views and such errors as may remain.

² Because the Central Bank is known to have the power to use open market operations to do so, in practice it rarely needs to apply such a mechanism aggressively. A simple announcement of its intentions (open mouth operations) usually suffices to move all other short-term rates, more or less, in line.

term interest rate,³ at least in the short run.⁴ The suggestion has now been made that the further development of e-commerce and associated computerisation will attenuate, or even remove altogether, the demand for monetary base, notably for currency; and that such vanishing demand for monetary base will in turn limit, or even prevent, the Central Bank from setting nominal interest rates in such a system, see King (1999)⁵, B. Friedman (1999) and in a more careful and extensive analysis, Bengtsson

³ In principle the Central Bank could choose another nominal price to peg, e.g. the exchange rate, a longer term interest rate, or even the price of cheese, leaving the short-term interest rate to float freely. Why it usually prefers to peg the short-term interest rate is a large issue which will not be pursued further here.

⁴ Ever since Wicksell (1907), if not before, it has been understood that, if the monetary authorities try to fix a nominal rate indefinitely, then after some elapse of time this will cause ever-worsening real instability. Central banks seek to respond by varying their nominal interest rates in response to economic developments so as to maintain longer-term price and economic stability. The choice of the optimal reaction function is a lively and topical issue connected with the names of John Taylor (1999) and Lars Svensson (1999) in particular.

⁵ In turn, King's analysis has been given wider publicity in the British newspapers, see for example King's 'personal viewpoint' on 'Credibility test', Financial Times, Monday, August 30, 1999, p. 12, and Charlotte Denny, 'Electronic currency trash cash', The Guardian, Thursday, November 4, 1999, Pt II on line, pp 2/3.

Meanwhile Friedman's arguments have similarly been given circulation in the Financial Times, see Sir Samuel Brittan on 'The End of Money', August 19, 1999, (p. 14), reproduced in Britain & Overseas by the Economic Research Council, 29 (3), Autumn 1999, pp 16-19.

King's work was further reproduced and extended by Bob McDowell of the Centre Jouffroy (Oct/Nov 1999).

(1999 a and b). Not surprisingly, proponents of the 'free banking' school are enthusiastic about this prospect, see Frezza (1997).

It is the purpose of this paper to argue that these economists are wrong on both counts. First, as a practical proposition, the IT revolution is not going to remove the demand for currency, (except in an Orwellian command economy, and probably not even there). This will be the subject of Section II of this note.

Second, as a theoretical matter, I shall argue that, even if the demand for currency should disappear, that the Central Bank would still be able to set the country's nominal interest rate. While it is, indeed, true that such control appears to rest on the Central Bank's ability to vary its monopsonistically supplied monetary base by open market operations, I shall argue that this is, in fact, a superficial epi-phenomenon. What the ability of the Central Bank ultimately depends upon is the fact that it is the governments' bank, and thus has the power to intervene in (financial) markets without concern for profitability, (let alone profit maximisation). It can, consequently, force its profit-seeking commercial confreres, in the last resort, always to dance to its tune. This will be the subject of Section III.

Before embarking on the main Sections of this paper, I would suggest that this latest theoretical flurry shares much in common

with Wallace's earlier (1983) claim that the Central Bank's powers rested on a tenuous legal restriction. His idea was that, had commercial bank note issue not been prevented by law, these banks would arbitrage between the zero interest rates on notes and the positive interest rates on (safe) Treasury bills and bonds. Since people would be informed that these (extra) notes were completely backed by safe securities, they would be fully acceptable. The Central Bank would then lose the power to control the volume of currency, which would then be expanded by private sector commercial bank issue to the point at which the nominal rate on bills equalled the nominal cost of note issue. The Central Bank would thus also lose its ability to control the interest rate.

In my view, (see 1993), the legal restriction on commercial bank note issue does, indeed, protect the Central Bank/Government enjoyment of seignorage revenues, a nice (though nowadays smallish) source of revenues/resources. What it does not do is prevent the Central Bank from setting interest rates. All that the Central Bank need do, were commercial banks given the right to issue notes, is to offer interest payments on its own liabilities. As independently noted by H. McCulloch (1986) and myself (1986), the technical problems of doing so could be overcome by offering lottery prizes on the serial numbers of outstanding notes, so that the expected return on note issue was determinate. With such interest being directly paid, setting

interest rates actually becomes even easier.⁶ No lower rate on notes/deposits would be competitive; no higher rate could be sustained against Central Bank asset/liability open market expansion.

⁶ There are arguments that such a system would be socially wasteful. Seignorage may in some cases be an economically desirable form of tax; and offering a lottery on the serial number of notes could have us all waste too much time checking out our note holdings. Very possibly so, but theoretically I claim that the Central Bank can still control interest rates whether, or not, the commercial banks are free to compete in note issuance.

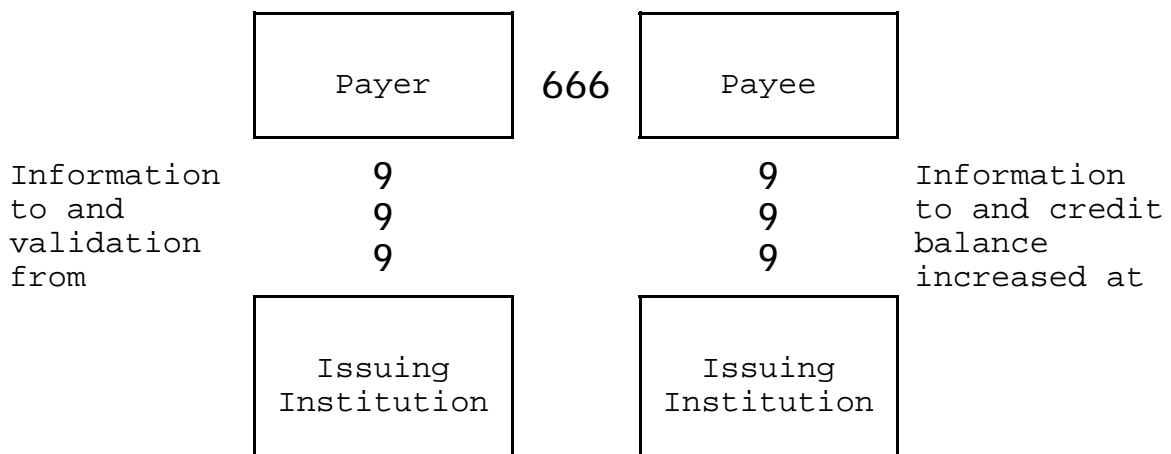
II. Might e-transfers replace the use of currency?

While individual agents may contract to exchange any bilateral sets of goods, or assets, (e.g. barter), agents selling goods, or assets, cannot nowadays refuse payment in legal tender. Such legal tender consists of the currency of each country (or currency zone such as euro-land), and, in effect, the deposits of the commercial banks at the Central Bank. Since the Central Bank also provides the currency issue, it is the monopsonistic supplier of the monetary base of the country. Its power to control this base, notably by open market operations, provides it with the ability to control short term interest rates. We shall discuss in Section III whether it might still be able to control interest rates even if the monopsonistic control over monetary base was to be discontinued, e.g. by the cessation of currency use and a shift of payments' clearing outside the Central Bank.

In this Section of the paper we ask, instead, the question whether the rapid and extensive advance of information technology might progressively eliminate the use of currency, and hence possibly undermine the Central Bank's position. There is little doubt that plastic cards (credit or debit) are being used for an increasing number of transactions, some of which would previously have been settled by cash transfers. Moreover, e-purses are being developed that allow the direct transfer of credit balances

from purse to purse without the immediate involvement of the underlying financial institution.

Normally most e-transfers involve direct information transfers with the issuing institutions. Thus, diagrammatically most e-transfers have taken the form, as follows:-



With e-purses the transaction can involve a transfer of value from payer to payee without information on that transfer immediately going to the financial institution involved.

This latter is important because the most important distinction (on this view) between the characteristics of currency on the one hand and e-transfers on the other is that currency is completely anonymous, whereas (at least up till now with the development of e-purses) e-transfers have facilitated, and proliferated, record-keeping of agents' expenditure patterns. Currency is anonymous in the sense that the recipient of a cash payment neither has to

know, nor learns, anything about the counter-party in the process of trade.⁷ The only information required is whether the note, i.e. the instrument itself, is genuine or counterfeit. By contrast most e-transfers immediately provide a record of what a customer has bought, i.e. exactly what goods/assets, to two counterparties, to the seller and to the underlying financial institution.

Even when e-purses are developed, which do not necessitate (but may allow) such information transfers, they must involve electronic equipment. How can the payer/payee be confident that the other counterparty will not be recording the transaction in a manner that may leave an audit trail that can subsequently be followed, (see, for example, the Report by the Committee on Payment and Settlement Systems and the Group of Computer Experts of the central banks of the Group of Ten countries (BIS, August 1996), especially p. 26)? Moreover, electronic equipment can go wrong (*ibid*, Section 3.3, p. 13), and 'hacking' may be a problem (n.b. the recent 'Love Bug'; also note *ibid*, especially Sections 4.2.3. and 4.3.1).⁸ Of course, currency may be counterfeit, and

⁷ As K. Rogoff, (1998), p. 286, notes:-

"Government currency has an anonymity feature that differentiates it sharply from media such as ATMs and credit cards. It is this anonymity that makes large-denomination notes so useful to the underground economy."

⁸ Also, see Implications for Central Banks of the Development of Electronic Money, (BIS, October 1996), pp 8/9.

One of the main problems in e-money is security, and maintaining

leaves the holder open to robbery⁹, but for the foreseeable future the risks are more familiar than with e-purses.¹⁰

In any case the development of e-purses allowing free transferability between users without recourse to the underlying issuers is as yet mainly a theoretical concept, not a practical reality. Thus The Report by the Committee on Payment and Settlement Systems (1996), had the following comments (pp 5/6):-

"Transferability. The Task Force found that free transferability, in which consumers, merchants or banks may make unlimited direct transfers between one another, is a theoretical concept only. In all systems analysed, transferability is restricted, although the degree and types of restriction differ across systems.

complex enough encryption algorithms is becoming a bigger problem. Breaking the code of e-money may not be too difficult with the high levels of computing power available today, and will only get worse in the future. A key issue that needs to be addressed is how to minimise the loss due to fraud, both to the end consumer and to the issuing commercial bank. When publicly visible (due to media exploitation), e-money fraud occurs consumers may not then be comfortable committing to this technology, and if they do, it may be for small transactions, to eliminate the coins and small bank notes in their wallets.

I am grateful to John Tsoucalas for these latter considerations.

⁹ As Rogoff, op. cit., and his discussant, R. McCauley, noted, the relationship between crime and cash holding is ambiguous. Less crime means that people feel safer to carry cash around on them, on the other hand, criminals 'use cash heavily', *ibid*, p. 277.

¹⁰ Kabelac (1999) states, footnote 21, that "the risks of loss, theft and counterfeiting are the highest, relatively speaking, for cyber money".

Either the actuality, or the suspicion, that e-transfers are subject to recording either by the counterparty (criminals and tax evaders will not trust each other) or by third parties is likely to make such a medium unpopular in those cases where agents wish to leave no tracks of their activities, whether the transfer comes within the grey, black or criminal economies (ibid, Section 6.1).

Electronic transfers must involve a transfer between a transmitting and a receiving device. Each separate party may be certain that her own device is leaving no record behind, but how can she possibly be sure that the same is true for the counterparty? So, if a transactor wants anonymity in e-transfers, it will not only be necessary for that to be technologically possible; it will still require trust between counterparties, and, as noted above, that will be unlikely.¹¹

Currency will do far better. Many of us have heard stories about the man paying for his stint in a brothel on his credit card, but this is likely to remain a minority means of payment in such circumstances. Bengtsson, (1999), has written, p. 25, "Moreover, in the last few years, the cash card has become

¹¹ One correspondent (K. Dowd) wrote to me, as follows:-

"Is it possible that IT might provide us with anonymity? If so, would you be willing to concede the case that the demand for currency might disappear?"

The answer to the latter question is 'no' for the reason given above.

available to the public. We use cash cards in the same situations as cash, for small transactions like buying a newspaper, or for illegal transactions as in deals on Pusher Street." For the reasons already set out, I think that the latter is extremely improbable; I shall deal with small transactions soon.

A considerable proportion of currency usage is already represented by holders who wish to maintain their activities out of sight of their own government, and/or are dubious about the maintained value of their own government's currency. For example, much of the holding of US dollars and of German Dm is by residents of other countries, e.g. Russia, who regard such currency as a better store of value than the local currency, see Rogoff (1998) and the many references therein. Currency usage is, to some considerable extent, related to 'bad' behaviour, either individual or governmental.¹² There are few signs that such 'bad' behaviour is on any trend decline, and technical innovations (and informational technology) are not likely to affect such behaviour patterns much in either direction.

¹² As Rogoff notes, *ibid*, Section 2, 'External and Underground Demand for OECD Currencies', pp 265-270, it is extremely difficult to estimate the division of those notes not held for domestic transactions purposes between those held externally and in the 'underground' economy. Fortunately for this analysis such a division is unnecessary here, since both motives derive from 'bad' behaviour, whereby the note user wishes to keep his activities out of reach of his own government.

Few of us use high value currency notes for ordinary transactions; personally I have never held notes of a higher denomination than £20 for means of payment purposes. One possible handle towards assessing how much outstanding currency is used because of 'bad' behaviour¹³ is to examine what proportion of currency outstanding is represented by high denomination notes. Rogoff, *ibid*, Figures 5a and 5b, p. 276, has already done this exercise, and these Figures are reproduced and extended for another couple of years. We also show the proportion of currency outstanding represented by notes of a value greater than £20, estimated at the exchange ruling at the end of 1997. See Diagrams 1(a) and (b) and 2(a) and (b).

The availability of high value note denominations facilitates crime, money laundering and 'bad' behaviour. Because such activities are so widespread, central banks issuing such high value denominations tend to receive more seignorage revenues. Rogoff, *ibid*, especially Section 3, 'Should the European Central Bank Cater to Underground and Foreign Demand for Euro Currency', pp 279-287, severely criticized¹⁴ the ECB for deciding to issue

¹³ A potential related measure is to test what proportion of notes outstanding have been physically contaminated by contact with drugs, notably cocaine which is often 'snorted' in this way. A report by J. Burns in the *Financial Times* (4th October, 1999, p. 4) stated that more than 99% of all the capital's banknotes revealed some, perhaps minute, traces of cocaine!

¹⁴ "If a Colombian drug lord offered a medium-term, zero-interest loan to the US Treasury in return for access to a superior smuggling and hoarding technology, presumably the

very high denomination euro notes, on the grounds that this would facilitate crime. The ECB was, however, following the prior example of Germany and the Netherlands, which have large value notes in circulation. I understand that the US Federal Reserve System has decided against the issue of \$500 bills precisely in order to restrain criminality.

The time series for currency usage within individual countries are commonly trended, some up, e.g. USA, and some down, e.g. Switzerland; and the values, and indeed signs, of the coefficients tend to vary from country to country, see for example Rogoff Table 4, p. 278 and Diagrams 3(a), (b) and (c). Much of the variation between countries appears to be idiosyncratic and country-specific. Because such trends are strong, it is often possible to find other apparently significant (trended) variables to explain them. It is much harder to find variables that help to 'explain' cross-country variations in the currency deposit rates. For example, measures of crime that sometimes help to explain trends in the ratio in individual countries (see Rogoff, *ibid*) drop out in a cross-country exercise.¹⁵ Nevertheless M. Drehmann and I have tried to explore

offer would be refused. Yet such an agreement is implicitly entered when criminals are offered the convenience and anonymity of large-denomination bills." Rogoff, *ibid*, p. 280.

¹⁵ Similarly, the ratio of total government revenue to GDP, which is often taken as a measure of the incentive to enter the 'black economy', and is expected to have a positive effect on the

(data-mine) what common factors might appear to have influenced such cross-country ratios. This exercise is described at more length in a separate, but associated, Financial Markets Group Special Paper, (forthcoming 2000). The preliminary results show some slight negative effects of technological-type variables (e.g. internet use) on the use of small currency denominations,¹⁶ but none of the holding and use of large denominations, and little on overall currency usage.

The one circumstance where one might, indeed, expect information technology to bring an end to the use of national currency would

currency/EDP ratio, in our own studies tends to enter with a negative sign in cross-country analysis.

This curious negative conclusion was reached independently, and on a different data set, by Brian Doyle in his paper 'Digging into the Underground Economy', unpublished, Board of Governors of the Federal Reserve System, (November 1999), who concludes, p. 13,

"I have estimated currency demand functions for fifteen industrialised nations and found that including total taxation revenues gives coefficients with negative values or with insignificant positive ones. Such results call into question current measurements [of] the size of the underground economy, and certainly the currency demand method of estimating it."

Our belief is that the negative sign on Revenue/GDP is accidental, owing mainly to low Revenue/GDP ratios in a few countries, e.g. Japan and Switzerland, with high currency ratios.

¹⁶ Following some work by Brian Doyle (2000), we wondered whether our variables would have a measurably different effect on holdings of large bills as compared with small bills and notes. Like Doyle, we arbitrarily chose any bill worth more than \$50 at the end 1999 exchange rate as large, and thereby divided our currency ratio into a large bill ratio and a small bill and coin ratio.

be when an (authoritarian) government might prescribe that all transactions must go through an electronic device. It is not hard to imagine the advantages that a government might envisage from being able to record (electronically) every payment that every agent in that country made.¹⁷ This is a perfectly feasible Orwellian nightmare. Of course, the inhabitants of that country would seek to hide some of their transactions from the government either by using foreign currencies (e.g. US \$s) or reverting to commodity money (e.g. cigarettes or, perhaps, gold).

Electronic devices involve the actuality, or at least the possibility, of recording; note transfers do not.¹⁸ That fact by

¹⁷ One correspondent commented that Singapore is the country where the government is pushing hardest 'down the path of e-money'.

¹⁸ The punctilious will comment that this is not quite true. The transfer of specially marked notes has been a means of catching criminals for decades. My defence to this is that the recording of transfers is an order of magnitude easier via electronic devices than by marking notes.

Another argument is that the money laundering legislation restricts the ability (in principle) of customers to make large withdrawals from, or deposits to, their bank without full reporting.

My colleague, Mervyn King, places some emphasis on this point. He wrote to me (private correspondence):-

"I agree that there will always be a demand for anonymity. The question is how that will be provided. The anonymity of cash payments has been very markedly reduced by money laundering legislation. It is now no longer possible to obtain large sums of cash from a financial intermediary without the authorities being informed. That is because the authorities can pass laws and bring informal pressure on financial intermediaries to provide the authorities with

itself will keep currency in being, and may already account for the greater proportion (by value) of currency outstanding. The distinctive nature of currency, as contrasted with e-transfers may also be an artefact of the regulatory environment, as well as of technology. If governments permit strong encryption without requiring law enforcement to have a "window"; if courts rule that transactions data are the private property of the transactor, and require a comparably strong probable cause (to goods stored in a person's house) before they can be scrutinized; and if e-money issuers can construct credible legal "firewalls" so that they cannot peek at their customers' transactions, then e-money will be a closer substitution for cash than otherwise.¹⁹

But there are numerous other reasons, thankfully more mundane, why currency will continue in use for the foreseeable future.

such information. Equally, electronic transactions can be made technically secure. Encryption is at the point where private sector intermediaries can provide encryption services of a form that will not be broken for a very long time, if ever. But what criminals and others would fear is not that the technology was not secure, but that the authorities would bring pressure to bear on the intermediaries to pass information to them. So I think that anonymity is less a matter of the technology of the means of payment and more a matter of government pressure and regulation. Hence I see no significant difference between cash and electronic payments in terms of anonymity."

¹⁹ I am grateful to Ed Green for these thoughts. Also see Green (1999).

In particular currency is legal tender within its national boundaries; it cannot legally be refused,²⁰ (except on evidence of counterfeiting). Plastic cards can be, and often are, refused, e.g. by taxis, restaurants, etc. While some plastic cards do have a (limited) international usage, the one essential that anyone going to a foreign country has to have is the appropriate foreign currency. Within each country there are numerous forms of competing plastic cards, each with a limited range of uses (e.g. store loyalty cards), in contrast to currency whose acceptability within each country is legally mandated to be universal. Over time it is possible that some brand (or brands) of card may become increasingly widely accepted, and that the electronic instruments needed for such exchanges cheaper and more widely available, (e.g. swipe machines in every taxi and pub), but that will take some considerable time; meanwhile currency has first-mover advantages; it is already there as a simple means of payment. Smart cards do have a potential advantage in that they could be programmed to provide the holder of a credit balance with a rate of interest, (this is technically

²⁰ What is most important is the general acceptance of a means of payment. The legal imposition of legal tender is simply a means of bolstering such acceptability. That status may be neither necessary nor sufficient to achieve such general acceptability. It may not be sufficient because a purchaser will not go to the cost of calling in the law if a seller refuses to accept legal tender currency, e.g. in a hyperinflationary country. It will not be necessary if convention makes the notes acceptable. I have been told that now Bank of England one-pound notes have gone, no notes are legal tender in Scotland or Northern Ireland.

more difficult with cash). It is, however, noticeable that issuers of cards have not been rushing to offer interest to holders of credit balances with themselves.

Payments using paper transfers, e.g. cheque payment, are expensive in their use of manpower and machines to complete. If the true social cost of such payment systems were charged to users, instead of the present cross-subsidy arrangements whereby cheque payment costs are subsidized by holding down interest payments to deposit holders, then electronic transfers would more rapidly substitute for paper transfers. By contrast the social cost of the transfer mechanism using notes is relatively small, though not entirely negligible.²¹ Hence electronic transfers are much more likely to replace cheque transfers than note transfers.²²

²¹ The banks grumble about the handling costs of cash, and there are costs of physical security and the inducement to / effects of crime. I am grateful to R. Clews for reminding me of this.

²² Electronic money, e-commerce, the internet, etc., are likely to make international flows of funds, whether on current or capital account, even easier and simpler than they are at present. This would make it even harder for the authorities in each country to maintain pegged exchange rates, driving the choice of exchange rate regime further towards the polar extremes of either a free float or absolute fixity, e.g. a currency board or unification. But the world has gone so far in this direction already that this would represent a matter of degree, not a fundamental change of structure. Such information technology poses more fundamental problems for national fiscal and regulatory issues (e.g. levying indirect taxation) than for monetary policies.

The international standardisation of e-money devices and

As electronic money becomes more widely usable, and also if it should offer a higher rate of return, it may indeed substitute for currency in a wider range of possible uses. But electronic money does not have the characteristics of currency. It is not anonymous, and it is not legal tender. Given these special characteristics, the demise of currency at the hands of information technology will not happen,²³ at least not unless an authoritarian government should decree that it must happen. The fact that such a prospect would terrify anyone with the slightest concern for liberty and freedom among people underlines just how important currency usage is for our way of life, including our 'bad' behaviour.

Although there has been some eye-catching futurology in recent months suggesting that electronics might bring about the complete replacement of currency, and with that a control problem for the Central Bank, a BIS report on the subject, a study on the

transaction systems will be critical to the widespread acceptance of financial institutions, and for the flexibility of consumers using their e-money across national borders. This could be another obstacle for penetration of the consumer market, and if standards are not in place, it would take at least 5 years for the market leader in e-money technology to be adopted as a standard.

²³ John Tsoucalas has commented (private correspondence) that, even in a technologically advanced economy, such as Australia, the data show that despite "the high penetration rate of electronic banking cash still has a specific purpose in the economy, and it appears other instruments and services are declining, such as the use of money orders and cheques."

'Implications for Central Banks of the Development of Electronic Money', (BIS, October 1996), reached much more mundane, (but also more firmly based) conclusions (pages 7 and 10 especially), that any such shrinkage could be handled without causing major problems to normal operations.

So, there would appear no reason to believe that the demand for currency will disappear in the foreseeable future. Even if currency holdings should continue to fall to an (increasingly) small proportion of GDP, or of transactions, the existence of a continuing determinate demand for monetary base leaves the Central Bank fully capable of controlling both the nominal interest rate and the price level, (see Woodford, 1997 and Bank of Japan, 2000); (we discuss what might happen in the purely hypothetical circumstance that the demand for cash does fall absolutely to zero in the next Section).

III. Could Central Banks set interest rates
in an economy without currency?

One of the difficulties about futurology is that it is so difficult to know what should be taken as remaining constant, and what subject to technology change. For example, the structure and nature of financial intermediation is just as much as under threat from IT, probably much more so, than currency usage. Mutual funds (unit trusts), for example, combine record (and safe) keeping, purchase and sale of underlying assets, and portfolio selection. They are, on average, not very good at the latter, with managed funds typically being outperformed by tracker funds. With IT and ECNs (electronic communication networks) reducing transactions costs, any individual could buy software enabling her to maintain her own tracker fund, or indeed to follow any chosen portfolio strategy for which guiding software could be written. Individuals (or companies) might sell portfolio advice, but there would cease to be advantages in having the (physical) holdings or transactions done through an intermediary. That gets rid of mutual funds, unit and investment trusts, etc.

In principle one might envisage all potential borrowers, even small, personal borrowers, filling in standardised forms (with penalties for misstatement), which are then aggregated and securitised. All that could be routinely done by computer.

These aggregated sets of securitised loans could then be bought, and sold, on ECNs. The loans would have specific maturities. Consumers uncertain about their need for immediate purchasing power could buy puts on their holdings of such securitised loans. The counterparties would be, presumably, companies with expected positive cash flows. Hence we could, in theory, also get rid of commercial banks. One can argue that all intermediaries exist because of some imperfections (e.g. information asymmetries, transaction costs), and that IT will remove them all, leaving instead just central (asset) markets, and principals, whether borrowers or lenders. Perhaps, but it will all take a long time; inertia is a strong force.

In the meantime what are the minimal, irreducible elements in a forthcoming future financial system? I would start by arguing that there needs to be an underlying means of payment, and for the reasons set out in Section 2, an anonymous means of payment. Currency will do excellently well in this respect. Indeed, rather than currency usage being under threat from IT, it is very likely to remain a more prominent and persistent component of the money stock than the deposits of financial intermediaries which make up the rest, and currently by far the larger part, of the various broader monetary aggregates.

Nevertheless for the purposes of this Section, I am committed to the assumption that the means of payment will be an electronic

transfer, a unit of `e', (despite the implication that everyone's `e' transfers may then be open to inspection by the government, the inland revenue service, one's nearest and dearest family members, etc., etc.). Individuals, and companies, will hold personal accounts consisting (mostly, possibly entirely) of capital market assets, which will offer e returns (interest or dividends) either as a continuous, or irregular, stream, and of capital market liabilities, (again with agreed, contractual payment streams). A payment from X to Y would involve a pre-programmed, computerised sale of some set, or sub-set of financial assets, or increase in liabilities by X and an equivalent pre-programmed investment by Y, once the `e' transfer had been received on her `e' purse.

Perhaps the simplest way to envisage this happening is that all agents (e.g. individuals and companies) hold their financial assets, i.e. claims on other agents, with a custodian, perhaps a computer company, not necessarily a bank. The custodian simply guarantees that the asset value is there. When a transfer is made, the custodian arranges the pre-programmed set of investment sales and purchases. The custodian would run the computerised settlement system but need neither issue liabilities nor make loans, i.e. it would neither be a bank nor a Central Bank, nor a financial intermediary.

Can we get rid of financial intermediaries altogether? Probably

not in fact. The reason is that most individuals will need specialised information to help them adapt their financial portfolios and transactions to their individual circumstances. Also it is unlikely that the selection of satisfactory loan applicants (i.e. those whose probability of default is low enough to make the expected risk/return profile worth the initial investment) can be reduced to computerisable form filling. So we will continue to need specialists to help select asset portfolios and to distinguish between good and bad loan projects. But, given that we, the bulk of the population, are uninformed, how can we distinguish between good, and bad, information purveyors? The obvious answer is to make the information purveyors hold the loans/assets that they recommend on their own books, using enough of their own capital funds to keep them honest, and then finance the rest of their financial requirements by offering various kinds of deposit, or mutual fund unit, liability. Hey presto, we find that we cannot eliminate specialised information, information asymmetries, and such imperfections/asymmetries bring us back to the need for some continuing financial intermediaries, banks, whatever Mr. Gates' wizardries.

Actually neither currency, nor banks, are essential to the ability of a Central Bank to set the interest rate in its own country, so long as its `e' unit measure is a separate unit, e.g. the £`e', from the `e' measure in another country, say the \$`e',

and £ and \$'e's are floating against each other.

It is useful for this purpose to think of banks as market makers in the money market.²⁴ Their deposit rate is the rate that they bid for money; their loan rate is their ask rate. Even if IT should remove information asymmetries and thereby banks, we can still think of a market with an order book of borrowers wanting (immediate) access to 'e', the ask side, and an order book of lenders on the bid side. So what determines the interest rate, i.e. the mid point of the spread between the bid and the ask for immediate 'e'? In the long run, of course, real factors determine, then as now, the real interest rate, e.g. productivity and time preference.

But in the short run the Central Bank can, perfectly easily, do so. If it wants to raise interest rates, all it has to do is to raise its own bid rate for 'e'. I am encouraged that Michael Woodford (1999) has reached a closely similar conclusion (also see Hall 1999). He writes, in Chapter 2, Section 3.4 ('Price-Level Control in the Absence of Monetary Frictions') as follows:-

"One may imagine payments technologies under which the desired real monetary base should fall to zero at some finite nominal interest rate (at which it is worthwhile to switch entirely to an alternative to government-supplied money), and one might imagine that financial innovation would bring this critical interest rate to a lower and

²⁴ For an analysis along somewhat similar lines, also see M. Krueger, 'Towards a Moneyless World', Durham University, Department of Economics, Working Paper 9916, Oct 1999.

lower level. In such a case, restriction of the monetary base would not allow the central bank to force nominal interest rates above the critical level; but then if innovation were to proceed too far, it could become impossible for the central bank to move nominal interest rates, even within the range of low positive rates consistent with approximate price stability. And even in the case of the sort of payments technology considered above, the central bank would seem to have no way to control interest rates if the limiting case of $\alpha = 0$ were actually reached.

These latter possibilities still seem rather remote under current circumstances, even in financially sophisticated economies like that of the United States; while... the cashless limit is already a reasonable approximation for many purposes, the Federal Reserve has no difficulty in controlling the federal funds rate through open-market operations. Nonetheless, it is perhaps worth commenting upon how interest-rate control would be possible in the genuinely frictionless economy that might one day be approached.

Under such circumstances, the payment of interest on the monetary base would become an important tool of monetary policy. We shall suppose that in this more financially sophisticated world, currency is no longer used, having been replaced by electronic means of payment, and so we shall need only to contemplate the payment of interest on bank reserves. The payment of interest on reserves has often been advocated, for example by Friedman (1959), on grounds of microeconomic efficiency. Elimination of the interest differential between monetary and non-monetary assets is required for efficiency, as otherwise resources will be wasted in attempts to economize on money balances. This can be achieved without the steady deflation proposed by Friedman (1969) - which (as we shall see) causes distortions of its own in the case of imperfect synchronization of price changes - if one can raise the nominal return on the monetary base to that nominal return on non-monetary assets that is consistent with stable prices."

Since the Central Bank's credit rating in its own 'e' area, as the government's bank, must be higher than that of any other entity, it can mop up all excess liquidity by its bids for 'e'. To do so, it cannot immediately purchase other assets, since that

would release the `e' liquidity back onto the market. This means that its bids for `e', e.g. by selling assets out of its portfolio, may cause a reduction in its profits (or a loss). But, unlike commercial entities, the Central Bank, the government's bank, can face a loss with equanimity.²⁵ It is that that gives it its power in the last resort to fix rates.

Let us consider next when a Central Bank wants to lower interest rates. It simply offers to make `e' available to prospective borrowers (it raises the price of money by making `e' available at a lower interest rate, higher price) at a lower interest rate, a finer ask rate, than its competitors on the market. Again by buying assets in exchange for `e' at a higher asset price, it may tend to make lower profits (more losses) than its commercial rivals, but because it is a public sector institution such non-profit-maximising behaviour not only does not matter to it; it is rather its source of power.

Because it is not profit-maximising the Central Bank is always in a position to dictate the finest terms on either the bid, or ask, side of the money market. It can, therefore, set the

²⁵ Currently seignorage makes Central Banks a profit centre. The Bank of Japan was stated to be the second most profitable company in Japan in 1998. The loss of seignorage in a world of `e' transfers may indeed turn paper profit into loss, but that can, perhaps, be handled. We expand on the fiscal implications of such a changed regime subsequently.

nominal interest rate for 'e' whether, or not, the system also includes currency and/or banks. Because the other players in the money market, whether banks or not, know that the Central Bank has the power of the government behind it, it is actually unlikely that the Central Bank will normally have to undertake a large volume of open market operations to get the market to adjust interest rates in line with its wishes. Open mouth operations will normally suffice.

In his Jackson Hole speech, and in correspondence with me, Mervyn King emphasizes the role of finality of settlement via the Central Bank. Thus he writes, 'What is crucial for central banks is that they offer finality of settlement'. I do not agree that this is essential. In my earlier futurology I assumed that all transfers were settled with a custodian computer system, not the Central Bank. What I do assume is that the e-liabilities of the Central Bank are always acceptable, (since it is the government's bank), so it can always force out onto the system as much e as it wants, or retire as much as it wants, (by open market operations in future, as now). Since e will be interest-bearing, it can only do so, if it is prepared to accept the implications for its profit and loss account in the process.

Some commentators, e.g. K. Dowd, doubt whether governments would

accept any such losses.²⁶ That is debatable. But if they do not want to absorb losses, they can always rig the system in their own, and the Central Bank's favour, by legislation. 'Free banking' enthusiasts will claim that they have already been doing so for centuries! Indeed where I, and King, do ultimately agree is that what gives the Central Bank its ability to control interest rates is that it has the power of the central government behind it;²⁷ and if the government wants to maintain this power,

²⁶ Thus he writes:-

"I agree that governments can absorb losses, up to a point, if they choose to do so, but do not believe that modern governments will actually do so. The pressures on public finance are just too great, in my view. I believe that your point is therefore theoretically valid, but not in practice accurate as a description of what real world governments are able and willing to do."

²⁷ King has written (private correspondence) to me as follows:-

"If financial intermediaries could settle with each other in real time, then the role of central banks in providing finality of settlement would disappear. My point is simply that that means that central banks are no longer necessary, not that they would not or could not exist. But their existence would depend on government regulation or legislation of some form to force financial intermediaries to use the central bank. Hence Jerry Jordan has suggested that in such a world a law should be passed requiring all tax payments to be settled with central bank liabilities. No doubt other forms of pressure or regulation could be brought to bear, as you hint. But I think it is important analytically to distinguish between the case where a central bank only can provide final settlement, and the case where the government passes legislation to ensure that the central bank is used in situations where technology no longer requires it."

Where I now think that I differ mainly from King is not in the interpretation of the future, as of the present and past. There is no technological barrier now, nor has there ever been one, to

it can organize the structure of the financial system to do so.²⁸ The ability of the Central Bank to control interest rates is an issue of political economy. To ignore the role of governments and power would be to miss the key point.

Critics may argue that any such legal restrictions imposed on an assumed structure of banking and clearing arrangements would be ad hoc. Perhaps, but the deeper point is surely that the Central Bank, as banker to the government, is well placed to get whatever legal, or structural, restrictions it wants to maintain its effectiveness passed into law, so long as the government believes that short-run control of interest rates in particular, and monetary policy in general, is well served by having its own Central Bank in place.

financial intermediaries settling directly with each other. Central Banks do not now exist because of some technological imperative, but because they have evolved to meet a combination of both governmental and structural needs. Thus I would argue that the existence of Central Banks has always depended in large part on government regulation and legislation. In this respect the future will be exactly like the past.

²⁸ A Working Paper prepared within the IMF, on 'Central Banking Without Central Bank Money' by Henckel, Ize and Kovanen (March 1999) reached broadly the same conclusion, e.g. p. 35.

In their case they assume the continuation of commercial banks and a privately-run clearing house, where claims on counterparty banks are settled. What then suffices to maintain Central Bank control is a legal requirement that forces end-of-day bank debtors to obtain their needed liquidity from the Central Bank at a rate chosen by the latter.

My esteemed colleagues, Professors M. King and B. Friedman, worry whether currency and Central Banks can survive the IT revolution. Many other financial intermediaries may disappear, or change their role dramatically, but currency and Central Banks are among the safer financial institutions to survive the next Millennium. Stop worrying.

Central Banks are unlikely to be forced to the sidelines by technological innovation. Such innovation may, however, significantly erode seignorage revenue, and even possibly lead to a context in which it requires the Treasury to absorb fiscal costs in order to allow the Central Bank to continue to control the level of nominal interest rates. This will raise, in more immediate and stark guise, the question of what benefits a country obtains from having an agent, a Central Bank, run monetary policy with some operational discretion, rather than rely on some more quasi-automatic mechanism. In other words the debate on 'Free Banking' versus 'Central Banking' is likely to continue, mutatis mutandis. For the moment the relative success of 'independent' Central Banks in hitting their inflation targets, without unacceptable side effects, has muted this debate. But if such success should prove transitory, the debate would reopen, whatever stage technology had reached. Central Banks may bring about their own demise by incompetence; they will be comparatively immune to technological innovation.

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