The Impact of Technology on Cash Usage

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I. Introduction

"Cash is dirty … Cash is heavy … Cash is inequitable … Cash is quaint, technologically speaking … Cash is expensive … Cash is obsolete." This is how James Gleick (1996) summarises the case against cash. By contrast, electronic means of payment are clean, technologically advanced and supposedly cheap and convenient. Thus, it is not surprising that industry representatives are optimistic that currency will be replaced by technologically more advanced electronic transfers and e-moneys of assorted varieties (Capie and Gormez 2000, Craig 1998). In a similar vein, monetary economists like K. Dowd (1997), B. Friedman (1999) or M. King (1999) have predicting the imminent disappearance of currency from common usage.

We are sceptical about the accuracy of these predictions. Indeed we believe that currency, notes and coin, may be better protected against fundamental changes induced by IT than many other financial products and mechanisms. For example, the operation of equity markets has been, and will continue to be, revolutionised by IT.

In the second Section of this paper we examine the particular characteristics of currency, notably its acceptability, anonymity and simplicity, and compare these characteristics with those of electronic alternatives.

In the third Section of the paper we examine how such characteristics have affected the relative costs of using differing payment media, and the returns that may be expected from producing and circulating e-money. In this Section we examine micro-level data on the cost structure of using differing means of payment and highlight the crucial role of security concerns.

In the fourth Section we shall review the macro-level time series data on trends in currency usage, and their determinants, in the main developed countries. We shall note that relative currency usage, measured as the ratio of currency outstanding to GDP, has in a few cases risen, and has in most countries only declined slowly. Absolute usage of currency, both in nominal and real terms, i.e. after deflation by an appropriate price index, generally continues to rise. By comparison, the outstanding value of e-money is minuscule.

We conclude, in Section 5, that expectations of the demise of currency at the hands of IT are distinctly premature.

II. The relative characteristics of e-money and currency

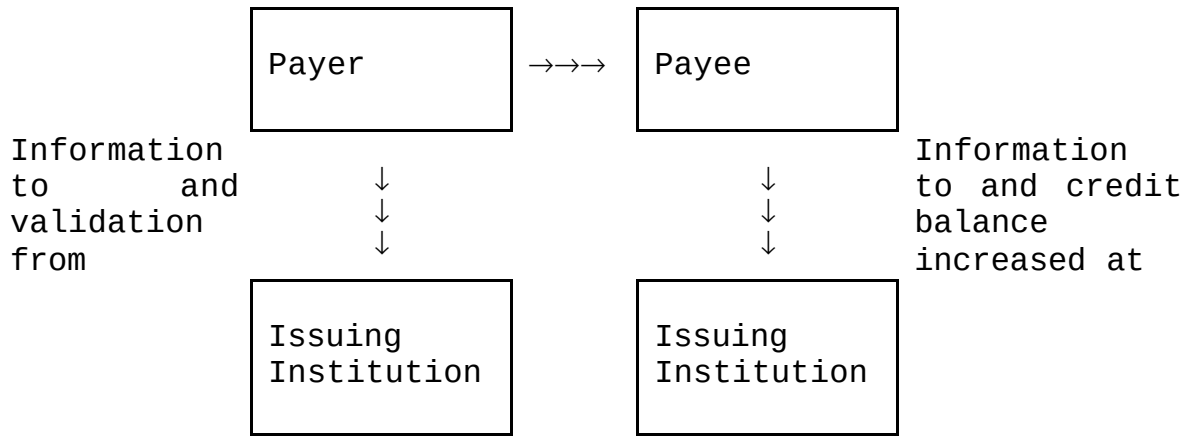
If the use of information technology, particularly e-money, is to drive currency, either largely or wholly, out of use, such e-money must be able at least to replicate, and in some respects improve upon, the characteristics of currency. In this Section we shall consider six characteristics, acceptability, speed of completing exchange, yield, security, convenience, and anonymity (or in other words the form of associated information transfer).

There is no doubt that IT mechanisms for affecting exchanges can equal, or improve upon, currency in some respects, and for some purposes. The speed of completion is usually as fast, or sometimes faster, with a plastic card or e-money; (though studies of a German Retailer organisation (Zellekens and Rueter 1996) show that cash is the fastest means of payment at the POS. Cards are usually faster at ticket machines - especially when they can be used without an associated need for contact and verification with the card provider). Whereas there is no easy way of providing a non-zero nominal yield on currency, it should be technically simple to provide for a positive yield on credit balances stored electronically, though purveyors have been so far noticeably reluctant to do so (reasons why this might have been so are discussed further in Section III). In many, perhaps most, respects it is more convenient to carry around a single card for small, repetitive purchases (e.g. telephone, subway) than a pocketful of cash. There is little doubt that plastic cards (credit or debit) are being used for an increasing number of transactions (mostly small valued), 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:-

Figure I



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 our 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.[1] 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).[2] Of course, currency may be counterfeit, and

[1] 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."

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

One of the main problems with e-money is security, and maintaining 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 should occur, 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.

leaves the holder open to robbery[3], but for the foreseeable future the risks are more familiar than with e-purses, (see also the next Section).[4]

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."

This statement remains as true in 2001 as it was in 1996.

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).

We are grateful to John Tsoucalas for these latter considerations.

[3] 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.

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

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.[5]

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 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, we think that the latter is extremely improbable; we will deal with small transactions soon.

Hoarders, moreover, will want both durability and also anonymity.[6] However, in all likelihood, they cannot have both. Given the security concerns analysed above, it cannot be expected that an e-

[5] One correspondent (K. Dowd) wrote to one of us, 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.

money issuer can develop a type of anonymous e-money with unrestricted validity.[7] Since the technical development is proceeding fast – helping both e-money issuers and hackers/counterfeiters – issuers have to upgrade their e-money periodically. Otherwise, they would run the risk that counterfeiters break the code and produce large amounts of fake e-money. This means that from time to time users of e-money have to exchange old money balances against new ones.[8] So, even a type of e-money that can be used anonymously in payments (like, for instance, Mondex) is not as good as cash when it comes to hoarding.

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.[9] There are few signs that such `bad' behaviour is on

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[6] Hoarding may be substantial. See Boeschoten (1992), Krueger (2000) and Van Hove (1999b).

[7] Therefore, the remark of Browne and Cronin (1995), 106 that 'electronic money does not depreciate physically (unlike banknotes)' does not apply. First, it is not even clear whether plastic money does indeed have a longer life-span (in all likelihood not), and, second, more important is the technical depreciation which forces e-money holders to 'update' their balances.

[8] The BIS (1996, 19) reports that some devices will automatically cease to function after a certain number of offline transactions.

[9] As Rogoff notes, ibid, Section 2, `External and Underground Demand for OECD Currencies', pp 265-270, it is extremely difficult

any trend decline, and technical innovations (and informational technology) are not likely to affect such behaviour patterns much in either direction.

Few of us use high value currency notes for ordinary transactions; probably many of us will never have held notes of a higher denomination than £20 for means of payment purposes. Habits, however, differ between countries, and in some countries, such as Germany, Japan and Switzerland, high value notes are much more commonly used than in the UK, for example. Nevertheless one possible handle towards assessing how much outstanding currency is used because of `bad' behaviour[10] 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 Figures 2(a) and (b) and 3(a) and (b).

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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. (In some cases foreign notes are the only way to protect oneself against very bad government behaviour.)

[10] 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!

The one circumstance where one might, indeed, expect information technology to bring an end to the use of national currency would 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.[11] 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.[12] That fact by

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

[12] 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. Our defence to this is that the recording of transfers is an order of magnitude easier via electronic devices than by marking notes. In addition, marking notes does not completely reduce anonymity. If neither of the two parties involved in a payment registers the transaction, anonymity will be preserved - no matter whether the note was marked or not.

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.

Mervyn King, of the Bank of England, places some emphasis on this point. He wrote to one of us (private correspondence):-

> "I agree that there will always be a demand for anonymity. The question is how that will be provided. The anonymity of

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.[13]

But there are numerous other reasons, thankfully more mundane, why currency will continue in use for the foreseeable future. In particular currency is legal tender within its national

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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 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."

[13] We are grateful to Ed Green for these thoughts. Also see Green (1999).

boundaries; it cannot legally be refused,[14] (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 different schemes become inter-operable or 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[15]; 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 more difficult with cash). It is, however,

[14] 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. We have been told that now Bank of England one-pound notes have gone, no notes are legal tender in Scotland or Northern Ireland. Thus, the legal tender function may be less significant than is commonly believed.

[15] On this, see S. Schmitz (2001).

noticeable that issuers of cards have not been rushing to offer interest to holders of credit balances with themselves.

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,[16] 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 `Implications for Central Banks of the Development of Electronic Money', (BIS, October 1996), reached much more mundane, (but also

[16] 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."

more firmly based) conclusions (pages 7 and 10 especially), that any such shrinkage is likely to be limited.[17]

So, there would appear no reason to believe that the demand for currency will disappear in the foreseeable future. Let us conclude this Section with an analogy. The relationship between e-money and currency is rather akin to that between computer-assisted virtual sex and masturbation. The former is conceptually superior and technologically more advanced, but the latter is simpler, always available, leaves no record (unlike the computer), has no moving parts to go wrong and is immune to distressful hacking. In both cases the latter simpler option is unlikely to disappear in the face of electronic competition.

III. The business case for e-purses and cash

One may argue that the main threat for cash comes from debit cards. In recent years debit cards have quickly gained considerable market share in the segment of POS payments. Indeed, in Iceland debit and credit cards have been so successful that some economists thinks that the end of cash may be close in Iceland (De Grauwe, Buyst, Rinaldi 1999). However, if anonymity is as important as we think (see proceeding chapter), debit cards will never completely replace cash. Costs and convenience may also

[17] See also BIS (2000), Godschalk and Krueger (2000), Goldfinger (1999) and Snellman et al. (2000).

favour the use of cash.[18] Even as online connections are getting faster and cheaper, the need to have such a connection and the time to type in the PIN (validate it, type it in again if an error occurred, etc.) make online transactions inconvenient – even for people who are not concerned about anonymity. So, the final blow for cash would have to come from other, more cash-like, means of payment. The prime candidate is the e-purse (embedded in a card or a mobile phone).

a. E-purses: Taking Stock

E-purses are used as a general means of payment mainly in Europe.[19] In many European countries, the circulation of card based purses is remarkably high.[20] In five European countries (Austria, Belgium, Germany, Luxembourg, Netherlands) card penetration (measured in per cent of the population) is higher than 50 per cent. However, most of these cards are not used. For the Belgian Proton card the share of activated cards (i.e. cards that were loaded at least once) is 30 per cent (of all cards issued). In all other countries surveyed this share is below 20 per cent. Even these figures may overstate the use of cards since the fact that they have been loaded once does not necessarily imply that they were used subsequently. In Germany where a card is defined as “active” if it

[18] Except perhaps in very small communities where everyone knows everyone else, and anonymity is extremely difficult to maintain (like Iceland?).
[19] After a failed pilot project in New York, the development in the US has almost come to a standstill.
[20] Unless indicated otherwise, the following overview is based on Van Hove (2000). Other useful sources are Forschungszentrum

is used at least once a month the share of active cards is a mere 1 per cent (Riehm 2000). Thus, most of the cards issued are not used for payments. A low level of usage also becomes apparent when looking at the frequency of use. For all cards issued the average frequency of card-use is below one transaction per month (in all countries) and below 3 transactions per month if only activated cards are considered. Average balances stored on e-purses provide a similar picture: there are only three countries in which the average balance per card is above 1 EUR (Belgium, Luxembourg, Netherlands); there is no country with an average balance above 5 EUR. To put the above numbers into perspective it is useful to look at the Belgian example. The Belgian Proton purse is in many ways the most successful scheme. However, in 1998 there were a mere 28 million Proton transactions compared with an estimated number of cash transactions of 4 billion (Van Hove 2000, 22).

Thus, so far, payments with e-purses are of marginal significance. In all cases usage per card is small and the cash-substitution effect is negligible. Even more worrying, in some countries e-purse use seems to be stagnating or even declining. Danmønt, one of the oldest e-purse schemes, has basically had constant usage figures over the last three years (Danmønt 2001). In Germany, the number of activated e-purses (GeldKarte) and the number of transactions rose in 1999. But the number of terminals and the value of transactions declined (Riehm 2000).

Karlsruhe (1999), Godschalk and Krueger (2000) and SmartEuro (2000).

b. Tentative Cost Comparisons

Costs of payment methods are difficult to measure. Even if they could be measured correctly they would be difficult to compare because payment transactions differ substantially: there are large-value and small value payments, remote payments and face-to-face payments, etc.

Never-the-less, there are a number of cost studies and they mostly provide a positive picture for cash. Most studies show that cash still is a highly competitive means of payment. Studies of American, Dutch and German retail organisations found that cash is the cheapest means of payment at the POS (see tables 1, 2 and 3).

Table 1 Costs of Alternative Payment Methods for US Supermarkets

	Cash	Cheque	ACH	Credit Card	Online Debit
Cost per transaction	0.072$	0.426$	0.279$	0.808$	0.299$

The numbers refer to 1993.
Source: Food Marketing Institute (1994), quoted from Chakravorti (1997, 5)

Table 2 Costs of Alternative Payment Methods for German Retailers

In DM	Cash	e-purse#	Direct Debit***	POZ*	ec-cash**	Cheque
Cost/transaction	0.17-0.29	0.378	1.32	1.45	1.71	0.98-1.39

Source: Zellekens and Rueter (1996) and Schneider (1998). The numbers refer to the mid 1990s. The costs of an e-purse payment refer to 1998.
* Electronic direct debit without online verification.
** Electronic direct debit scheme with online verification offered by German banks
*** Electronic direct debit scheme with online verification offered by other providers
# GeldKarte transaction

Table 3 Costs of Alternative Payment Methods for Dutch Retailers

In EUR	Cash	Debit Card	Giro	e-purse	Credit Card
Cost/transaction	0.095	0.22	0.19	0.25	2.50

Source: Jaarsma and Rijt-Veltman (2000) quoted in Van Hove (2000). The numbers refer to 1998.

A similar pattern is emerging for payment costs of UK banks. According to estimates of Retail Banking Research (a market research and consultancy company) the cost per cash transaction are the lowest (see table 4).[21]

Table 4 Costs of Payment for UK Banks

Cash	Electronic Transfer	Card Transaction	Cheques	Credit Transfer (paper)
0.083	0.2	0.3	0.45	0.5

£ per transaction; Source Retail Banking Research

Not all studies, however, reach the same conclusion. In a study of payment costs in Iceland and Belgium De Grauwe, Buyst and Rinaldi (1999) find that card payments are cheaper than cash payments (see table 5).

Table 5 Costs of Card and Cash Payments in Belgium and Iceland 1997

	Cards	Cash
Belgium	26 BFr (1.3%)	22.6 BFr (9%)
Iceland	29 BFr (1.6%)	125 BFr (n.n.)

Source: De Grauwe, Buyst, Rinaldi (1999); percentages in brackets refer to transaction costs in per cent of the average transaction value; in 1997 one US$ was equal to 35.77 Belgian Francs

Without detailed knowledge of the source of the data and the methodology used, it is difficult to determine which estimates deserve more credibility. One reason for the differences may be that from the point of view of the retailer the relevant costs are not just the direct costs of a particular payment device. Retailers are interested in the costs of the entire payment process. Zellekens and Rueter (1996) show that “speed of payment”

[21] This is partly due to the fact that most cash transactions do not require the involvement of a bank.

is a decisive cost factor. Whether a supermarket has to man 5 or 6 cash counters over the day is much more important than the question whether e-purse handling at the end of the day is half an hour faster than sorting out cash receipts. Since cash still is a very fast means of payment the overall costs of using cash are comparatively low.

Table 6 Various Instruments in Retail Payments in Germany

in % of turnover	Cash	Bill	Retailer Cards	Credit Cards	POZ*	Electronic Cash**	Check	Other
1994	78.7	6.5	0.4	3.3	1.7	0.8	8.3	0.3
1997	76.5	6.5	0.5	3.5	6.5	2.5	3.5	0.5

*

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: – (1998, 6)

Table 7 Payments for Goods, Services and Financial Transfers in the UK

	Cheques	Paper Credit Transf.	Automated Payments	Credit Cards	Debit Cards	Other Cards	Postal Order	Cash
1989	15.4	2.2	6.9	2.7	0.3	0.4	3.7	68.3
1998	11.4	1.7	12.6	4.8	7.2	0.8	3.5	58.0

Source: APACS

Table 8 Retail Payments: The Share of Cash and Non-cash Transactions

	% of Retail transactions	
	Cash	Non-cash
U.S.	75	25
Europe	76-86	14-24
Japan	90	10

Source: Federal Reserve System (1998). Numbers probably refer to the early 1990s (no date given).

The competitiveness of cash is also reflected in its almost unchanged high market share in retail payments.[22] In Germany, for instance, access products such as POS payments (with and without online verification) have been growing strongly. Still, between 1994 and 1997, the share of cash has declined only marginally (see table 6).

[22] In Holland the share of cash in retail transactions is estimated to be 83 per cent. See Jaarsma and Rijt-Veltman (2000) quoted in Van Hove (2000).

In the UK, traditionally a more cheque-oriented economy, the use of both, cheques and cash has fallen significantly throughout the 1990s. Still, cash is by far the most important means of payment (see table 7). These estimates are in line with estimates of the Federal Reserve System for the U.S., Japan and Europe (see table 8).

These numbers show that cash is a competitive payment product and that most countries are still far away from a cash less society. Even if e-purses became much more efficient this might primarily affect other means of payment. So far, the one instrument that has strongly lost ground vis-à-vis new payments methods is the cheque (ECB 1999, 46-7).

c. Security and the Role of Counterfeiting

A group of economists sees bank notes as particularly vulnerable to the activities of counterfeiters. Dowd (1998) claims that the problem of counterfeiting has become so bad that central banks actively encourage the use of electronic substitutes. According to Neal and Eisler (1996, 36-48) the problem of counterfeiting US$ notes has reached dramatic proportions. They claim that terrorists finance their activities with faked dollars and that dollar counterfeits are used as a weapon in ‘monetary warfare' against the United States. However, their estimate of US$10 billion of counterfeits (2.3 per cent of the total amount of currency circulation) is not supported by empirical evidence. According to the Fed, in 1995, detected counterfeits amounted to 0.0075% of the currency in circulation (Allison and Pianalto 1997, 562). Although

this is high compared to countries like Germany (see table 9), it is hardly an alarming figure. Of course it may be possible, that detected counterfeits give a misleading picture. However, as Allison (1996, 321) points out, the Fed receives a large portion of the total currency balances each year. Each month about 20 per cent of the domestic circulation is received. Since all bank notes that are returned to the Fed are examined, the Fed gets a fairly accurate picture of the amount of counterfeiting. Information about foreign circulation may be less reliable. But since a certain fraction of foreign circulation is returned to the US each year, the Fed gets also information about counterfeiting abroad. On average, the share of counterfeits of all notes returned from abroad was lower than the average for the total circulation (0.005 per cent, see Allison 1996, 322).[23]

When interpreting these figures it should be kept in mind that – at least in the case of the US – the majority of counterfeits is seized before they get into circulation (Roberds 1998, 44).

Table 9 Detected Counterfeits in Three Countries

	Detected Counterfeits	Bank Notes in Circulation	Counterfeits in % of Circulation
United States (1995)	30 million US$	390 billion US$	0.0075
Canada (1999)	4.2 million Can$	36.5 billion Can$	0.011
Germany (1999)	2.316 million DM	274 billion DM	0.00079

: A (1996, 321), A (1997, 562), (2000 ,30 2000), (2000, 126-8)

A noteworthy feature of the data is that counterfeiting seems to be a more serious problem in the US and Canada than in Germany

[23] See also United States Treasury (2000) report on counterfeiting of US$ abroad.

(see table 9).[24] Still, it appears that the problem of counterfeiting is greatly exaggerated by some authors. The reported figures can hardly be used as an argument against cash. Plastic card fraud, for instance, causes much higher losses. In the UK alone, plastic card fraud (debit-, credit-, and check-card) produced losses of more than UK£ 100 millions in almost every year since 1990 (APACS 2000).

The small scale of counterfeiting of bank notes can be partly explained by technical progress. Technical progress has not just favoured the development of new media of payments. It has also increased the quality of bank notes – a fact that is sometimes overlooked. In many countries, bank notes incorporate a number of safety features that make counterfeiting difficult.[25]

While counterfeiting is hardly a fundamental threat for currency it may well be one for e-purses. In particular for those types of e-purse that promise anonymity, counterfeiting may become a large problem (Ely 1997, 102-3). In order to defend themselves against the attempts of hackers, e-purse issuers will have to upgrade their systems continuously. But even if they do so, the risk remains that hackers successfully break the encryption.[26] This has some unpleasant implications for e-purse issuers. The typical e-purse user is no expert in encryption and therefore unlikely to be

[24] The Fed has introduced new notes with better safety features relatively late. See Allison and Pianalto (1997).
[25] In Australia, the introduction of polymer notes has reduced counterfeiting dramatically. See Coventry (1998).
[26] Successful attempts to crack encryption are reported in Bonorris (1997, 33), Pollack (1996) and Wayner (1998).

willing to shoulder the risk of counterfeiting.[27] Therefore, issuers will have to carry the risk themselves if they want to persuade households and firms to switch to e-purses. This implies that issuing e-purses can be a very risky business. As McAndrews (1997, 24) points out, digital counterfeiting can easily wipe out the entire reserves of an e-purse system. Even a 100 per cent backing of the e-money stored on e-purses could be insufficient to prevent bankruptcy (McAndrews 1997, 14).

A fraud case that occurred in Japan illustrates the potential dangers (see Pollack 1996). Japanese ‘Pachinko’ (pinball) parlours introduced magnetic stripe cards as means of payments. These cards were issued by Sumitomo Bank and Mitsubishi Corporation. The card technology was supplied by Nippon Telegraph and Telephone (NTT). Large-scale fraud became possible when gangs stole reading machines and started to copy new value on old cards. The damage was considerable. Sumitomo and Mitsubishi lost a combined US$600 billion. That is about 15 times the annual value of detected bank note counterfeits in the U.S., Canada and Germany combined.

Admittedly, magnetic stripe cards are not very safe. Therefore, the industry moves increasingly to smart cards. Smart cards have an embedded chip and are much safer. However, even smart cards have been cracked (Wayner 1998).

Last but not least, attacks from the ‘outside’ are not the only problem. Even when safety against attacks from outside may be

[27] Cash users are forced to shoulder the risk of fraud. However, simple visual inspection can help a cash-user to some extent to determine whether a bank note is faked or not. In the case of e-money such inspection is impossible for the normal user.

sufficiently high, this still leaves fraud committed by insiders. This problem is emphasised by a number of authors. Bonorris (1997, 28), for instance, argues that ‘

A

. The BIS (1996b, 52) also underlines that an attack on ‘administrative security’ during the manufacturing, issuing and distribution process may be a more severe problem then attempts to break the code embedded in stored value cards.

The unresolved security problem and the potential dimension of the problem, make e-money issuers prone to crises of confidence. If it is known to the public that fraud can lead to bankruptcy of an e-money issuer, rumours about fraud can easily spark a run (McAndrews 1997, 24).

When assessing the existing security measures, the BIS (1996b, 21) concludes that adequate security for electronic money systems can be achieved. However, as the BIS points out, there is a trade-off in the areas of cost, functionality, speed and reliability. Thus, higher security involves either less seigniorage (maximum balances per card), less convenience and flexibility for the user (restricted offline use, time limits) or higher costs (better storage devices, better cryptography, online authorisation etc.). Thus, security issues may have important implications for costs and revenues.

d. Is there a Business case for e-purses?

A key problem for e-purse issuers is counterfeiting. Given the potentially large size of fraud, issuers will have to find an effective way to deal with this risk (and the other risks involved in running an e-money scheme). In order to protect themselves, e-money issuers will have use the following means against counterfeiting:

- frequent technical updates
- limitations on the maximum amount that can be stored on cards
- limitations on the duration of e-money balances
- no peer-to-peer payments[28]

Limitations on maximum values do not just decrease the maximum damage that can occur within a certain period. Low maximum values also create smaller incentives for hackers. Thus, the lower is the maximum balance per card, the lower the probability of counterfeiting. Therefore, risk considerations favour fairly low limits for the maximum balances that can be loaded onto a card. Limitations on the duration of e-money balances allow issuers to frequently update e-money balances. The use of technically advanced systems is an important protection against fraud. Finally, the exclusion of peer-to-peer transactions allows issuers a more effective control of the system – in particular, faster recognition of an attack.

[28] Only one scheme, Mondex, allows peer-to-peer payments. However, this makes Mondex more prone to fraud. To protect the system, Mondex has to use a much more sophisticated chip. Whereas Proton cards cost EUR 2.5 a Mondex card is estimated to cost between EUR 8 and 10 (SmartEuro 2000, 12-13).

These measures do not just reduce risks they also have potentially huge effects on costs and revenues. Frequent updates of the system in order to stay on top of the technological development substantially increase the costs of e-money schemes. The other measures reduce the way in which e-money can be used. In particular, they limit the use of e-money for hoarding purposes. This has serious implications for e-money issuers. Only a fraction of the total stock of bank notes, maybe not even 5 per cent, is used for legal payments (Avery et al. 1986 and 1987, Boeschoten 1992). If the demand for e-money mainly comes from people who want to use it as a means of payments in legal transactions, average balances per smart card are likely to be small. Ely (1997, 103) calculates that 100 million cards with an average balance of US$100[29] would yield merely US$10 billion of total e-currency in circulation, as compared with a present total currency circulation of US$530 billion. This implies that the potential amount of seigniorage is also relatively small. Assuming an interest rate of 6 per cent this would yield US$600 million or US$6 per card. In an estimation of potential seigniorage losses of the Bundesbank, Janssen and Lange (1997, 7) assume a card circulation of 60 million and average balances of DM 78.50 (about EUR 40). Using again an interest rate of 6 per cent an average seigniorage of DM 5.25 (about EUR 2.65) per card can be calculated. Given that a card costs already EUR 2.5, this is hardly enough to break even.[30]

[29] An average balance of US$100 is also assumed by Boeschoten and Hebbink (1996), 2.

[30] Technical change and the normal ‘tear and wear’ limit the life span of a card. Therefore, costs cannot be spread over many years.

Davis (2000) quotes estimates that a European-wide smart card system based on CEPS (Common Electronic Purse Specifications) would cost between US$ 4.8 and 6.6 billion.

If seigniorage is not high enough to cover the costs of e-purse schemes issuers will have to rely on fees. Goldfinger (1999) cites a calculation by Edgar, Dunn and Company (a consulting firm), that shows that a medium sized issuer with 400,000 cards and 250 transactions per card would break even in 5 years with the following fee structure: customers pay 7.5$ per year and a load fee of 0.3$, merchants pay a commission of 0.55%. Clearly, 250 transactions per year is a far cry from reality. Currently, issuers are happy to record 10 transactions per year per card (Van Hove 2000). So, either they would have to take higher fees or accept temporary losses (that might turn out to be permanent). However, relatively high fees will not make it easier to market e-money. So far, merchants have resisted the introduction of costly new payment methods. One reason for this is that the partial substitution of cash will not reduce costs very much because cash handling involves high fixed costs. Customers are often quite content with existing means of payment (Good 1998, 15, Van Hove 1999a) and are not willing to pay for yet another card.

Taking the views of customers and merchants into account, there are clearly narrow limits for the potential size of fees. This implies, first, that it is unlikely that interest will be paid on e-money balances and, second, that it is still not clear whether e-money schemes will ever reach profit territory (Godschalk and Krueger 1998, Goldfinger 1999). Of course, issuers could start

with low or zero fees and raise fees later on when e-money is used more widely. But such a strategy is not without risks. First of all, there may be political pressures that make it difficult to raise fees and, second, there may be competitive pressures. To give just one example, German banks never managed to introduce a fee for the use of Eurocheques. Thus, the business case for e-purses looks doubtful – at least for medium and large value payments (Godschalk and Krueger 1998, 10). The only area where e-purses will unambiguously be highly competitive is the area of unattended POS.[31] There seems to be a clear business case for the replacement of coins. In particular, payment at vending machines, phones etc. is much more convenient with cards.[32]

[31] Another area might be internet payments. However, in this area e-money does not compete with cash.

[32] This result is in line with the findings of Kabelac (1999) who shows that e-money has a comparative advantage in small denomination payments.

IV. The Evidence on Cash Usage from Macroeconomic Time Series Data[33]

Several of the technological developments discussed in earlier Sections of this paper have already been under-way in advanced countries for many years, so if technology was to be a serious threat to cash usage, one might expect to find some signs of this in the data by now. So the first priority of the empirical exercise in this Section is to examine whether technological variables could be found that had significant effects on cash holdings. These are the first set of factors we try to determine.

Perhaps the best published papers on cash usage in recent years are by Boeschoten (1992) and by Rogoff (1998). Rogoff’uiemp5l ctor4119 4

payment, but the threat of mugging will deter cash holdings among law-abiding citizens.

So, the second set of factors potentially driving cash usage will be `bad behaviour', e.g. the grey or black economy domestically, but also bad economic behaviour by governments with bad inflation records causing substitution of cash issued by good governments (e.g. US$ or DM) for domestic currency. Thus a second set of potential variables were those that might prove a measure of `bad behaviour', such as Rogoff's tax/GDP and crime proxy variables.

Besides technological and `bad-behaviour' variables, cash holdings, as a % of GDP, may be influenced by standard macro variables, interest rates representing the user cost of holding non-interest-bearing cash, and some measure of real income (to test whether the income elasticity of cash holding is greater or less than unity). Such `macro' variables provide a third set of possible variables.

The ratio of currency holdings to GDP in most (developed) countries in the last few years has been strongly trended, but the trends have gone in different directions (Figure 4a, b and c). If we were to explain currency holdings adequately, we reckoned that we needed to be able to give some explanation for the cross-country differential trends. So our basic econometric model has been a combination of cross-country and time-series, a panel approach.

Taking 1997 as an example, the overall average cash to GDP ratio in our sample is 5.3%. These numbers would appear to imply that

each person on average would hold about $1635 in the US, and in Japan 418.200 Yen (3485 US$) if all such cash was held domestically. The picture is even more surprising if one looks at data for large notes outstanding. Figure 2 (presented earlier) shows that these represent a remarkably large proportion of all currency outstanding in many countries. According to the currency statistics each American should carry nine one hundred dollar bills, and each German at least one 1000 DM bill (625 US$) in 1997. These numbers are hardly congruent with common money holdings for day-to-day purchases. One commonly held view in the literature is that huge amounts of cash holdings are used in the black or grey economy for crime, tax evasion, prostitution, drug dealing, betting, etc. Furthermore, it seems clear that a lot of US$, Swiss Francs, German Marks and Japanese Yen are held abroad. Doyle (2000) finds in his recent study that roughly 30% of US currency and up to 77% of the Swiss currency is held abroad, (also see the studies of Porter and Judson for the US (1996) and Seitz for Germany (1995)). Such huge foreign money holdings can be attributed to international criminal activity and also to “dollarisation” in countries with high inflation records and an unstable political environment. The impact of crime and “bad behaviour” is likely to be greater for large bank notes, as these facilitate storing and movement of large sums of money.

Besides the likely different effects of crime and “bad behaviour” for large (rather than small) notes, we also expect that modern payment technologies like debit or credit cards would have a more pronounced effect on small notes. This should be the case as small notes are used for everyday transactions and might more easily be substituted by card payments.

Following Doyle (1999), we split cash outside central banks into large and small bank notes and run our different regressions for these series as well. We arbitrarily set the boundary for small notes at the local currency value of £50.[34]

To generate a comparable data set we had to restrict ourselves to annual data from 1980 to 1998 for 18 OECD countries.[35] Even so, for many variables, data were only available for parts of this period and for a sub-set of countries. In all regressions we used the biggest data set available.

The main variable of interest was cash holdings. We used as our main series, and dependent variable, the ratio of cash outside central banks to GDP (CGDP). To generate the series for small and large bank notes we arbitrarily set the boundary at the local currency value of £50. We then deflated both series by GDP, which gave SmallGDP and LargeGDP.

Our regressors can be roughly divided into three categories: general macroeconomic variables, technological variables, and “bad behaviour” variables. We next discuss each set separately.

[34] At the end 1999 exchange rate.

[35] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United States and United Kingdom.

Macroeconomic Variables

1) Interest rate (i)

This is taken as the nominal overnight money market interest rate.

2) Real consumption per head (cons)

We converted each series into dollar values at the 1990 exchange rate. For 5 countries this variable could not be constructed for the year 1998. Otherwise the data set is complete.

3) Inflation (infl)

This is derived as the percentage change of the consumer price index.

4) The ratio of consumption over GDP (consgdp)

Rationale

The choice of an interest rate and real consumption per head reflects theories of the demand for money. According to theory, the interest rate should be negatively correlated with currency holdings. Real consumption per head is used as the proxy for real income per household. We used consumption rather than GDP, since the dependent variable was deflated by GDP, so errors in estimating GDP would cause spurious correlation. This should be less so, when consumption deflated by population is used. Moreover, most cash is used for consumption goods (not for

investment). The income elasticity of cash holding is normally found to be less than unity. Given our linear estimation with variables expressed as ratios, the coefficient for real consumption per head should therefore show a negative sign.

The rationale for including inflation was to see if higher inflation decreases the demand for money. This should be the case as an increase raises the opportunity cost of holding cash and thus should lead to a decline in money holdings. Given that expected inflation rates are already incorporated in the interest rate, no additional negative effects might be seen for this variable.

The variable Consgdp was used to measure cyclical effects. We believe that the use of cash should be more stable than GDP. Shopping for everyday necessities where lots of cash is used is not as hard hit by a recession as investment or inventories. The demand of cash in the underground economy might also be more stable.[36] A recession would thus imply that Consgdp is relatively high and the ratio of cash to GDP also increases. We therefore expect a positive sign for Consgdp on CGDP.

Technological Variables

1) The volume and value of cheque and card payments

[36] In the black economy the demand for cash might even rise in a recession. Might it not be that crime rises during recessions?

The series of the volume (value) of cheque and card payments were deflated by GDP per head. We were able to cover 10 OECD countries from 1991 till 1998.

2) The number of ATMs and EFTPOS terminals

The series are both normalised to the number of ATMs and EFTPOS terminals per million inhabitants. Except for Australia, New Zealand and Norway, data were available from 1991 till 1998.

3) Internet hosts (intern)

The series is the number of internet hosts per 10,000 people. All countries from 1994 till 1997 were included.

4) The number of telephone mainlines (tel)

The series is normalised to the number of telephone mainlines per 1,000 people. It was available for all countries except Japan from 1980 till 1997.

Rationale

Initially one might expect that the effects of credit cards and EFTPOS would be to decrease money holdings. Are we not paying our shopping bills or underground tickets with a credit or debit card now, when we would have used cash ten or fifteen years ago? This casual observation appears to be supported by looking at cross-country differences (Figure 5 and 6). A negative linear relationship between cardpayments / EFTPOs and CGDP seems quite

apparent for 1997. This has been found in the literature. E.g. Snellman et al (2000) or Boeschoten (1992) found a significant negative relationship between these technological variables and the use of cash.

The effects of ATMs might be ambiguous. On the one hand, ATMs should decrease the transaction costs of money holdings. According to the Baumol-Tobin theory of the transaction demand for money, this implies a decrease in money holdings. On the other hand, more ATMs imply that cash is more readily available, and so an easier substitute for non-cash payments. Thus it might even increase the demand for money. The latter argument gets some support by a cross-country scatter plot for 1997 (Figure 7). Evidence for both arguments can also be found in the literature. Snellman et al (2000) finds a significant negative relationship, whereas earlier studies (e.g. Boeschoten (1992)) show no significant or a positive effect.

The latest development in payment technology is the advance of internet banking. Some, for example Friedman (1999), even forecast that this, combined with other modern payment technologies, might threaten the existence of cash in the future altogether. We tried to see if there were already some significant effects over recent years. We were, however, unable to find data series for internet banking. We therefore used the number of internet hosts in each country form 1994 to 1997 as a proxy. The cross-country scatter plot for the year 1994 (Figure 8), suggests that there might indeed be a negative relationship between CGDP and this variable.

The last technological variable we considered is the number of telephone mainlines. This is used as a general proxy for technological change. We hope that this is also related to technological progress in the banking sector. We are not too convinced that it is a very good proxy. It is, however, attractive as the available data covers the entire time period and is available for nearly all countries. It should have a negative effect on cash holdings.

"Bad Behaviour" Variables

1) Crime

The total number of assaults or major assaults was normalised by population. A consistent data set could only be constructed for 10 countries from 1980 till 1997.

2) The ratio of total tax revenue over GDP (RGDP)

Total government revenue was deflated by GDP. We were able to obtain these data for all countries. Data for the entire time period were, however, only available for 5 countries. Whereas data are available in this case, the question of exactly which series to use, e.g. what categories of payments to government, whether to include local as well as central government, is less clear. The econometric results can be sensitive to the precise definitions chosen.

3) The ratio of the total value of the highest value note outstanding to the total value of currency outstanding (hnrel)

This series was constructed by taking the ratio of the total value of the highest value note outstanding to the total amount of cash outside central banks.

4) The five year and ten year depreciation of the local currency with respect to the dollar (5/10)

This is defined as the percentage change of the local currency relative to the dollar exchange rate at date t and t-5 (t-10). All countries are covered for the whole time period. The two series were multi-collinear, so in practice we only used the five-year series.

Rationale

Our variable “crime” is used as a proxy for criminal activity. Rogoff (1998) argues that the effect of an increase in crime on cash holdings is ambiguous. On the one hand, it should be negative as the likelihood of getting robbed increases and thus people carry less cash. On the other hand, it should increase the demand for cash in the criminal fraternity.

Cagan (1958) was the first to argue that the high amount of cash outstanding could be due to the demand for cash in the underground economy. The ratio of taxes to GDP should increase money holdings as citizens try to evade taxes by shifting part of their economic

activity to the black or grey economy, in which paying with cash is the common practice. Other studies confirmed this result, see Tanzi (1982), Porter and Judson (1996), Rogoff (1998) or Sprenkle (1993). Using cointegration methods, Doyle (1999), however, challenged these findings, as his results for 15 industrialised countries indicate that the amount of taxes either have no significant, or a negative effect, on currency holdings.

As mentioned earlier, criminals tend to pay and store large sums of money in cash. It is much easier with high value notes. Given other criteria, international criminals should prefer currencies with a higher value of the highest note outstanding. A higher ratio of the total value of the highest value note outstanding to the total value of currency outstanding should thus increase the total demand for money.

A vast amount of Dollars and Deutsche Marks outstanding are currently held outside the country of origin. Besides historical reasons and ease of acceptance, the demand for foreign money holdings might be attributed to a low inflation record. This effect should reinforce the domestic negative effect of inflation. Furthermore, the stability of a currency towards the “world” currency, the US dollar, should be an important determinant in foreign money holdings. We try to take these effects into account with the five and ten year depreciation of the currency with the respect to the dollar. Depreciation should generally weaken the demand for the currency. Given our definition of the exchange rate as the amount of home currency per US$, the sign should be negative.

Estimation Procedures

There is no theoretical model which specifies exactly which variables should be included and which not. We, therefore, worked our way from a general to a specific parameterisation of the demand for cash. We used two criteria for the elimination of variables to arrive at our preferred specification: the first was whether that variable had a low t-statistic; the second was whether it most limited the size of our sample to fewer countries and years. Due to theoretical reasons the interest rate and real consumption were never eliminated.

This procedure left us with Specification I, with nine independent variables, each of which was significant and correctly signed in at least one of the equations.

Specification I:

[Insert Specification I]

As we had to estimate in first differences, in order to eliminate trended variables, and to achieve stationarity, and had data for ATMs and EFTPOs from 1991 till 1998 for 16 countries, we had only about 70 data points from 1992 till 1998. For the effects of payment technologies, these results are the best we can present. The results can be seen in Table 1.

The omission of ATMs and EFTPOs enlarged the sample to over 130 data points from 1981 till 1998. This gave us Specification II.

Specification II

[Insert Specification II]

Our results are shown in Table 2.

[Insert Table 1 and Table 2]

Our discussion of these regressions follows the broad separation of explanatory variables into those that are (i) macroeconomic, (ii) technological and (iii) “bad behaviour” variables.

Macroeconomic Variables:

Both in Specification I and Specification II (Tables 1 and 2) the interest rate (i) always enters negatively (as would be expected from standard theory) for CGDP and LargeGDP. For SmallGDP, not only the significance but also the sign changes with fewer years. This weak result for small notes is not surprising. We assume that they are used for everyday transactions. Small changes in the interest rate should not alter standard everyday transaction habits drastically.

Real income (Cons) enters negatively as predicted, though not significantly so for large bank notes. This, again, is not unexpected as we assumed that large bank notes are used primarily for ”bad behaviour”.

Our cyclical variable (Consgdp) enters with a positive sign and is significant for SmallGDP and CGDP. For LargeGDP, no significant effect can be shown, (perhaps because `bad behaviour’ is more pro-cyclical than consumption?). The effects of the cyclical variable are highly robust to changes in the data set.

Inflation dropped out earlier in the process of testing down to the preferred specification.[37]

Resume:

In our estimations we find the standard effects for macroeconomic variables on the demand for cash. We additionally showed that cyclical effects are an important determinant for money holdings relative to GDP.

Technological Variables:

ATMs and EFTPOS terminals are the only technological variables we found significant in any specification. Given our results (Table 1) it seems that both have pronounced effects only on the demand for small bank notes.

The impact of EFTPOS is significantly negative only for SmallGDP. This, at first disappointing, result is, however, not at odds with our earlier discussion, where we argued that progress in payment technology should have a more distinct effect on small bank notes. As these are mostly used for everyday transactions, they are more easily replaced by electronic payment methods. We also assumed

[37] This may seem surprising since, on its own, inflation is significantly negatively related to currency holding. But, according to theory, (the Fisher relationship), nominal interest rates depend on real rates, plus expected inflation. So, once nominal interest rates enter into demand for money studies, (e.g. Goldfeld 1973), inflation often drops out. It is only in cases where nominal interest rates fail to reflect inflationary expectations well, (as often occurs in hyperinflationary conditions), that inflation becomes strongly significant in multiple regression exercises.

that large bank notes are held mainly in the black and grey economy and predicted, therefore, no great impact of modern payment technologies on the demand for them. This, indeed, seems to be the case and the insignificant effect for large bank notes drives the effect on the overall demand for cash. In contrast, the demand for small bank notes appears to be significantly and positively related to the number of ATMs.[38] People may go more often to the cash machine to get small amounts of money, implying an increase in the demand for small bank notes.

Resume:

The evidence for technological variables altogether implies that they did not have an important effect on the demand for cash in the last 10 years. The only significant influence could be shown for ATMs (positive) and EFTPOS (negative) on the demand for small bank notes under certain specifications, (and these latter results were not all that robust to varying the number of countries, or years, included in the regressions).

"Bad Behaviour" Variables

All the proposed "bad behaviour" variables, except "crime", appeared to have an impact on money holdings.

[38] Its impact on LargeGDP and CGDP is not significant, but shows a negative sign.

In accordance with results in the literature, we found a positive effect of taxation on the demand for money. The effect on holdings of small notes is less than for large ones, which is not surprising.

One has, however, to be very cautious with this result. The significance level of RGDP is highly dependent not only on the time period covered, but also on the countries included. One can see the effects of the inclusion of different years by changes in the estimates from Specification I to Specification II (Tables 1 and 2). More worrying is how volatile the result is to the exact countries included. For example, we re-estimated Specification II without Austria. This small change had a drastic consequence for the significance level of RGDP. Its t-statistic dropped from 1.81 to just over 0.33. The positive sign, however, remained.

The effects for hnrel are amongst the most robust in our exercise. The higher the ratio of the total value of all the highest value notes outstanding to the total value of notes outstanding the more cash there is relative to GDP. This is exactly what we expected. This effect is reversed for small bank notes. It seems that the use of the highest value note has a negative effect on the use of small bank notes. We may, perhaps, be picking up the two different effects of crime, since we expected hnrel to be a proxy for cash use in “bad behaviour”. There we noted two effects: it lowers money holdings, as the likelihood of getting robbed increases (the effect on small bank notes). On the other, hand it increases the demand for cash as one needs large sums of cash to ship and store value. Unfortunately, our data set for the

variable “crime” was too limited to investigate these effects more thoroughly with another more direct proxy for criminal activity. Future research might help to clarify this issue.

The five year depreciation with respect to the $US shows the assumed negative influence on the demand for cash in Specification II with the most data. The sign and the significance level are, however, highly year and country dependent.

Resume:

“Bad behaviour” seems to have an important impact on the demand for cash balances. National and international dimensions of “bad behaviour”, such as RGDP, hnrel and the 5 year depreciation, appear to be the main driving forces for cash holdings. The signs of these variables are quite robust. For RGDP and the five year depreciation, the t-statistic is, however, very volatile, depending on the set of countries and the time period covered.

Conclusions

If the last twenty years are a guide to the future, then we are quite confident that cash is not an endangered species. On our evidence, the effects of modern payment technologies on the demand for cash are not that strong.[39] We could only find a significant

[39] These results are in line with those Snellman et al (2000).

negative effect for EFTPOs on the demand for small money balances. This, however, is quite powerful. If we assume an average annual growth of EFTPOs of 20% and that we could extrapolate the estimated linear relationship, then it would only take 15 years until no small bank notes would be held in the US anymore. However, the advance of ATMs has seemed to increase the demand for small notes. Given these opposite forces, it seems that technology is not crowding out small bank notes entirely. In any case technology so far has had no appreciable effects on the demand for large bank noets, and hence on the overall demand for currency, whose overall amount outstanding is more influenced by large, than by small, note holdings. Furthermore, “bad behaviour” variables show strong positive effects on the demand for small and large bank notes.

V. Conclusions

New means of electronic payment are, no doubt, fascinating from a technological point of view. This by itself already makes them look superior. In addition, they have some undeniable advantages when compared with cash. However, technological sophistication can also imply more complexity, including the need for more information transfers and more steps in the process. There is nothing as simple and straight-forward as making a cash payment. The payer hands over a physical object, eg. a bank note, to the payee. Even a small child is capable of comprehending such a transaction. In principle, the two parties involved do not need any special software or hardware for this transaction. There is also no need to inform a third party to make the transfer valid.

The payee can immediately re-spend the money he or she received. By contrast, e-payments usually involve a third party as intermediary. Even in offline transactions funds received have to be authenticated by the issuer and cannot be immediately re-spent (the only exception being Mondex). The transaction itself consists of communication between electronic devices. For payer and payee there is no direct way of control what type of information is exchanged and what is stored. These features of electronic payments have important implications.

Users concerned about anonymity will generally prefer to use cash rather than e-money. There are many reasons why people may prefer anonymity – many of which are connected with “bad” behaviour. Black or grey economies as well over-intrusive governments are examples of such behaviour. [The following three sentences are from the conclusions of chapter 4 and would have to be deleted from that chapter.] Even though politicians always announce that they want to be tougher on crime, we are sure that they will not succeed entirely. Black and grey economies will persist in the future. Similarly, governments will continue to “mis-behave”. This implies a powerful source of demand for cash balances.

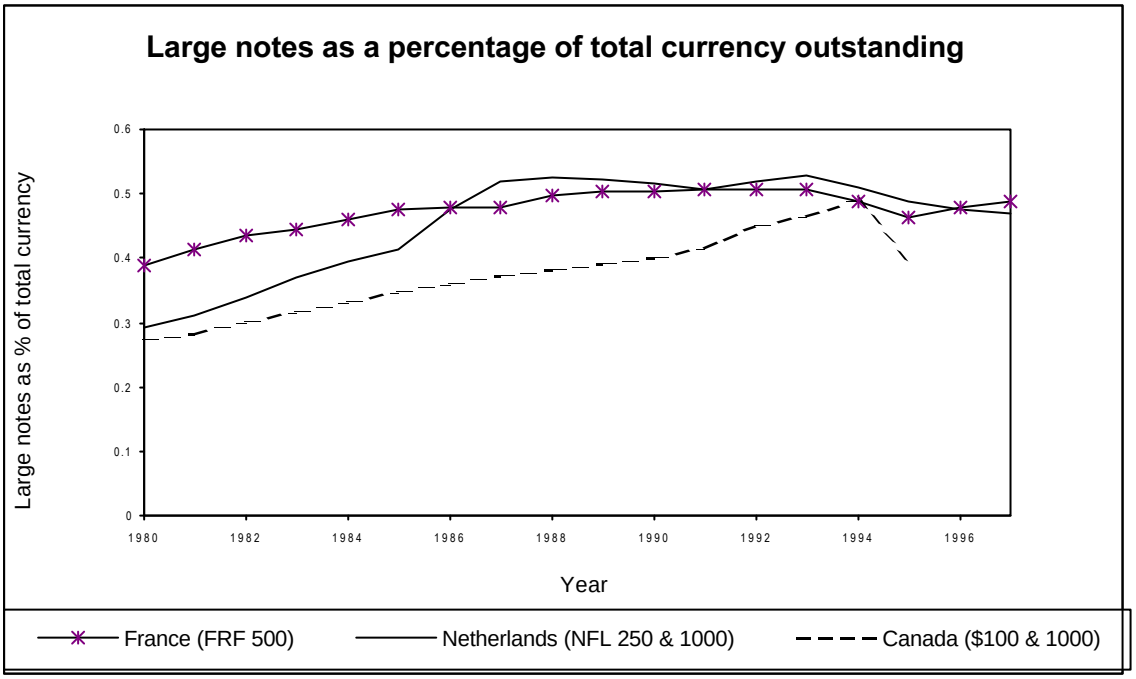
Surprisingly, sophistication also seems to increase vulnerability. The simplicity of cash means that every cash user can to some extent help to detect fraud. In an e-money system this task is entirely confined to the system operators (and specialised police

forces). This implies that costs to protect the system will remain high.

Renowned economists such as B. Friedman or M. King 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 new Millennium. Stop worrying!

Figure 2

(a)


Large notes as a percentage of total currency outstanding
Large notes as % of total currency
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
Year
France (FRF 500)
Netherlands (NFL 250 & 1000)
Canada ($100 & 1000)

(b)

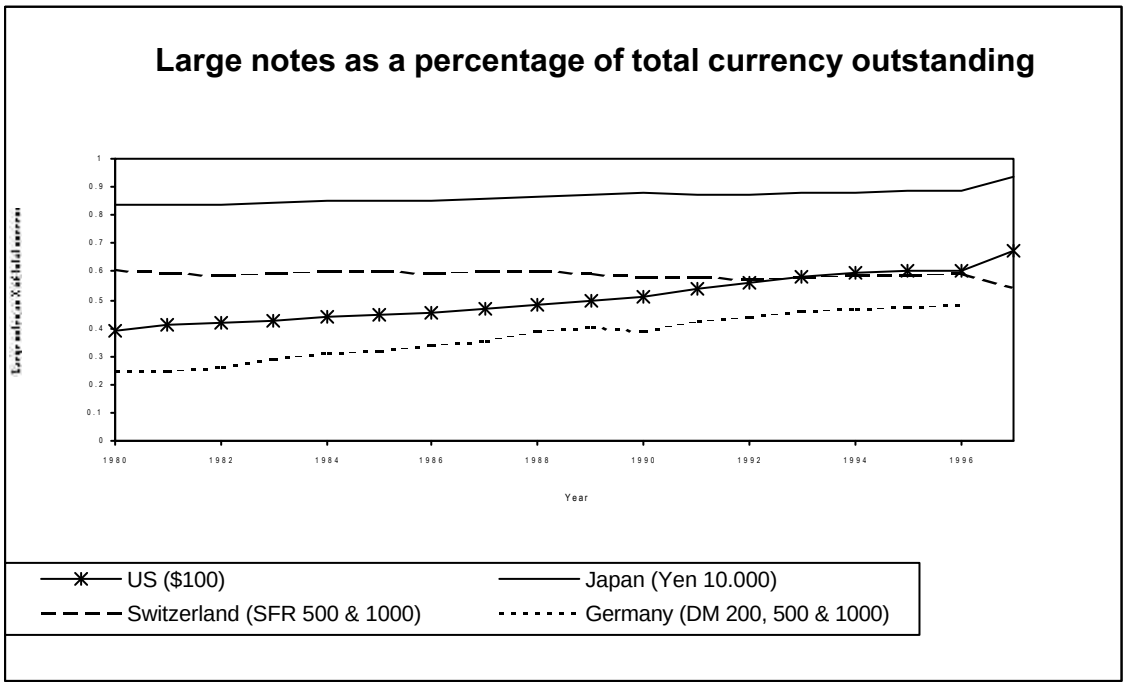
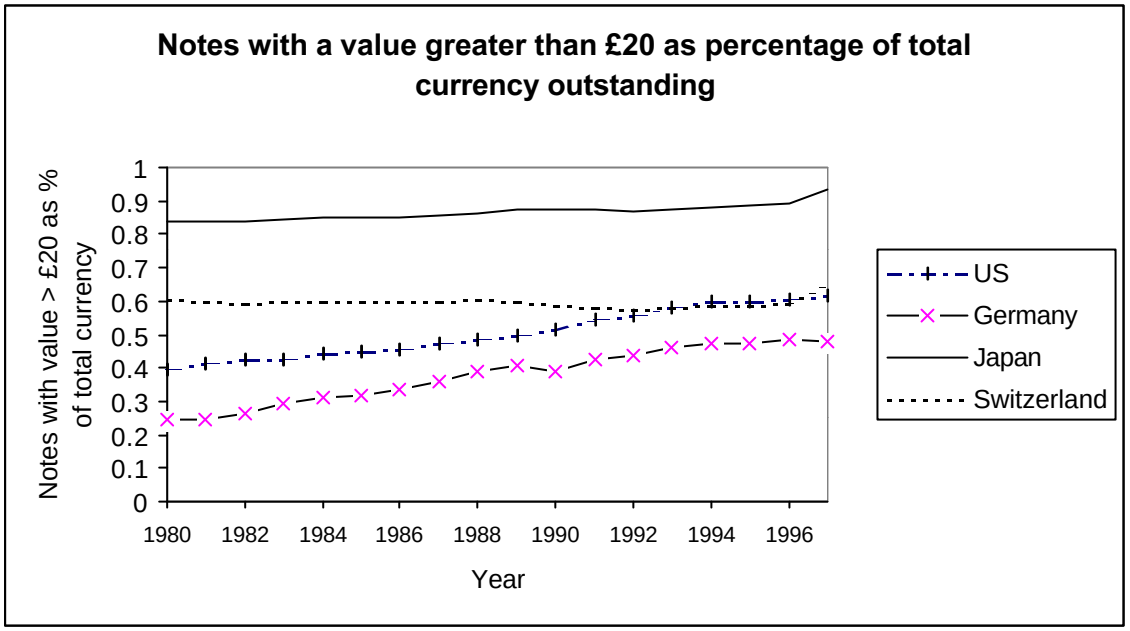

Large notes as a percentage of total currency outstanding
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
Year
US ($100)
Japan (Yen 10.000)
Switzerland (SFR 500 & 1000)
Germany (DM 200, 500 & 1000)

Figure 3

(a)


Notes with a value greater than £20 as percentage of total currency outstanding
Notes with value > £20 as % of total currency
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
Year
US
Germany
Japan
Switzerland

(b)

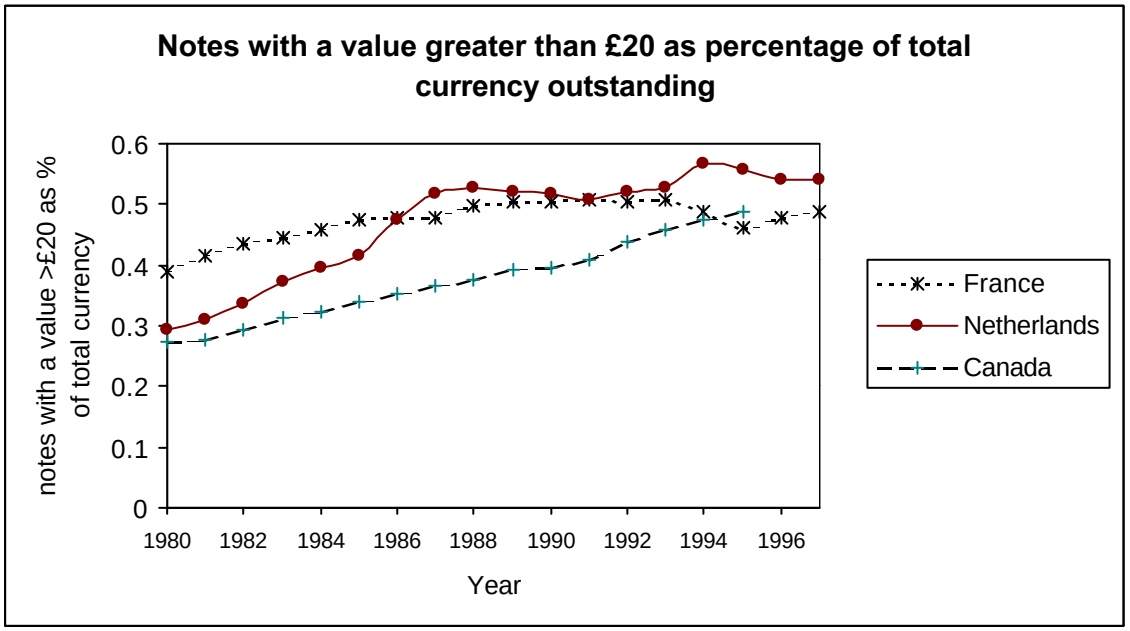
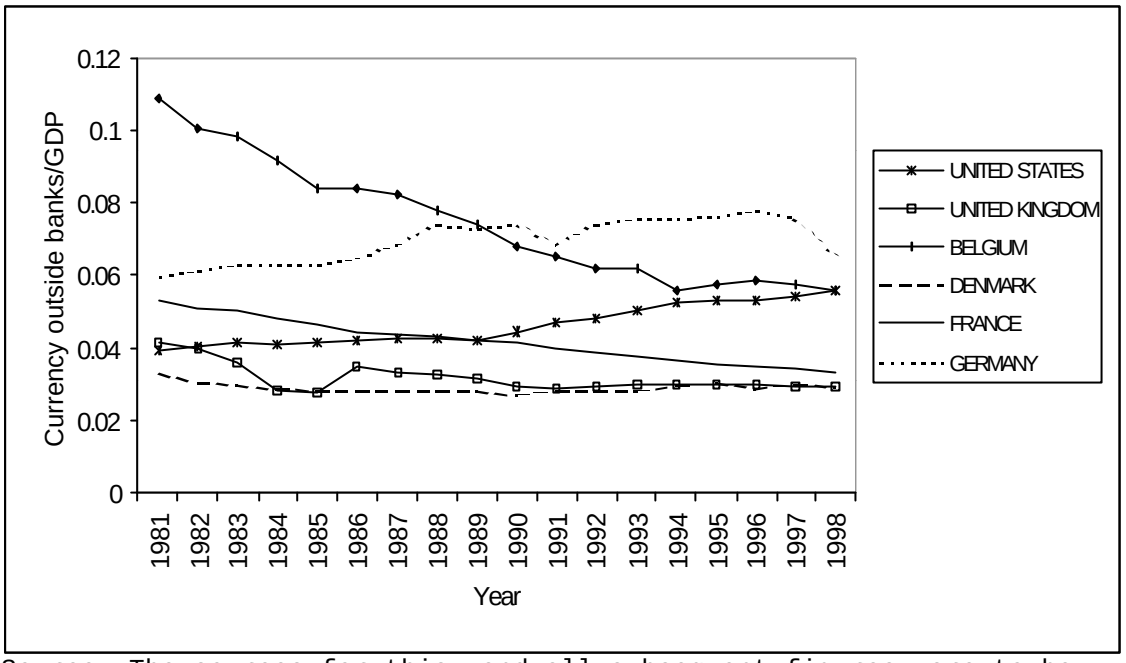

Notes with a value greater than £20 as percentage of total currency outstanding
notes with a value >£20 as % of total currency
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
Year
France
Netherlands
Canada

Figure 4

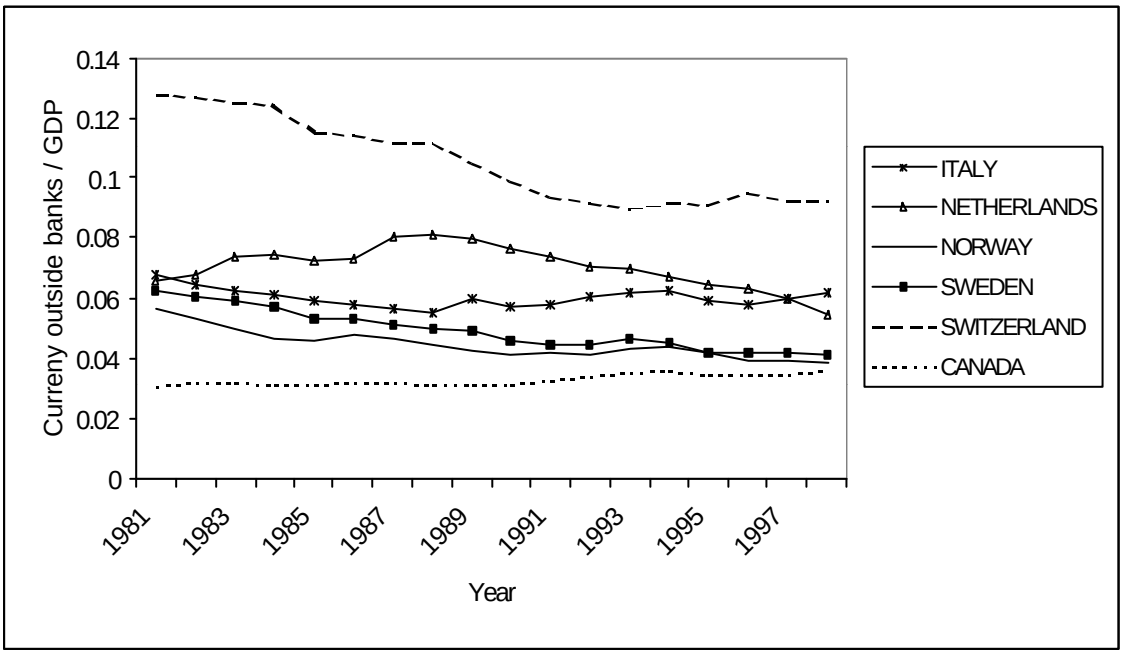
Currency outside central banks over GDP

(a)



Source: The sources for this, and all subsequent figures, are to be found in Drehmann and Goodhart (2000)

(b)



(c)

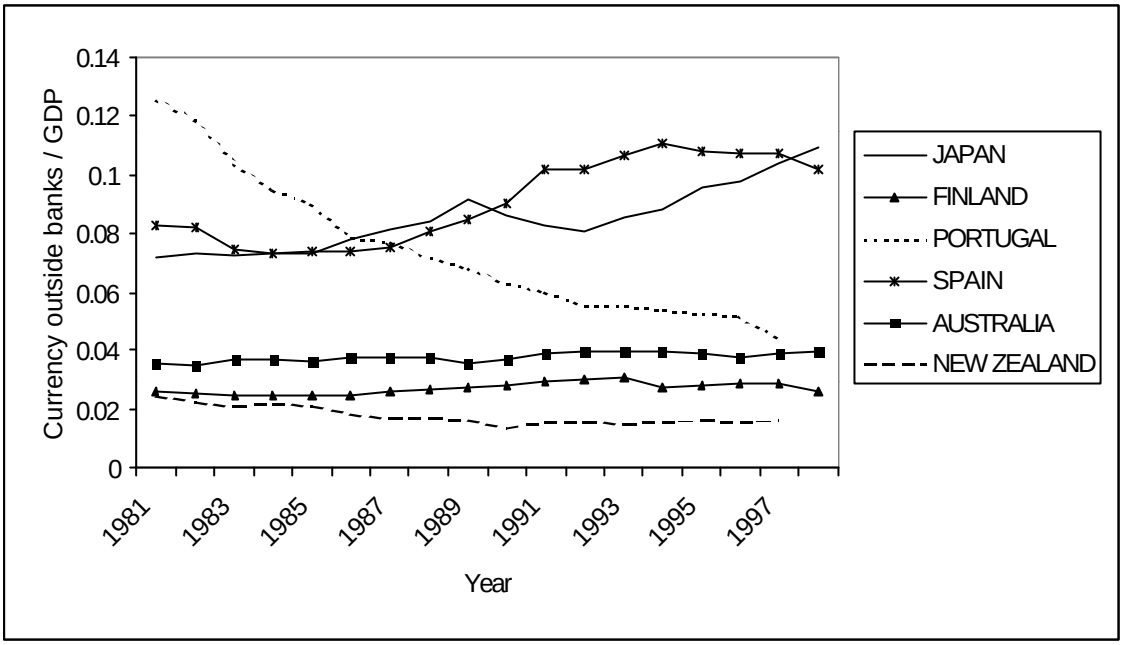

0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Currency outside banks / GDP
1981
1983
1985
1987
1989
1991
1993
1995
1997
Year
JAPAN
FINLAND
PORTUGAL
SPAIN
AUSTRALIA
NEW ZEALAND

Figure 5

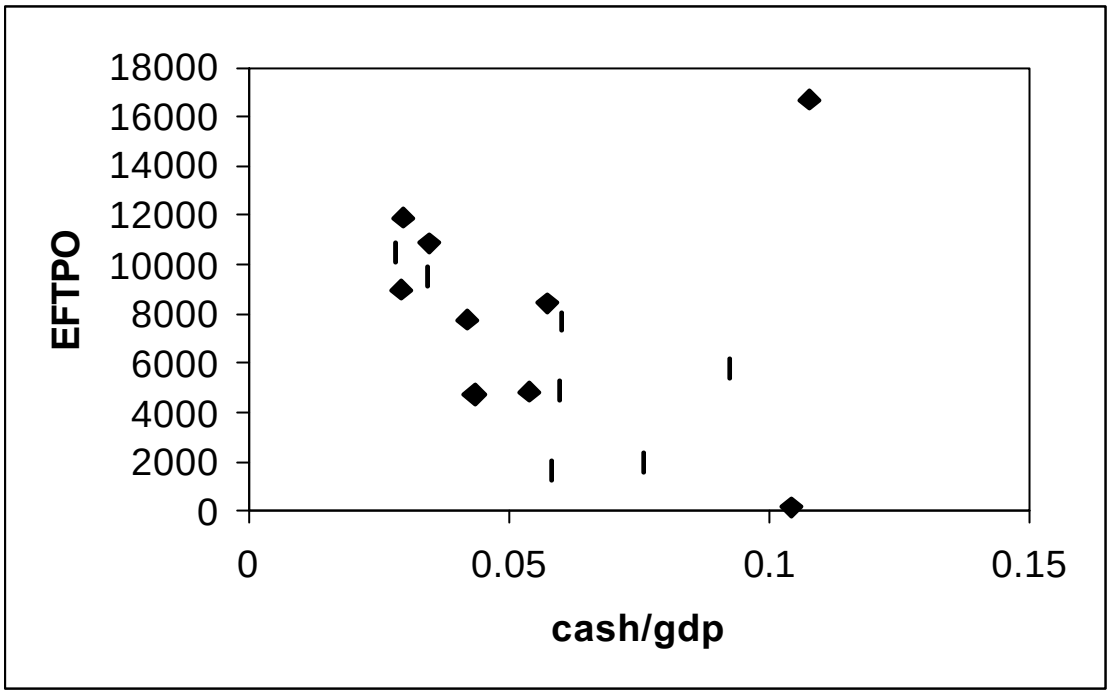


Figure 6

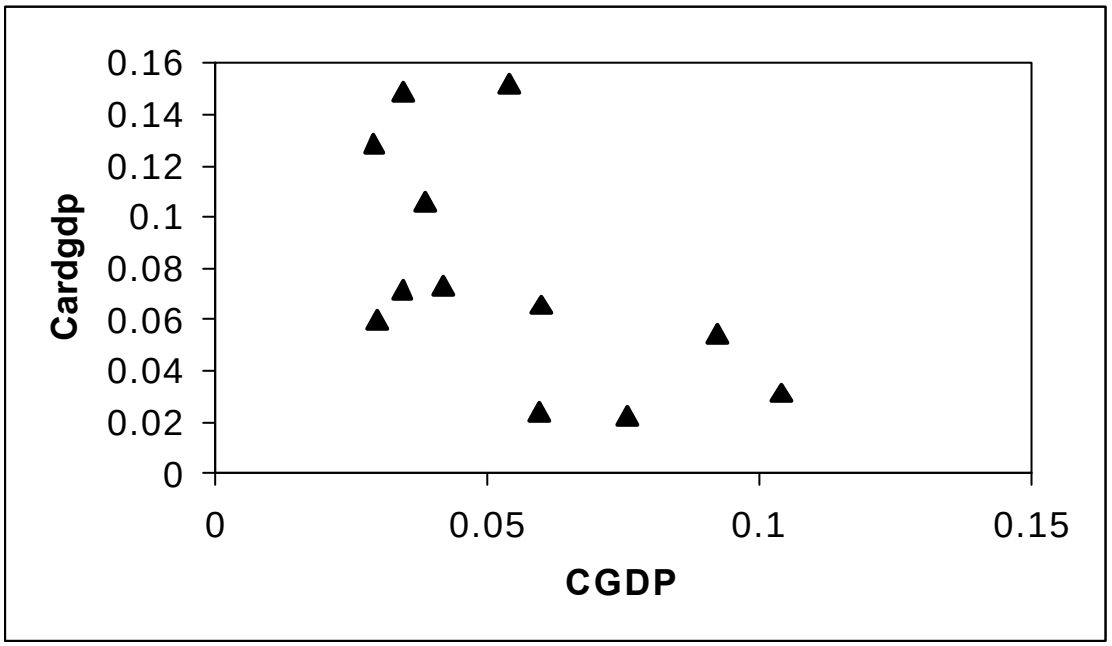


Figure 7

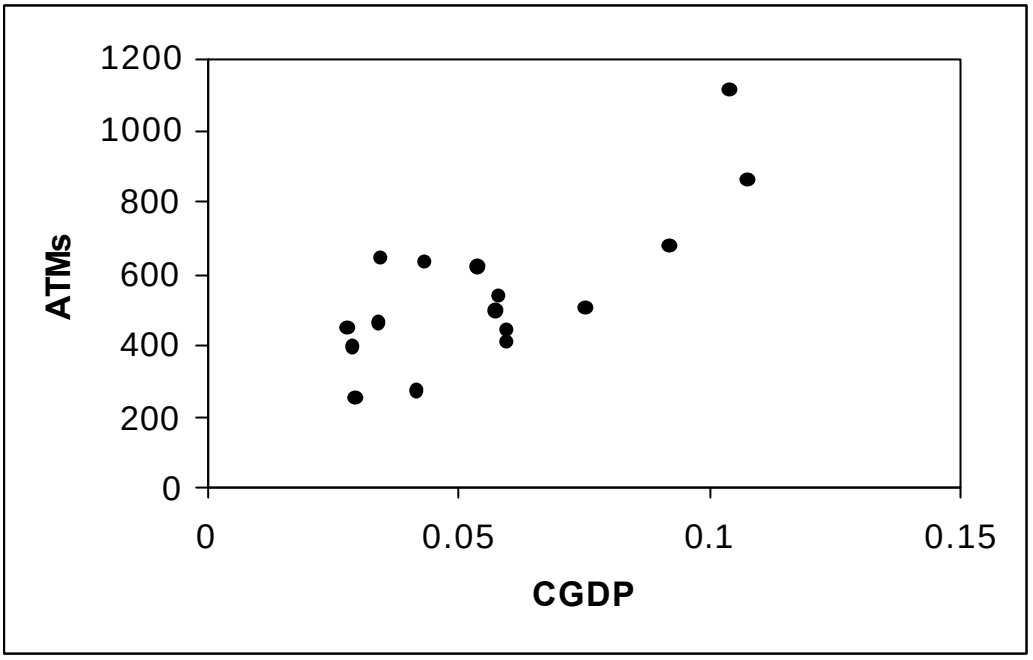
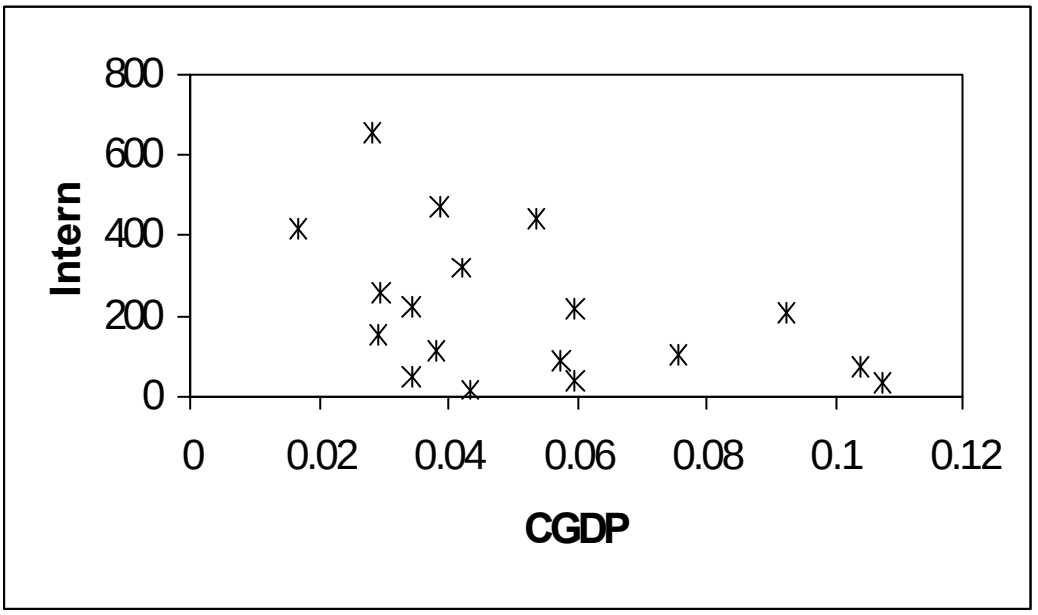


Figure 8



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