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International Cash Conference 2012
The usage, costs and benefits of cash
Theory and evidence from
macro and micro data

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Carl-Ludwig Thiele
Dinner Speech on 28 February 2012

Carl-Ludwig Thiele
Mitglied im Vorstand der Deutschen
Bundesbank

Ladies and gentlemen,

I am delighted to welcome you here to the charming Knyphausen vineyard after a successful second day of our conference. After the rather frosty weather that has gripped Germany over the past few weeks, I am glad that you have been able to make your way here and that the atmosphere at the conference is not icy but warm and lively.

We are now two-thirds of the way through the Deutsche Bundesbank's inaugural cash conference which has taught us many interesting things about hoarding, consumers' payment behaviour and the link between cash and the underground economy. The presentations awaiting us tomorrow are equally enlightening; addressing topics such as currency unions, monetary income and cashless means of payment versus cash.

Cash is not just vital for all of us in our everyday lives; it is also a multifaceted area of research. This simple fact is all the more important given the doubt expressed by many as to whether "cash" is actually justifiable as a field of research. Even at central banks, many associate cash with bundles of notes or containers full of coins stored away in vaults. However, over the years, cash has evolved into a serious branch of research. In global terms, we do not constitute a large research community. But being small in number has the advantage that many of us already know each other – or have the chance to meet at conferences such as this one.

Nevertheless, our field of research is extensive and will stay this way as long as cash retains its great popularity. "Why do people hoard cash instead of using one of the many interest-earning alternatives?", "Why is one country's cash in demand abroad where it is not even legal tender?", "Why do people still pay in cash when so many payment cards have been issued?" These are just a few of the many questions raised concerning the use of cash.

These questions indicate that cash users are almost being asked to justify their choice. As far as the use of cash as a means of exchange or storage of value is concerned, there are alternatives which are frequently presented as being cheaper, more efficient or just more modern. At times, cash is stigmatised as an anachronism; this has encouraged a number of groups to declare a "war on cash", which is to culminate this year in a "no cash day" on 21 June. Irrespective of this fact, in Germany around half of all sales and four-fifths of all transactions are still rendered in cash. These are the results of our latest survey on cash behaviour that will be published during the course of 2012.

Demand from abroad also plays a contributory role in the increasing amount of cash in circulation. Almost two-thirds of the banknotes issued by the Bundesbank are needed to satisfy demand from other countries, primarily non-euro-area countries. Cash as a medium for storing value is and remains popular, both at home

and abroad. This was shown in no uncertain terms by the surge in demand for 500 Euro banknotes – the largest available euro de-nomination – following the collapse of Lehman Brothers in October 2008. Apparently many people still believe that cash is best.

It follows that cash will not die out any time soon. Further research in this area is thus merited. The global academic community's positive response to this cash conference shows just how great the interest in this topic is. With this conference, the Deutsche Bundesbank wants to play its part in promoting the exchange of ideas among researchers. As we are all well aware, this occurs not just during the official conference events but also in the informal discussions during the coffee and meal breaks, which are often just as fruitful. On that note, I would like to propose a toast to a continued successful conference and wish you a pleasant evening.

Cheers!

Helmut Rittgen
Inaugural address for the International Cash Conference on 27 February 2012

Helmut Rittgen
Head of the Deutsche Bundesbank's
Cash Department

Ladies and Gentlemen,

as head of the Cash Department, I would like to extend to you a warm welcome to the International Cash Conference 2012, which the Deutsche Bundesbank is hosting here in Eltville in the beautiful Rheingau region, and thank you for coming. My particular thanks naturally go to the speakers. When I look at the conference programme, I think that their efforts have paid off. I, for my part, look forward to two days of exciting presentations and hopefully lively discussions about cash.

This first scientific cash conference to be hosted by the Deutsche Bundesbank is a special wish come true for me. When I took up office as head of the cash department, it was my objective to promote the scientific side of all issues concerning cash. We want to encourage the exchange of ideas between academics and central bankers in the area of cash, which is likely to be of benefit to both sides.

Many of the questions and tasks we deal with cannot be resolved without sound scientific analysis. We realised this back in 2002 when Germany's Federal Ministry of Finance asked us to present a study on developments in coin circulation in Germany. The paper which thereupon appeared in 2003 looked at both quantitative and qualitative aspects of demand for coins. This included changes in behaviour of consumers in connection with the introduction of euro banknotes and coins as well as longer-term changes in the population's payment habits, such as a more intensive use of card-based payment instruments. The objective was not only to take stock of the present situation but also to forecast coin circulation.

Building on this study, we extended the focus to look at cash in a more general context in subsequent years and also discussed questions relating, for instance, to the components of the demand for cash. The Bundesbank has since released numerous publications on this topic both for the general public and specialists. Let me name just two discussion papers on the circulation of German-issued banknotes abroad: "Foreign demand for euro banknotes issued in Germany: estimation using direct and indirect approaches". Two further discussion papers on payment habits:

– "Choosing and using payment instruments: evidence from German microdata" and
– "Using cash to monitor liquidity – implications for payments, currency demand and withdrawal behavior" followed.

In this context, we would like to highlight the excellent cooperation with other areas of the Bundesbank and with external researchers.

Cash is one of the Deutsche Bundesbank's core business areas and still plays a very important role in payments in Germany and in other countries. The exchange of information with academics and other central banks on cash issues is therefore

very important to us. We have invited participants from all over the world to this conference and selected a broad range of topics. This variety is probably unique on the "market" for scientific conferences on the topic of cash. We therefore believe that we are filling a gap. As with our studies on cash, we would like to hold such a conference regularly every two to three years in the future. We could well imagine taking turns with other central banks.

As you can see from the programme, we will deal with five major subject areas: The first theme block deals with the sensitive issue of the shadow economy. It is closely related to the sometimes declared "war on cash". As you know, cash – because it is an anonymous means of payment – is said to promote or enable illegal transactions or tax evasion. However, premature conclusions should be avoided when dealing with the issue of the shadow economy. Much uncertainty surrounds estimates of the extent of the shadow economy and the cash used for this purpose. Even if no cash were available, the shadow economy would very likely find

other ways to make payments. Fighting the "true" causes of the shadow economy such as tax systems that are felt to be unjust therefore appears more promising. I am already curious about the oral presentations on the shadow economy of Michael Pickhardt, Gerhard Graf and Edgar L Feige.

The second block of issues emphasises the costs and benefits of cash: here, supporters of the "war on cash" claim that cash is inefficient from an economic perspective because of the high costs it entails. A look at relevant studies shows that the results presented often lack sufficient evidence and that not all relevant circumstances are taken into consideration. Last year, we therefore started with the assistance of external experts, to draw up our own comprehensive study on the costs and benefits of cash and cashless means of payment in Germany. We will certainly benefit from the oral presentations of Andrea Zaghini, Frans Pleijster and Jakub Górka.

Third, the circulation of cash abroad: alongside the hoarding and transaction motive, demand from abroad is an important component of demand for banknotes. The Bundesbank is researching these issues together with external scientists. It became evident that the sharp increase in the circulation of "German" euro banknotes since the introduction of euro cash has been driven almost exclusively by demand from abroad. For the USA, estimates of the foreign demand of currency are presented by Ruth Judson and Edgar L. Feige this afternoon. Tomorrow Kari Takkala focuses on another driver of cash demand: cash consumption in the euro area.

The fourth theme block relates to households' payment habits: in order to better understand German payment behaviour, we carried out a representative household survey for the first time in 2008. We found that cash is the preferred means of payment at the point of sale in Germany. Cash therefore best met most of the criteria on which the choice of means of payment is based, such as costs, speed

and anonymity. More in-depth microeconomic studies show that demand for cash in Germany represents rational economic behaviour, the desire to control spending say, and is not simply the result of inertia or habit. This will also be confirmed by the lecture of Helmut Stix tomorrow. Also on Tuesday Kim P. Huynh gives a speech on the impact of retail payment innovations on cash usage and Scott Schuh lectures on U.S. consumer's demand for cash in the era of electronic payments.

Finally, in the fifth theme block, on currency unions, Russell C. Krueger investigates cash requirements for future currency unions in Africa and the Gulf. I wonder to what extent these regions can profit from the real experiment of the EMU. Gerhard Rösl of Regensburg University will demonstrate that some of the questions with which we as a cash department within the Eurosystem are confronted, are virtually impossible to resolve without highly specialised expertise. Mr Rösl will explain the impact that the design of central bank branches has an effect on central banks' monetary income and profits.

I hope that we enjoy a lively exchange of ideas over the next few days.

Michael Pickhardt and Jordi Sardà
Cash, Hoarding and the Underground Economy

Michael Pickhardt (left)
Brandenburg University of Technology

Jordi Sardà (right)
Universitat Rovira i Virgili

1 Introduction

Estimates of the size and scope of underground economies[1] are often carried out by using a so-called 'monetary method'. A central assumption of all monetary methods rests on the assertion that everyone involved in underground economic activities has a strong preference to conceal these activities and, therefore, prefers to use cash (currency) in all underground economy transactions. Hence, *ceteris paribus* the demand for cash should be higher the larger the size of the cash using underground economy.

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1 Here we use the term „underground economy" interchangeable with terms such as shadow economy, hidden economy, black economy, etc. (see also Kazemier 2006; Pickhardt and Sardà 2011).

This idea was pioneered by Cagan (1958) and later Gutmann (1977), Feige (1979, 1989), Tanzi (1980, 1982, 1983), Klovland (1980, 1984), Bhattacharyya (1990), Escobedo and Mauleón (1991) and others developed variants of the monetary method. More recently, however, Breusch (2005a,b) and Ahumada et al. (2007, 2008) have shown that many of the estimates using either the Tanzi or Klovland method suffer from serious econometrical or mathematical shortcomings. Therefore, results obtained from these methods may provide misleading information to policy and law makers. Pickhardt and Sardà (2011, 2012) have made a first attempt to address these issues by developing the Modified-Cash-Deposits-Ratio (MCDR) approach, which they have applied to Germany and Spain, respectively. Moreover, Berger et. al (2012) have applied the approach to Greece.

The purpose of the present paper is to further refine the MCDR approach by incorporating cash hoarding and to discuss in some detail implications of the MCDR approach with a view to identify possible applications and limitations. The remainder of this paper is organized as follows. In the next section we briefly review essential aspects of the MCDR approach and discuss relevant assumptions. In section three we extend the MCDR approach by incorporating estimates of hoarded currency. The final section concludes.

2 The MCDR Approach

In this section we briefly reconsider essential aspects of the MCDR approach. In particular, we first deal with the theoretical and econometrical background and then discuss the underlying implications and assumptions of the approach in some detail.

2.1 Motivation and Background

As noted, the MCDR approach was primarily developed with a view to avoid econometrical and mathematical problems that were discovered some years ago with respect to the popular monetary approaches of Tanzi (1980, 1982, 1983) and Klovland (1980, 1984). Additional motivations were related to: (i) the possible inclusion of cash using illicit economic activities not caused by tax pressure, (ii) simplifying plausibility testing and, (iii) raising the level of transparency (see Pickhardt and Sardà 2011, 2012).

Essentially, the MCDR approach follows a 'back-to-the-roots path' by first going back to the pure calculation method of Peter M. Gutmann (1977). Among other things, Gutmann's approach rests on the assumption that over time agents in the legal economy wish to maintain a constant ratio λ of currency to sight deposits.[2] Unfortunately, however, for many industrialized countries this assumption does not seem to hold as the growth rates of sight deposits substantially exceeded those of cash or currency during the last decades. As a consequence, the original Gutmann approach may lead to a negative size of the underground economy, which does not seem to be plausible. Pickhardt and Sardà (2011, 149-150), therefore, replace the aforementioned assumption by the equally strong assumption that "all currency in circulation in the base year, C_0, represents the entire cash agents wish to hold in any year after the base year for the set of legal transactions they prefer to carry out in cash." Otherwise, the remaining assumptions of the Gutmann approach continue to hold. By formalizing these assumptions and after some rearranging the authors derive the following equation,

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2 Gutmann (1977, 27) writes: „The amount of currency required for legal transactions in 1976 is assumed the same percentage of demand deposits as in 1937-41."

$$\frac{C_t - C_0}{C_0 + D_t} = \frac{Y_{Ut}}{Y_{Lt}} \; ,$$

(1)

with C_t denoting currency in circulation outside banks (MFIs) at the end of the year, C_0 denoting currency in circulation outside banks at the end of the base year or base period, D_t denoting sight or demand deposits held by domestic non-banks (non-MFIs) at the end of the year, Y_{Ut}/Y_{Lt} denoting the relative size of the cash using underground economy and t denoting the time index. Also, by assumption, we have $C_0 = C_{Lt}$, and, thus, $C_t - C_0 = C_{Ut}$, where C_L denotes currency used for transactions in the legal economy and C_U denotes currency used for transactions in the underground economy.

Equation (1) states that the relative size of the cash using underground economy (r.h.s. of (1)) can be measured by the ratio of currency used for underground economy activities (C_U) and money used in the legal sector of the economy $(C_L + D = M_L)$. Moreover, equation (1) generates a positive size of the underground economy for many industrialized countries and, therefore, solves a fundamental problem of the original Gutmann approach.

This notwithstanding, equation (1) rests on some rather strong assumptions. For example, according to (1) it is assumed that the *nominal* amount of currency in circulation outside banks at the end of the base year or period represents the entire amount of currency agents wish to hold for legal transactions during each and every subsequent period. Hence, in (1) the distorting effect of inflation is ignored. Yet, the inflation effect may be incorporated by adjusting C_0 in each year with the prevailing inflation rate, as measured by the consumer price index (CPI). Effectively, this amounts to assuming that agents wish to hold a constant *real* value stock of currency for legal transactions during all periods under consideration. Likewise, according to (1), changes in the population size would have no influence on C_0, but would be reflected in both C_t and D_t, and that may thus lead to some distortions over time. To address this issue, C_0 may be adjusted over time with an index that reflects population developments. This procedure then implies the assumption that

on average agents wish to hold a constant *per capita* real value stock of currency for legal transactions during all periods under consideration. In Pickhardt and Sardà (2011, 2012) these changes are denoted as auxiliary modifications one *(mod1)* and two *(mod2)*, respectively.

In addition, in both the German and the Spanish case distortions caused by the introduction of Euro coins and notes on January 1, 2002 have been taken into account by an econometric estimation, which in the German case was based on a slightly modified version of the method proposed by Seitz (1995). With respect to the German case the results of this estimation were also used for estimating the amount of currency held outside Germany *(mod3)*. Regarding equation (1) both changes require an adjustment of C_t, and the latter also an adjustment of C_0. Then, by taking all adjustments into account, Pickhardt and Sardà (2011) obtain the following equation,

$$\frac{INFC_t - INPIC_{0t}}{INPIC_{0t} + D_t} = \frac{Y_{Ut}}{Y_{Lt}}, \tag{2}$$

where $INFC_t$ denotes forecasted currency in circulation outside banks, inside Germany, and $INPIC_{0t}$ denotes the inflation and population adjusted amount of currency that was in circulation outside banks, inside Germany, at the end of the base year or base period. In the Spanish case, however, it is assumed that no substantial amounts of Pesetas were held outside Spain, and, therefore, no such adjustment was necessary (see Pickhardt and Sardà 2012). Equation (2) then amounts to,

$$\frac{FC_t - PIC_{0t}}{PIC_{0t} + D_t} = \frac{Y_{Ut}}{Y_{Lt}}, \tag{2'}$$

Application of (2) and (2') yields a time series of the size of the cash using underground economy in Germany and Spain, which are denoted as G3 and S2 in Pickhardt and Sardà (2011, 2012), respectively.

Moreover, while the former work focuses primarily on developing the theoretical background of the MCDR approach, the later exposes the S2 profile, as the dependent variable, to an econometric estimation procedure. Provided that this procedure yields a regression with reasonable diagnostic statistics, not only the creditability of the relevant MCDR underground economy profile is supported, but also essential causes of the latter are identified. To this extent, even policy conclusions may be derived with the MCDR approach. For example, based on the results of the econometric estimation procedure Pickhardt and Sardà (2012) conclude that a growth and competitiveness enhancing macro policy, combined with a fundamental labor market reform, accompanied with less tax pressure and an intensified fight against criminal activities, in particular illicit drug related crimes, is best for fighting the cash using underground economy in Spain.

2.2 Discussion

The brief sketch of the MCDR approach in the preceding subsection provides an introduction to its essential elements. This subsection aims at a deeper discussion of its assumptions and implications with a view of going beyond earlier discussions of the approach. A good starting point for the discussion are the auxiliary modifications four to seven mentioned by Pickhardt and Sardà (2011, p. 153), which they did not address due to a lack of data. These modifications concern: cash hoarding by national non-banks *(mod4)*, changing cash use preferences of national non-banks *(mod5)*, the use of deposits for underground economy transactions *(mod6)*, and the benchmarking procedure *(mod7)*.

2.2.1 Hoarded Currency

Non-banks may hold currency not only for transaction purposes but also for hoarding purposes. This notwithstanding, it is difficult to explain cash hoarding in the legal economy with behavior patterns of *homo economicus*. In addition, there is little empirical evidence about actual motivations for keeping cash hoards (e.g. see Stix 2012, Bajada 2002, Nenovsky and Hristov 2000, van Hove and Vuchelen 1994, Sprenkle 1993, Boeschoten and Fase 1992, Sumner 1990). Yet, precautionary motives caused by a fundamental distrust in the banking system and other safety measures, for example, in case of a loss of debit and/or credit cards might be plausible motivations for holding cash hoards in the legal economy (see also Stix 2012). In any case, however, there is ample anecdotal evidence that cash hoards do exist in the legal economy.

In contrast, with respect to the cash using underground economy, cash hoarding may well be explained by rational behavior. For example, cash hoards may emerge from saving motives because interest bearing demand deposits are by definition not considered as a feasible option. In addition, cash hoards may be build up with a view to create larger amounts of cash, which could then be easier handled by the money laundering branch of the underground economy. To this extent, agents engaged in the cash using underground economy may well have a much stronger motivation for keeping cash hoards, which was already noted by Cagan (1958, pp. 315–316).

Bartzsch et al. (2011a,b) have recently conducted two comprehensive studies on the foreign demand for Euro banknotes issued in Germany, which also generate cash hoarding data for Germany. In section three we use their data to further refine the MCDR approach by applying auxiliary modification four.

2.2.2 Non-cash Payment

In this subsection we shall deal with auxiliary modifications five and six jointly. To begin with, recall that the MCDR approach implies by assumption that any additional spending in the legal economy that goes beyond $INPIC_0$ (PIC_0) is carried out via demand or sight deposits and, thus, fully handled via non-cash involving payment methods such as checks, debit cards, and credit cards. Put differently, new non-cash payment methods pose a problem for the MCDR approach only if they effectively lead to a partial replacement of $INPIC_0$ (PIC_0) or, alternatively, if over time more currency is used for legal transactions than indicated by $INPIC_0$ (PIC_0).

Therefore, with respect to the applicability of the MCDR approach, the important question is how to verify whether or not agents in the legal economy use over time and on average a stable real per capita amount of currency to carry out those legal transactions they wish to handle in cash. Despite some anecdotal evidence, there is, unfortunately, a fundamental lack of useful time series data on this topic. This notwithstanding, over time economic growth, technical progress, innovations, etc. may lead to fundamental changes of individual cash payment preferences. It is important, however, to recognize that these changes may have opposite effects.

For example, economic growth may make many households much richer over time, which in turn may prompt these households to source out part of their household production to market exchanges. Going out for lunch or dinner rather than cooking at home, using a laundry rather than doing all washing at home, taking a hair cut at a hair dresser rather than at home, using market based leisure activities rather than staying at home, are just a few examples. Even if some of these market exchanges are paid via non-cash payment methods, others are paid in cash and, thus, might cause an increase of cash used for legal transactions. In contrast, however, technical progress, economies of scale and scope, etc. may,

among other things, make many products much cheaper, which would reduce the need for cash. Hence, subject to a lack of useful time series data on the cash use of domestic non-banks, with respect to the MCDR approach it is assumed that all conceivable influences on $INPIC_0$ (PIC_0) balance over time.

Another issue is the use of demand deposits for underground economy transactions, such as fraud and the like. These cases amount to the implicit assumption that the MCDR figures no longer cover just the cash using section of the underground economy. Technically, in both (2) and (2'), this notion implies, $D_t = D_{Lt} + D_{Ut}$, and, therefore, we get,

$$\frac{INC_{Ut} + D_{Ut}}{INPIC_{0t} + D_{Lt}} = \frac{Y_{Ut}}{Y_{Lt}}, \tag{3}$$

$$\frac{C_{Ut} + D_{Ut}}{PIC_{0t} + D_{Lt}} = \frac{Y_{Ut}}{Y_{Lt}}, \tag{3'}$$

respectively, where D_{Lt} denotes demand deposits used for legal transactions, D_{Ut} denotes demand deposits used for underground economy transactions, both at the end of the year. But again, there is currently no time series data or estimation method that allows for obtaining data on either D_{Ut} or D_{Lt}.

Barter exchanges are another important issue with respect to non-cash payment methods, as they may be used in underground economy transactions instead of cash. For example, barter exchanges may have played an important role for underground activities in Germany after World War II and until the 1950s, because many markets did not yet exist or were still underdeveloped. But even in more recent times barter exchanges may play an important role in some industries. The market for recorded music and movies is a good example. To copy a music CD or MP3 file for a friend in exchange for another copied CD or simply a favor may be regarded by many people as some sort of petty crime. Yet, if such beliefs are fairly common

within the population and even internet based platforms are available, allowing for a wide distribution of these barter exchanges, a whole industry might get into trouble.

Finally, money laundering is an important issue that may have a non-negligible impact on (2) or (2'). In the present context, the money laundering branch of the underground economy essentially ensures that a large number of small retail cash proceeds from activities such as illegal drug consumption or illegal prostitution can be channeled into (allegedly) legal investment projects.[3] Provided that this sort of money laundering takes place domestically, in (2) or (2') it would reduce C_{Ut} by dissolving hoards of cash held in the underground economy and would increase D_t, thereby reducing the size of the cash using underground economy according to the MCDR approach.

2.2.3 Benchmarking

Arguably the most important issue with respect to all monetary approaches is the benchmarking procedure, because it is this procedure that inevitably introduces some arbitrariness to the underground economy estimates. Regarding the MCDR approach the benchmark assumption for both the German and Spanish case has been 'zero percent of cash using underground economy in 1960'. As demonstrated by Pickhardt and Sardà (2011, p. 155), choosing a different base year leads to different values and choosing a different (positive) initial percentage of the underground economy would also lead to different values with respect to the size of the underground economy. Moreover, contrary to conventional beliefs, Ahumada et al. (2008) have demonstrated that estimates using the Tanzi method also require a benchmark value, if short-run models, which include the lagged dependent variable, are used.

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3 Note that money laundering for terrorist financing may work the other way round, i.e., either small amounts of legal cash (e.g. donations) or even large sums are channeled into illegal terrorist projects.

It is for this reason that any estimate of the size of the underground economy that rests on the MCDR approach or another monetary method carries some arbitrariness. Therefore, interpretations of estimated underground economy figures, in particular with respect to economic policy recommendations, should take these aspects into account and special attention should be given to the benchmark selection procedure.

For example, the MCDR benchmark 'zero percent of cash using German underground economy in 1960' was chosen for the following reasons. First, in 1958 the Deutsche Mark became convertible and the federal state of Saarland became part of Germany again. Second, the macroeconomic environment in 1960 was rather favorable, with full employment and a booming economy. Third, many cash using underground activities such as illegal soft and hard drug dealing, illegal prostitu-

tion, human trafficking, etc. either did not exist or were on a rather small scale. Fourth, as noted, during the 1950s many underground economy activities may have been based on barter exchanges, rather than on cash involving market exchanges. In this context it is worth emphasizing that the MCDR benchmark assumption does not imply that there was no underground economy in 1960, but that the cash using section of the underground economy was negligibly small.

Also, regarding the Spanish case, all aspects mentioned above apply as well, except for the first one. In addition, in 1960 Spanish taxes in total where on rather low levels and potential unemployment problems were solved via emigration.

Furthermore, the benchmarking problem also applies to non-monetary approaches, notably the popular MIMIC approach (e.g. see Pickhardt and Sardà 2006). As the MIMIC approach generates only an index, a benchmark obtained from a different source, often a monetary method, is required to calibrate the index. Obviously, if there are alternative potential benchmarks to choose from, the actual size of the underground economy is essentially determined by the benchmark choice of the researcher and only the development of the underground economy over time is determined by the MIMIC estimation procedure. This may have important implications for the policy recommendations that are given based on results obtained from a MIMIC approach.

2.2.4 MCDR and other Monetary Approaches

Recently, Cebula and Feige (2011, 2012) have developed an alternative modification of the Gutmann (1977) approach, which they apply to U.S. data. Their first modification consists of taking into account that U.S. currency may be held abroad. The second modification they suggest consists of taking into account "technological innovations in the financial industry that significantly reduce the

volume of 'checkable deposits' (D)",[4] which effectively modifies Gutmann's original assumption that the ratio of currency to deposits remains constant over time (see section 2.1).

The third modification deals with the benchmark procedure. Their original benchmark is 'zero unreported income in 1940' and they introduce two alternative benchmark values that come from independent audit based estimates of unreported income for the years 1988 and 2001, conducted by the Internal Revenue Service (IRS). The fourth modification they propose is a relaxation of Gutmann's assumption that currency is the exclusive medium of exchange in the underground economy. As an alternative they assume, based on IRS audit data, that 20 percent of all unreported income transactions are paid by check and just 80 percent by cash. Finally, the fifth modification is a relaxation of Gutmann's assumption of equal velocities in the legal and underground sector of the economy. They suggest instead that the income velocity in the underground economy is higher than in the legal economy, which would *ceteris paribus* lead to a larger size of the underground economy, but they do not apply this last modification to the actual calculation procedure.

Hence, in comparison with the MCDR approach, the main difference occurs with respect to Gutmann's assumption that the currency to deposits ratio stays constant over time. In the MCDR approach Gutmann's assumption is replaced by the alternative assumption of a constant average (per capita, *mod2*) amount of (real, *mod1*) currency that is held for legal transactions, whereas Cebula and Feige (2011, 2012) adjust the amount of deposits D_t, but otherwise maintain Gutmann's assumption. Mathematically, this difference is shown in the appendix. It follows from this mathematical difference that *ceteris paribus*, (i) the Cebula and Feige

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4 According to Cebula and Feige (2011, p. 7), the term 'checkable deposits' refers to demand deposits plus other checkable deposits.

approach leads to lower (higher) values for the cash using underground economy than the MCDR approach, if deposits are increased (decreased), (ii) the Cebula and Feige approach cannot handle the case where cash hoards are transferred into demand deposits, because this would lead to an unwarranted increase of cash held for legal transactions.

With respect to the popular monetary approaches of Tanzi (1980, 1982, 1983) and Klovland (1980, 1984) the main difference with the MCDR approach is that the amount of currency held for underground economy transactions, C_U, is simply calculated in the MCDR approach (i.e. the nominator of (2) or (2')), but econometrically estimated with a currency demand function in both the Tanzi and Klovland approaches.[5] This difference shows another advantage of the MCDR approach. In comparison with a currency demand estimation, more variables that directly explain the underground economy development may be included, if the MCDR underground economy profile is directly exposed to an econometric estimation. This in turn may allow for deriving more refined policy recommendations.

3 New MCDR Estimates for the German Underground Economy

In this section we provide up-dated figures for the size of the cash using German underground economy and further refine the MCDR approach by taking recent estimates on the extent of cash hording in Germany into account.

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5 Among other things, Tanzi considers a relative measure, *C/M2*, as the dependent variable, whereas Klovland considers an absolute measure, real currency *C/P*, as the dependent variable, in their respective currency demand estimations, where *C* denotes nominal currency, *M2* is the conventional monetary aggregate and *P* denotes the price level.

3.1 Evidence for 2009 and 2010

The German underground economy profile G3, provided by Pickhardt and Sardà (2011, p. 151-152), covers the period 1960 to 2008 and by applying (2) with data for 2009 and 2010 we can extend the G3 profile to the period 1960 to 2010.

G3 profile (1960–2010)   Figure 1

In percent of GDP

Note: Own calculation.
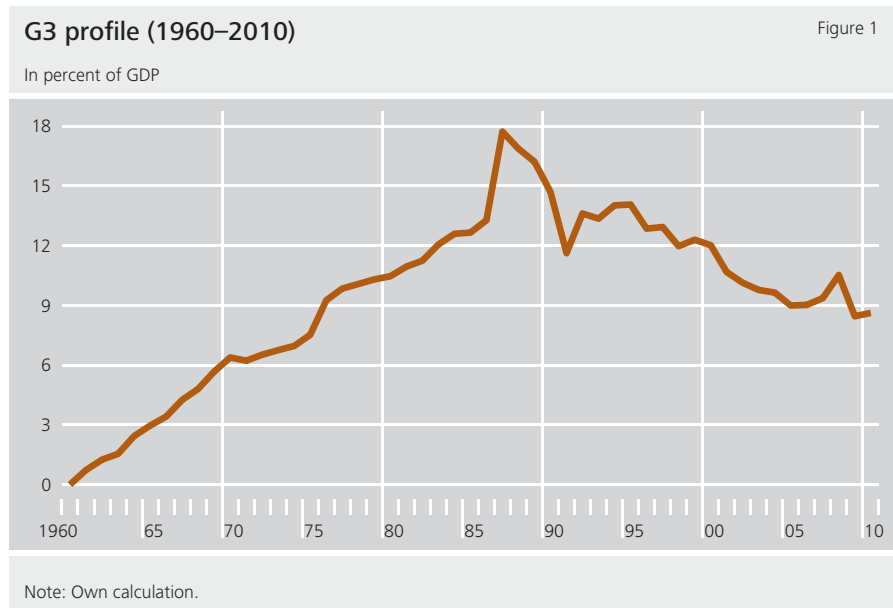
Figure 1 shows the G3 profile for this latter period and Table 1 shows relevant calculation data for the post reunification period 1992 to 2010. Note, however, that during the period 1987 to 1991 the G3 profile may not fully reflect the development of the cash using German underground economy due to withholding tax effects and the German reunification (see Pickhardt and Sardà 2011, 155-156). Inspection of Figure 1 and Table 1 shows that the size of the cash using German underground economy slightly decreased since 2008. Moreover, data provided in Table 1 suggests that this decline is due to the comparatively strong increase in

deposits. But, of course, the years 2008 to 2010 are also affected by the world wide economic crisis.

Relevant data for calculating G3 (1992 to 2010)						Table 1

INFCt	INPIC0t	Dt	CUt	MLt	Year	G3
82,846,343,844	44,278,218,606	239,000,000,000	38,568,125,238	283,278,218,606	1992	13.61
87,773,897,349	46,449,261,498	263,000,000,000	41,324,635,851	309,449,261,498	1993	13.35
93,260,561,978	47,842,037,505	276,000,000,000	45,418,524,472	323,842,037,505	1994	14.02
97,439,675,255	48,832,566,672	297,000,000,000	48,607,108,583	345,832,566,672	1995	14.06
100,351,926,365	49,656,819,360	345,000,000,000	50,695,107,005	394,656,819,360	1996	12.85
102,819,687,122	50,618,187,010	353,000,000,000	52,201,500,111	403,618,187,010	1997	12.93
106,170,377,324	51,079,364,224	409,000,000,000	55,091,013,100	460,079,364,224	1998	11.97
109,381,786,133	51,449,284,263	420,000,000,000	57,932,501,870	471,449,284,263	1999	12.29
111,805,128,774	52,267,908,942	443,000,000,000	59,537,219,832	495,267,908,942	2000	12.02
115,230,631,800	53,416,830,779	526,000,000,000	61,813,801,021	579,416,830,779	2001	10.67
118,058,779,537	54,213,896,534	576,000,000,000	63,844,883,004	630,213,896,534	2002	10.13
121,063,748,103	54,778,545,502	624,000,000,000	66,285,202,601	678,778,545,502	2003	9.77
123,425,252,319	55,671,144,548	647,000,000,000	67,754,107,772	702,671,144,548	2004	9.64
126,266,811,764	56,728,633,761	717,000,000,000	69,538,178,003	773,728,633,761	2005	8.99
130,270,017,850	57,598,520,036	748,000,000,000	72,671,497,814	805,598,520,036	2006	9.02
137,241,491,631	58,745,111,452	780,000,000,000	78,496,380,179	838,745,111,452	2007	9.36
153,340,722,350	59,257,851,951	835,000,000,000	94,082,870,399	894,257,851,951	2008	10.52
151,753,268,600	59,738,889,765	1,029,489,000,000	92,014,378,835	1,089,227,889,765	2009	8.45
161,087,038,300	60,710,276,269	1,104,387,000,000	100,376,762,031	1,165,097,276,269	2010	8.62

Note: Own calculations. All variables are denoted in Euro, except columns year and G3, with the later denoted in percent of official GDP.

Moreover, by dividing column two *(INPIC$_0$)* of Table 1 with the relevant annual population data, we obtain the amount of currency each agent would hold on average at the end of the year for transactions in the legal economy. For example, at the end of 2010 (2009, 2008) this amounts to 742.6 (730.3; 722.6) Euro. Data in column one *(INFC)* of Table 1 also allows for a comparison with the 'domestic circulation' values obtained by Bartzsch et al. (2011a,b). For example, in 2009 these values range from 40 to 205 billion Euros, subject to the underlying approach. But half of the estimates range between 130 and 180 billion Euros, which compares fairly well with the independently obtained MCDR amount of 151.75 billion Euro according to Table 1.

Moreover, Table 2 provides some additional time series data obtained from the seasonal methods for estimating the demand for Euro banknotes issued in Germany (see section 2.2.2 of Bartzsch et al. 2011b). This method is of interest as it allows for distinguishing cash held for domestic transactions and cash held for hoarding purposes.

Currency in Circulation in Germany (2002 to 2009)					Table 2
Year	Transaction	Hoarding	Domestic Circulation	G4UH	G4LH
2002	45.9	9.1	55	8.69	10.28
2003	45.9	12.2	58	7.97	9.94
2004	49.3	15.7	65	7.41	9.86
2005	47.3	22.7	70	6.05	9.26
2006	51.1	23.9	75	6.05	9.30
2007	56.4	28.6	85	6.95	9.69
2008	72.4	32.6	105	6.88	10.92
2009	58.2	36.8	95	5.07	8.74

Note: Transaction denotes currency held for transaction purposes, Hoarding denotes currency held for hoarding purposes and Domestic Circulation denotes currency in circulation inside Germany, with all three columns denoted in billions of Euros. Data refers to the end of the year, was kindly provided by Franz Seitz in March 2012, and is based on the seasonal methods of Bartzsch et al. (2011b, pp. 9-21). G4UH denotes the hoarding adjusted size of the cash using German underground economy in percent of GDP, if all hoarded cash (column three) is held in the underground economy and G4LH denotes the same, if all hoarded cash is held in the legal economy (own calculations).

Inspection of Tables 1 and 2 reveals that the data of currency held for legal transactions (columns two in both tables) is surprisingly similar, given that the data has been generated with two entirely different methods. Differences in 2005 and 2008 are obviously due to the fact that the results shown in Table 2 are more sensible to specific influences in each year.[6] For matters of convenience, results presented in columns $G4_{UH}$ and $G4_{LH}$ of Table 2 are discussed in the following section.

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[6] Data for 2009 in Table 2 should be identical with relevant data in Table 2 of Bartzsch et al. (2011b, p. 37) and, therefore, with Table 3, column 3. Existing differences are entirely due to rounding effects.

3.2 Hoarding

As noted, recent estimates of cash hoarding in Germany by Bartzsch et al. (2011a,b) allow for addressing auxiliary modification four of the MCDR approach. Table 3 shows relevant results of the two studies for 2008 and 2009. Subject to the approach that is used, the stock of hoarded cash ranges from 40 to 110 billion Euro in 2009.

The incorporation of hoarded cash into the MCDR approach requires a correction of some variables used in (2) or (2'). The actual correction procedure depends on whether the calculated amount of hoarded cash is held: (i) entirely in the underground economy, (ii) entirely in the legal economy, or (iii) to some extent in both sections of the economy. Subject to the discussion in the preceding section it is most likely that option (iii) is true. But since we do not know the exact proportions, for illustrative purposes alone, we assume that two thirds of the hoarded cash amount is held in the underground economy and one third in the legal economy.

Technically, option (i) amounts to correcting the C_t value in (1), or the $INFC_t$ value in (2) or the FC_t value in (2'). Regarding the German case, we have to adjust $INFC_t$ in (2) by deducting the hoarded cash amount, which yields the $HINFC_t$ figures shown in Table 3 (see appendix for mathematical details). Application of (2), with the $HINFC_t$ figures rather than the $INFC_t$ ones, yields the $G4_{UH}$ underground economy sizes provided in Table 3. In contrast, option (ii) essentially amounts to a correction of the denominator in (1), (2) or (2'), by deducting the hoarded cash amount (see appendix for mathematical details), which yields the $G4_{LH}$ underground economy sizes shown in Table 3. Option (iii) is a mix of the former two procedures, subject to the assumed distribution of the hoarded cash amount, and yields the $G4_{LUH}$ underground economy sizes shown in Table 3.

G4 Estimates				Table 3
	2008	**2009**		
Hoarding	20	40	70	110
$HINFC_t$	133.34	111.75	81.75	41.75
$G4_{UH}$	8.28	4.78	2.02	[-1.65]
C_{LT}	39.3	19.7	—	—
$G4_{LH}$	10.76	8.77	—	—
$G4_{LUH}$	9.1	6.07	4.3	1.78

Note: Hoarding is denoted in billion Euro (end of the year) and taken from Bartzsch et al. (2011a,b), Tables 11 and 2, respectively. HINFC denotes hoarding adjusted, inside Germany forecasted currency held outside banks at the end of the year in billion Euro (own calculation). G4UH denotes the hoarding adjusted size of the cash using German underground economy in percent of official GDP, if all hoarded cash is held in the underground economy (own calculation). CLT denotes cash held in the legal economy for transaction purposes, in billion Euro (own calculation). G4LH denotes the hoarding adjusted size of the cash using German underground economy in percent of official GDP, if all hoarded cash is held in the legal economy (own calculation). G4LUH denotes the hoarding adjusted size of the cash using German underground economy in percent of official GDP, if two thirds of hoarded cash are held in the underground economy and one third is held in the legal economy (own calculations). "---" denotes that a calculation leads to (implausible) negative values.

Inspection of the G4 results in Table 3 makes it clear that taking domestic cash hoarding into account may either reduce or increase the size of the cash using German underground economy. Also, the 2009 cash hoarding estimates show a rather wide range and for this reason alone it is hard to assess which of the G4 values may best reflect the true size of the cash using German underground economy in 2009.

This notwithstanding, and provided that the MCDR figures are otherwise close to the true values, it seems to be fairly evident that the 110 billion Euro hoarding estimate is compatible with the MCDR approach, only if option (iii) applies and a substantial amount of hoarded cash is held in the underground economy. Regard-

ing the other two options, the 110 billion estimate leads either to a negative size of the cash using German underground economy or to a negative amount for cash transactions in the legal economy C_{LT}, so that the size of the underground economy cannot be calculated (see Table 3). The same is true for the 70 billion Euro estimate, if it is assumed that all or a large fraction of the estimated amount of hoarded cash is held in the legal economy.

Alternatively, one might take a second look at the results of a representative household survey on banknotes hoarded by adults (i.e. people aged over 14) in Germany, conducted in 2008 on behalf of the European Central Bank (see Bartzsch et al. 2011a, p. 23; Table 3, column 2008). As noted by Bartzsch et al. (2011a), the results may underestimate the true size of cash hoarding in Germany. However, the results may be regarded as a rough indicator for the amount of cash hoarded in the legal economy, as it is particularly unlikely that people report cash hoards held for, or stemming from, underground economy activities. Hence, if we assume that cash hoarded in the legal economy, C_{LH}, amounts to about 20 billion Euro in 2009, then the estimates of 40 and 70 billion in terms of C_H seem to be the most plausible in terms of section 2.2.1 and the comments on the 110 billion Euro estimate made above. Moreover, based on the assumption $C_{LH} = 20$ billion Euro, cash hoards held in the underground economy, C_{UH}, amount to 20 or 50 billion Euro, respectively. This distribution of the total amount of hoarded cash, C_H, would generate a size of the cash using German underground economy in the range of 3.93 to 6.74 percent of GDP for 2009, according to the MCDR approach.

Finally, Table 2, columns $G4_{UH}$ and $G4_{LH}$, provide some time series data on the hoarding adjusted size of the cash using German underground economy for the period 2002 to 2009, which is based on cash hoarding data obtained from the seasonal methods (see Bartzsch et al. 2011b and column three of Table 3) and the application of options (i) and (ii), respectively. The results are by and large in line with the observations already made above.

In summarizing, the G3 values for 2002 to 2009 (Table 1) do not require any correction, if it is assumed that almost all of the hoarded cash is held in the legal economy. In contrast, if it is assumed that almost all of the hoarded cash is held in the underground economy, the size of the latter is much lower than the G3 values suggest. In this context, it is worth noting that any estimate of cash hoards held in the underground economy essentially amounts to an estimate of accumulated past profits from underground economy activities. Most likely, however, cash hoards are held in both the legal and underground section of the economy and anecdotal evidence suggests that the hoarding corrected size of the cash using German underground economy has ranged between four and seven percent of GDP in 2009, according to the MCDR approach.

4 Concluding Remarks

Recent estimates concerning currency hoarding in Germany allow for further refinements of the MCDR approach for calculating the size of the cash using German underground economy. In a first step, we have updated existing estimates and have obtained values for the size of the cash using German underground economy in 2009 and 2010. Next, we have used available estimates of currency hoarding in Germany for 2008 and 2009 and demonstrated how these data would affect the size of the German underground economy according to the MCDR approach. In particular, in the most extreme setting, we showed that the size of the cash using German underground economy may have ranged in 2008 (2009) between 8.28 (2.02) and 10.76 (8.77) percent, with 10.52 (8.45) percent of official GDP as the previously calculated size.

In addition, we have discussed the assumptions and implications of the MCDR approach in more detail than in previous work. However, it must be emphasized that the criticism put forward by Thomas (1999) and various other authors against the original Gutmann (1977) approach are by and large still valid with respect to the MCDR approach. Yet, the hoarding adjustment which we did here and previous work on the extent of the cash using Spanish underground economy shows two fundamental advantages of the MCDR approach. First, it can accommodate practically any number of additional modifications, while maintaining its transparency, provided that relevant data is available. Second, exposing the obtained underground economy profiles to econometric estimation procedures may not only add to their creditability. In fact, it may also allow the researcher to investigate the causes of the underground economy in a more comprehensive way than this would be possible with the Tanzi, Klovland or MIMIC method.

Appendix

Part A of the appendix deals with the technical incorporation of hoarding into the MCDR approach and part B deals with the technical differences between the MCDR approach and the approach of Cebula and Feige (2011, 2012).

A

Let C_H be the observed or estimated total amount of cash hoarding by domestic non-banks and let C_T be the total amount of cash used for domestic transactions, where here and in the following all variables refer to the end of the year, but for simplicity alone we suppress the time index t. Then, the total amount of cash held outside banks, C, may be defined as,

$$C = C_T + C_H , \tag{A1}$$

Note that (A1) implies that cash may now be held for two purposes, transactions and hoarding. Further, since cash may be used both in the legal and underground sector of the economy, we may restate (A1) as,

$$C = C_L + C_U = C_{LT} + C_{LH} + C_{UT} + C_{UH} , \tag{A2}$$

with $C_T = C_{LT} + C_{UT}$ and $C_H = C_{LH} + C_{UH}$ and where C_L denotes cash held in the legal economy, C_U denotes cash held in the underground economy, C_{LT} denotes cash used for transactions in the legal economy, C_{LH} denotes hoarded cash in the legal economy, C_{UT} denotes cash used for transactions in the underground economy, and C_{UH} denotes hoarded cash in the underground economy.

Based on (A2), option (i), i.e. all hoarded cash is held in the underground economy, amounts to $C_{LH} = 0$ and, thus, we get $C_{LT} = C_L = C_0$. Moreover, regarding the nominator of (1) we are interested in obtaining C_{UT}, which according to (A2) and

option (i) is now defined as, $C_{UT} = C - C_0 - C_{UH}$. However, option (i) does not affect the denominator of (1) and, therefore, with respect to option (i) equation (1) is modified to,

$$\frac{C - C_0 - C_{UH}}{C_0 + D} = \frac{Y_U}{Y_L} \text{ ,} \tag{A3}$$

In contrast, if option (ii) holds, i.e. all hoarded cash is held in the legal economy, we get $C_{UH} = 0$ and, thus, $C_U = C_{UT}$, and $C_{LT} + C_{LH} = C_L = C_0$. Hence, the nominator of (1) is now unaffected, with $C - C_{LH} = C_{LT} + C_{UT}$ and $C_0 - C_{LH} = C_{LT}$, or simply $C - C_0$. However, option (ii) now affects the denominator of (1) due to $C_0 - C_{LH} = C_{LT}$ and, therefore, with respect to option (ii) equation (1) is modified to,

$$\frac{(C - C_{LH}) - (C_0 - C_{LH})}{(C_0 - C_{LH}) + D} = \frac{Y_U}{Y_L} \text{ ,} \tag{A4}$$

As option (iii) is just a mix of options (i) and (ii), we can use a simplified version of (1),

$$\frac{C - C_0}{C_0 + D} = \frac{C_U}{M_L} = \frac{Y_U}{Y_L} \text{ ,} \tag{A5}$$

and incorporate hoarding by stating,

$$\frac{C_U - C_{UH}}{M_L - C_{LH}} = \frac{Y_U}{Y_L} \text{ .} \tag{A6}$$

Note that options (ii) and (iii) essentially rest on the assumption that C0 represents all cash (i.e. for transactions and hoarding) agents wish to hold in the legal economy. If, alternatively, it is assumed that C0 still represents the entire cash agents wish to hold for transaction purposes only, then option (i) shows the effect of hoarding in general and options (ii) and (iii) disappear.

B

As noted in Pickhardt and Sardà (2011, p. 149), the original Gutmann (1977) approach can be restated as,

$$\frac{C - \lambda \cdot D}{\lambda \cdot D + D} = \frac{C - C_{L0} \cdot \dfrac{D}{D_0}}{C_{L0} \cdot \dfrac{D}{D_0} + D} = \frac{Y_U}{Y_L}, \tag{A7}$$

where λ denotes the fixed cash to deposits ratio C_{L0}/D_0 of the base year or period. Then, the main modification on which the MCDR approach rests consists of replacing Gutmann's assumption that agents wish to hold a fixed ratio of cash to deposits over time by an equally strong alternative assumption, as noted in the main text. Technically, this amounts to removing the ratio D/D_0 from equation (A7), so that equation (1) of the main text emerges,

$$\frac{C - C_0}{C_0 + D} = \frac{Y_U}{Y_L}. \tag{A8}$$

In contrast, Cebula and Feige (2011, 2012) maintain Gutmann's original cash to deposits assumption, but adjust demand deposits D by taking into account that in the U.S. "checkable deposits were swept into money market deposits". Hence, in the U.S. the cash to deposits ratio was raised due to innovations in the financial industry, which caused a downsizing of checkable deposits essentially unrelated to underground economy activities. Technically, the main modification of Cebula and Feige (2011, 2012), therefore, is to replace D in (A7) by $D_{adj.}$, with $D_{adj.} > D$. This procedure yields,

$$\frac{C - C_{L0} \cdot \dfrac{D_{adj.}}{D_0}}{C_{L0} \cdot \dfrac{D_{adj.}}{D_0} + D_{adj.}} = \frac{Y_U}{Y_L}, \tag{A9}$$

and a comparison of (A8) with (A9) shows the main difference of the two approaches.

Also, to illustrate the first claim made in the main text of section 2.2.4, assume the following numerical values: $C = 150$, $C_0 = 60$, $D = D_{adj.} = 1,000$, $C_{L0} = 15$, $D_0 = 250$, for (A8) and (A9), which should yield a size of the cash using underground economy of 8.49 percent in both cases. Then, $\Delta D = \Delta D_{adj.} = 100$ (-100) yields 7.76 (9.38) percent in case of the MCDR approach, but 7.20 (10.06) percent in case of the Cebula and Feige approach.

With respect to the second claim (see section 2.2.4) note that in (A9) any increase in deposits ($\Delta D_{adj.} > 0$) inevitably leads to an increase in cash used for legal trans-actions, i.e., the term $C_{L0} * (D_{adj.}/D_0)$, which is unwarranted if cash hoards are just transformed into deposits. Of course, this effect goes back to the original Gutmann assumption, which Cebula and Feige maintain.

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Do Unofficial Cash Uses threaten Official Cash Provision?

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1 Introduction

Official cash provision, especially the provision of national cash, mostly banknotes, by a central bank, serves two broad goals. First, cash, foremost in the form of banknotes, is a sign of the sovereignty of a state. It is generally used as a symbol of the state. The state can show its individual quality and its overall political goal by the design of the banknotes it issues. Everybody has the banknotes as its disposal and uses the common sign of the state in daily transactions. This sign or symbol can act as an important connecting piece for the members of the economy at large. In addition, a national cash system is always used as legal tender in order to attain a monopoly position and thereby also monopoly profits for the government. Those monopoly profits enhance the possibility of revenues, like tax revenues, for the government. On a macroeconomic level, a national cash system can be used by government to reach specific inflation goals for the economy, hereby eventually increasing the monopoly profits. According to some macroeconomic hypotheses,

national cash systems may also be of help for some governments who want to follow individual macroeconomic policy goals like employment or growth. All these reasons will contribute to the decision for a national cash system.

Second, cash is a means of exchange[1] contributing to a reduction of transaction costs for all participants in market activities. If there is an official cash provision, and if the second feature of money holds, i.e. if it is a trustworthy store of wealth, cash conveys reliability to the participants of transactions promoting the use of cash and reducing transaction cost still more. To some extent, cash contributes further to lower transaction costs simply because it has the feature of anonymity. Anonymity in itself reduces costs in market transactions. Market transactions with cash are very simple. All participants can concentrate their attention on the goods which they want to exchange, the qualities of the goods and their prices. They do not have to memorize account numbers, personal identification (PIN-) numbers, or even their names, which for most transaction parties are completely irrelevant. Also the calendar date and the time of the transaction need not always be known. No sophisticated or expensive appliances are necessary for payments with cash, again reducing transactions costs.

However, it is just the character of anonymity which triggers unofficial uses of cash. Anonymity will be essential for many activities like theft and robbery of cash. Anonymity enhances unlawful behaviour of people who want to disguise their monetary wealth or their income they reap from their wealth position. Anonymity is a central feature of cash which is exchanged in order to pay for black activities. Black activities need cash, and only few black activities will take place if not cash but in-kind exchanges are chosen as a means of payment. So the question arises if

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1 The differentiation between the function of money or cash as legal tender and as a means of exchange is not always clarified in textbooks on general economics and even on monetary economics. However, the functions of legal tender and of means of exchange are very distinct qualities of money which need not go together or to be identical in currency systems of the real world.

by the official provision of (good and reliable) cash the government or the central bank in charge furthers unofficial activities. Does the official cash provision support illegal or unlawful behaviour? Should, therefore, cash be reduced or should banknotes be banned? Should the ban on banknotes be that far-reaching that their complete abolishment is warranted, or would it be at least advisable to issue new bank notes editions every couple of years in a modified, e.g. redesigned, way making undetected transactions and hoards virtually impossible?

On the one hand, the ban on banknotes would only be viable if cheap alternatives are at hand. In addition to banning banknotes, the remaining role of the central bank as issuer of legal tender or official cash needs to be clarified and eventually completely restructured. As to the repeated issue of redesigned banknotes, it should be very clear that such a procedure would be quite expensive, and increase costs for all participants in transactions. Both decisions, abolishment of banknotes altogether and repeated issues of new banknotes, would, on the other hand, serve to reduce the possibilities of an anonymous cash system as a transmission vehicle for unofficial or unlawful activities. Following these lines would build up serious impediments for cash to serve as an illegal store of wealth (also legal hoards), as an illegal means of payment, and as a medium of income earned in the black sector of an economy. Of course, a lot of questions relating to those far-reaching recommendations have to be asked and answered satisfactorily. This paper will not answer all those questions. We are addressing only three issues.

Chapter 2 concentrates on the illegal use of cash in order to carry out black activities. Are those activities indeed a real threat for official cash provision? The answer to this question depends on whether they are quantitatively important or increasing over time. In chapter 3 arguments are put forward dealing with the role of cash as a store of value used for building up hoards. In this connection we look for convincing evidence, during the last decades, for the supposition that hoards serve in the first line as drivers to pile up resources which are needed for activities

in the shadow economy? Finally, chapter 4 tackles some empirics on unofficial or unlawful activities taking place in alternative payment systems. It is observed that these activities increase the less it is possible to pay with cash. Overall, the arguments put forward are solely related to questions of cash use in Germany or to cash uses of German money. Chapter 5 concludes.

2 The importance of cash for black economies in Germany

Black economies are activities which also occur in the regular economy. They have, however, to be kept secret in order to avoid the obligations of the regular economy, namely to pay taxes or social insurance fees[2]. Cash allows anonymity in transactions which is needed for the carrying out of black activities. In general, the anonymity is confined to the persons involved and their transactions on the microeconomic level. A single transaction is confined in its visibility to the parties engaged directly in black activities. Other people, unless they proceed with detailed detective work, neither can ascertain the black activity, nor its dimension, nor its monetary worth. But black economies could be recognizable on a macroeconomic level because of the amount of the cash use which is somehow needed for black activities and which adds to the use of cash for official activities in the regular economy. A central prerequisite of macroeconomic visibility is, however, the sufficient dimension of black activities in the economy and therewith of cash use for those activities.

The macroeconomic visibility of black cash use must become apparent in overall cash figures. This is an assumption of the currency approach which since the eighties is applied in order to estimate the dimension of black economies not only in Germany but in many countries throughout the world.[3] According especially to

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2 See Graf (2011)
3 See Kirchgässner (1983). See also Feld and Schneider (2010)

Schneider,[4] the assumed dimension of black economies in Germany is about 10 percent up to 15 percent of GDP[5]. His estimates of the size of black economies are based on the development of overall cash issued by the Deutsche Bundesbank in form of Deutsche Mark or of the Bundesbank-issued Euro banknotes.[6] However, the estimates do not take into account that only parts of the overall cash in circulation serve current transactions, both in the official and the black section of the German economy, and that not all denominations of banknotes are equally suitable for official and unofficial uses. Besides this, there are, e.g. uses of cash in national hoards and in hoards in other countries which add to cash demand and may be completely unrelated to current transactions and to unofficial cash uses.

A threat concerning a central's bank cash provision could be assumed if the use of cash for black activities reaches a dimension in the economy which is socially unsustainable. In other words, are black economies, which need cash, fostered by the official provision of cash? Does the central bank insofar contribute to illegal activities by providing the necessary vehicle for these activities on a scale which is not tolerable for a state under the rule of law?

In some cases, data protection can have similar consequences. A law system which protects personal data cannot only contribute to personal security but could, at least in theory, also contribute to the abuse of secure personal data in connection with illegal activities. The question is still more far reaching as many goods provided by government, e.g. public goods, could also be misused.

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4 See Institut für Angewandte Wirtschaftsforschung (2008), Pressemitteilung. Prognose zur Entwicklung der Schattenwirtschaft in Deutschland im Jahr 2008, Tübingen. This press release refers to a volume of black activities in Germany of 347 bn. Euro.
5 15 percent of German GDP is about the same size as the value of all "German" banknotes in circulation at the end of 2010. See Bartzsch et al. (2011), p. 1
6 The currency approach, in addition, needs the very artificial and not validated assumption that there must be an initial year or period where no black activities took place. So, starting from this hypothetical period, all increases of cash demand henceforth could be ascribed to the growing black economy.

Coming back to official cash provision, the question of abuse of the officially provided means of payment for black activities is not a question of existence of black activities (they do exist!) but foremost a question of scale of these activities within the economy. Is an amount of black economies of some 10 percent of GDP based on the central bank's cash provision still tolerable? Could the central bank come under attack because she gives assistance to unofficial activities in the alleged amount by issuing banknotes at will? The answer to this question may seem to depend on the exact monetary equivalent of black activities or, at least, their relation to GDP. Furthermore, the strictness of the answer could be influenced if the estimates of the black sector can only delimit a band for its relative size to GDP which might be some percentage points more or less than 10 percent. But, if finally, the dimension of black activities is much smaller, if its dimension is virtually negligible, the answer must be different, however, it could be given with much more certainty.

As already indicated above, the estimates about the size of black activities are by no means "sure". They rely on an approach taken over from monetary theory, especially monetarism, of the sixties and seventies in the last century. Cash in circulation was simply used as a once and for all quantity described by the symbol C, without differentiating according to diverging cash uses with respective separate economic influences.

But cash does not serve only one single purpose. It is not confined to its use in everyday transactions in the country where it is issued. Since long, we know about different uses especially of German banknotes issued by the Bundesbank. Quite a sizeable amount of them circulates outside of Germany and is used in foreign countries as a store of wealth in hoards.[7] Additional influences are itemized in a

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7 See Seitz (1995)

former paper of the author.[8] As a result, banknotes issued by the central bank in Germany are not restricted to transaction purposes in either the official or the unofficial black sector of the national German economy. So, the growth of cash figures over time is by no means solely due to an increasing black sector, as would be the reasoning behind the estimates of Schneider and his followers. If one takes into account that, besides the transaction motive, there are other reasons to hold banknotes in rising amounts growing cash dimensions simply show the composite influence of all increasing separate demands for banknotes issued in Germany, both Deutsche Mark bills and Euro-banknotes issued by the Deutsche Bundesbank. Altogether, the dimension of black economies in Germany is overestimated at large and will not reach dimensions of 10 to 15 percent of GDP.

There are other findings which forcefully contradict the assumed dimension of black economies of 10 to 15 percent. They consist in empirical findings which are not a full-fletched proof but are serious evidence based on results of government activities and research analyses.

The first counterargument builds on the results of investigations of thousands of public employees of the German customs authorities. Those employees are part of a task force which was initiated in 2004 named FKS (Finanzkontrolle Schwarz-arbeit or: detection force for black activities)[9]. According to the federal court of auditors, the task force detected damages caused by black activities of about 0.6 bn. Euro in the year 2007.[10] This is a dimension of less than one thousandth of GDP. In the years to follow the task force still proceeds with its operations. The results in 2010 were an amount of damages detected caused by black activities

8 See Graf (2011), p. 54-55. Another critique of the currency approach is put forward by Pickhardt/ Sarda (2011). They criticize the currency approach because of its very special assumptions about the cash-deposit ratio which lead to an exaggeration of the estimates of the underground economy in Grmany.
9 See Bundesgesetzblatt (2004)
10 See Bundesrechnungshof (2007)

which reached 0.7 bn. Euro or a third of a thousandth of GDP.[11] Again, for 2011 the yearly report of the federal ministry of finance about activities of the customs administration indicates an amount of, once more, 0.7 bn. Euro for detected black activities.[12] Meanwhile, the picture those reports show, is quite secure. Black activities are confined to a very limited size which does not reach any macro-economic significance.

Nevertheless, it could be argued that the task force cannot detect all black activities since one of their central features is to be executed clandestinely. This holds espe-cially for black activities where both parties – principal and agent – are private households. A text book example would be the activity of a cleaning lady (a private person) in another private household. Albeit this concession, and even if the black activities between purely private households may add to the overall dimension of black activities, the gap between a third of a thousandth and 10 to 15 percent of GDP can never be filled.

The second counterargument against the large dimension of black economies in Germany is based on an analysis of cash data put forward in a recent discussion paper of the Deutsche Bundesbank[13] which relies amongst others on findings published in two articles in the monthly reports of the Bundesbank[14]. The essential result, at this stage of our argument, is that cash or banknotes in Germany used for internal transaction purposes reach an amount of 10 % of cumulated issuance of Euro banknotes in Germany, which again equals some 30 bn. Euro at the end of 2009.[15] This amount of 30 bn. Euro must be sufficient in order to accomplish all private consumption expenditures executed with cash. Consumption expenditures

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11 Bundesministerium der Finanzen (2011), p. 19
12 See Bundesministerium der Finanzen (2012), p. 18
13 See Bartzsch et al. (2011)
14 Deutsche Bundesbank (2011)
15 See Bartzsch et al., p. 23. Similar absolute dimensions of transaction balances are mentioned in Deutsche Bundesbank: Monatsbericht Juni 2009

in Germany in 2009 made up more than 1,400 bn. Euro. Most payments for private consumption are handled with bank cards or directly with transfers from deposits. But still about 60 percent of retail sales were paid with cash. Even if the transaction balances of 30 bn. Euro circulate several times throughout a year,[16] they must in total be sufficient to execute all payments for transactions in the official and the unofficial, especially black, economy. It is simply impossible to execute a dimension of black economies of several hundreds of bn. Euro besides the regular or official transactions with a relative small cash balance of 30 bn. Euro. So again, black activities in Germany can only constitute a relatively small proportion of all activities or of GDP, at least according to the value of the transactions altogether.

All in all, black activities are by necessity fuelled by official cash provision. But, the central bank should not be made uncertain as to the minimal size of this assistance to unofficial cash uses. The central bank, therefore, is not forced into a double cost problem. On the one hand, black activities cause social costs because they lead to an unequal treatment of similar activities (some are taxed – some others are not). A renewed issue of redesigned or completely remodelled banknotes could reduce some of these costs. The repeated issue of banknotes would, however, entail substantial production costs for the new banknotes. It would reduce the quality of banknotes as transaction means as they never become well-known. Finally, it would severely limit the seigniorage the central bank can reap which again comes at a loss for society.

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16 Estimates are given in Deutsche Bundesbank (2011), p. 27. The figures there are, however, not suitable for direct application to our argument.

3 Are hoards an indication of shadow economies?

The lion's share of banknotes issued by the Deutsche Bundesbank circulates outside Germany, with the bulk of it even outside the euro area.[17] This conclusion is derived for the period from 2002 to 2009, i.e. a period during which the Euro is legal tender in the euro area member states. For former periods of time, before the introduction of the Euro, the Deutsche Mark was equally not confined to trans-actions in Germany but served in increasing amounts as a store of wealth in foreign countries. There are estimates of foreign uses of Deutsche Mark banknotes, at least for the eighties and nineties, which arrive at similar results and dimensions. One is an estimate of Seitz.[18] Another estimate based on somehow differing estimation methods is explained in Graf (2011).[19] In the final years of the DM-regime the hoards of Deutsche Mark outside Germany made up some 120 bn. DM. Since the introduction of the Euro as cash in 2002, the German-issued banknotes add up to 220 bn. Euro, or 65 percent of the cumulated net issuance of Euro banknotes in Germany circulate outside Germany, again the largest part in hoards.[20]

Hoards, however, are not concentrated in foreign countries. Hoards of banknotes also occur in Germany herself. An estimate of actual domestic hoards in Germany exhibits an absolute amount of 70 bn. Euro at the end of 2009 or of 20 percent of cumulated net issuance of Euro banknotes in Germany.[21]

For both constituents of hoards one can ask the question: Why do people hold cash which does not lead to any interest revenue? Revenues could, however, be attained indirectly, by the security of the cash value of a noninflationary money.

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17 See Bartzsch et al. (2011)
18 See Seitz (1995), p. 38 and 43
19 See Graf (2011), p. 61
20 See Bartzsch et al. (2011)
21 See Bartzsch et al. (2011), p. 27

Nonmonetary revenues could also be due to the possibility of accumulating large values which can be disguised from other people or from government agencies, especially revenue offices. In order to follow this goal, it is advisable for hoarders to use few banknotes with large denominations. In general, the hoards may not be the result of illegal behaviour, or the accumulated banknotes must not be earned by unlawful activities. But they could nevertheless stem, to some extent, from activities in shadow economies or be finally used – by dissolving the hoards – in order to engage in shadow economies.

The suspicion of hoards built up for present or future engagements in shadow activities seems to be quite obvious at first hand.[22] A deeper look, however, raises at least some doubts about the assumed connection between hoards of banknotes issued in Germany and an assumed similar size of shadow economies. Before concluding this issue, some words are necessary about the meaning of shadow economies and the possible threat with respect to the official cash provision.

Shadow economies are not always defined in the same way. In general shadow economies is used as a generic term.[23] The activities under this heading consist out of black economies and criminal activities like drug traffic, trafficking, blackmail attempts and so on. Most shadow activities (besides black activities) not only need acts of violence but also sufficient means of payments which can keep secret the initiation or the result of the shadow activities. So, there is again the question of the involvement of officially provided cash for the execution of criminal shadow

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22 See e.g. Seitz (1995), p. 48-49 and Bartzsch et al. (2011), p. 21

23 E.L. Feige (2012) proposes to use the expression „unreported economy" as a generic term which better suits the phenomenon. The unreported economy in the sense of Feige naturally encompasses activities which are called black economy here. In addition, Feige stresses possibly large dimensions of the unreported economy in the US caused by insufficient income tax reporting. This noncompliance with tax laws in the US can to a large extent be ascribed to the procedure of income tax management via assessments and must not have a mirror image in Germany, at least not in absolute dimensions or in relation to GDP.

activities. Shadow activities, at least their criminal components, differ insofar from black economies as they, not necessarily but often, take place on an international level. On the contrary, black economies are mostly confined to the domestic economy so that the cash amounts do not necessarily leave one country, and unwind within a short time. The other part of shadow economies will use larger money amounts and could probably put in some stopovers. This may also be the reason for the building up of hoards.

Theoretical reasoning alone cannot answer the question whether the hoards of German banknotes held domestically or in foreign countries are indeed an indication of criminal activities in the international shadow economy. The hoards could also and exclusively serve as a secure store of value emanating out of completely legal activities, which are held for future expenditures in the official sector of the respective economies. Arguments in favour of this hypothesis of near to complete legality of cash hoards will be put forward below.

At least for the time-period near the end of the DM-regime, plausibility results in non-proven evidence about cash developments. In the years 2000 and 2001 DM-banknotes in circulation decreased by an amount of 125 bn. DM. Where did those huge amounts of banknotes, consisting in general out of large denominations, go, and couldn't their disappearance leave tracks of illegal origins of the banknotes? As is shown in below in Table 1, the banknotes found their way, at least to a large part, in deposits of private households in Germany which increased in an equal amount.[24] Especially banknotes with large denominations of 1000 and 500 DM, which served foremost as hoards, contributed most to the opposite development in deposits of private persons, they decreased about 60 to 70 bn. DM Besides the differing developments of banknotes in circulation and private deposits no special economic consequences of the introduction of the Euro can be inferred.

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24 Graf (2011), p. 60 f.

Neither the decrease of banknotes in circulation nor the increase in banking deposits entailed any remarkable influence on overall consumption, macro-economic growth, and inflation at that time.

DM-banknotes and private deposits in Germany 1999 – 2001						Table 1
Year	DM-banknotes altogether		DM-banknotes, large denominations, 1000 and 500 DM		Deposits of national private persons	
	Million DM	Growth in %	Million DM	Growth in %	Million DM	Growth in %
1999	274,133	+ 7.4	121,313	+ 7.2	487,0	+ 11.6
2000	262,089	- 4.4	115,722	- 4.6	507,1	+ 1.8
2001	149,755	- 42.9	57,323	- 50.5	626,1	+ 23.5

Source: Deutsche Bundesbank: Yearly reports (Geschäftsberichte), monthly reports (Monatsberichte)

The mirror-image of cash hoards, which were dissolved and added to private deposits, would probably not have materialized if the hoards consisted to a large extent out of moneys earned in illegal activities. As the dissolved hoards included both national and foreign-hold DM-hoards the huge transactions must have been visible and would have given rise to the suspicion of being related to unlawful behaviour.

However, the assumption put forward here, is that the hoards consisted, to their largest part, out of legally earned stocks. Our argument could be sustained by the developments before and after the introduction of the Euro. There are different trends in the holdings of cash and of deposits of private persons before and after the transition to the new currency which seem supportive for our reasoning. Table 2 summarizes some of the obvious characteristics of the two periods.

The first period in Table 2 encompasses the years 1990 to 1997. The final year has been chosen, as it seems that the rearrangement of cash and deposits did not happen on a large extent up to 1997. Since 1998 the transition to the Euro was supposed to be a secure event, and, already in 1998, the amount of DM-banknotes in circulation dropped the first time.

The second period covers the years from 2002 to 2008, and is due to data availability, which in our case is confined to the data sources provided by Bartzsch (2011).

Table 2 indicates very clearly that in the first period from1990 to 1997 banknotes in circulation grew less than the deposits of private persons. In our reasoning this can be interpreted to a smaller extent by a gradual adaptation of liquid assets to the expected transition in currency regimes. The larger part is probably due to the general habit of increased use of deposits for everyday transactions.

DM-banknotes and private deposits in Germany 1990–1997 and 2002–2008			Table 2
Period	DM-banknotes altogether	Deposits of national private persons	Cumulated net issuance of Euro banknotes by the Bundesbank
	Average yearly growth throughout the period in %	Average yearly growth throughout the period in %	Average yearly growth throughout the period in %
1990–1997	7.2	11.9	-
2002–2008	-	6.4	17.0

Source: see Table 1, and Bartzsch (2011), p. 15 (own calculations).

In the second period from 2002 to 2008, the Euro had been introduced as legal tender and the expectations of the public exhibited firm confidence in its stability and its permanence. So, liquid stocks were built up, mainly in the form of cash hoards, which could easily be maintained inside and outside of Germany. The necessity to transform banknotes into deposits did not seem to be a decisive motive for the people with assets which were denominated in Euro. In any case the positive experiences with the transition year(s) from DM to Euro were no impediment against the concentration on cash hoards

The paper of Bartzsch et al. (2011)[25] provides additional arguments for the differences in the cash use behaviour. The dynamic development of German-issued Euro banknotes since 2002 which is shown in Figure 1 in Bartzsch et al.[26] designs a trend line of the development of the hypothetical volume of banknotes in circulation. The hypothetical line simply follows an extrapolated linear trend of the nineties. This theoretical line is confronted with the actual development of the volume of German banknotes in circulation. The hypothetical line ends at a banknotes volume of less than 200 bn. Euro in 2010. The actual volume, however, attained virtually the twice this amount in 2010. This huge difference could be the result of the expansion of hoards after the introduction of the Euro. At least to some extent, the Euro is and was a currency with broader international character than former national currencies of European countries. So it does not come as a surprise that hoards constituted out of Euro-banknotes grew fast and even faster than a decade before.

Why, however, were these hoards built up foremost in the form of German-issued Euro-banknotes? Again, the answer to this question can only be tentative. The

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25 See p 24 ff.
26 See p. 2. A similar graph is shown in the monthly report of the Deutsche Bundesbank (2011), p. 32

geographical proximity of Germany to countries in eastern and south-eastern Europe, where banknotes could not only be piled up in hoards but eventually could also be used directly in transactions, may be one reason for the concentration on German-issued banknotes. The nearness to Germany could prove to be an advantage in cases of rumours because a quick transformation of banknotes in deposits was at hand. The reasoning put forward concentrates on well-founded official uses of the banknotes. Nevertheless, motives cannot be excluded which are based on activities in the shadow economies. With reference to the prior period in the nineties the part of the shadow economy must be limited. And even if more than only marginal parts of banknote-holdings could be accounted for by motives to fuel shadow activities, the weight of shadow uses is limited. Hoards as such have no sizeable circulation velocity, so the hoards will not execute leverage effects on total money supply or the transaction volume in the economy.

Summing up, the increased use of DM-banknotes and German-issued Euro banknotes in domestic and international hoards can only to a small part, if at all, be ascribed to motives in connection with shadow economies. This again, albeit with some reservations, is an argument which enforces the role of official cash provision in Germany. This role is not offended in a decisive way by unofficial activities and cash uses. Some reservations about our arguments, however, have to be allowed for. Especially the process of building up and use of the hoards under discussion seems to be a worthwhile field for future research. The plausibility referred to need additional evidence.

4 More Threats concerning cash and alternative payment instruments

The cash system of an economy is always under attack from criminal activities of counterfeiting, especially of banknotes. This is a permanent challenge for all currencies throughout the history. This threat is, moreover, not confined to banknotes but occurs also within systems of specie. The danger for cash systems is well-known. It is reflected in data e.g. of the European Central Bank[27], and the Deutsche Bundesbank.[28] But according to the statements of both central banks, the risks from counterfeiting are manageable since their amounts are effectively limited to a very low level. The Euro-System, in addition, like any system of legal tender is always prepared to prevent counterfeiting and provides measures to detect and restrict such criminal offenses.

The central banks, however, cannot take action as far as "normal" burglary is concerned. This is a threat which is not exclusive for cash systems but spreads over all assets which can be stolen.

Are there alternatives to cash, and couldn't they lead to less unofficial activities? Alternatives consist in a wide variety of card systems and digital currencies. All those payment instruments are more and more used in everyday transactions without, however, crowding out cash in a sizeable way. Especially transactions with small values will now and in the foreseeable future need cash as the costs for the equipment necessary in order to process the handling with credit cards or prepaid cards are relatively high. In addition, the extended use of card systems is not without risk for both parties since criminals since long concentrate the efforts on the misuse of cards and electronic transfers.[29] A very impressive evidence for this

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27 See ECB Annual Report (2010), Ch. 2, 3.2
28 See Deutsche Bundesbank (2010), p. 126-127
29 See ESTA (2011), p. 3

tendency is the information given by the German statistics about criminal offenses (Polizeiliche Kriminalstatistik).[30] According to data published in the official statistics, criminal activities utilising cards and computers increase at a high rate, whereas counterfeits of cash money are relatively insignificant and not rising.[31]

A similar result can be inferred from a report which is presented by the ESTA.[32] According to this report the use of cash as sole means to facilitate black economies or unofficial activities in a parallel or shadow sector of the economy is outdated. Criminals do not any more rely on cash in order to try to cover their tracks. They rely nowadays much more on wires or transfers, on credit cards, on prepaid cards, and on digital currency. Probably, these procedures need sophisticated agents. But this is not paramount to say that only less educated people will still use the traditional black activities with cash or banknotes. The threat on any payment system materializes, is always present, and cannot be overcome by banning one of the most common, most economic and beneficial one – cash.

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30 See Bundesministerium des Innern (2010)
31 See Bundesministerium des Innern (2010), pp. 4, 45 and 46
32 See ESTA (2009) Newsletter No. 59, p.3

5 Conclusion

Official cash provision by a central bank is one of her most important tasks. By the official provision of cash, a central bank enhances decisively the reduction of transactions costs in the economy, and adds substantially not only to economic growth but to the social welfare of a country altogether. The reduction in transaction costs needs cash with the quality of legal tender. This contributes to the security and reliability of all transactions which otherwise would be impossible at the same low level of costs. Sometimes, official monetary and cash policy neglects one important task of cash provision which supplements its use as a cheap medium of transactions. Official cash is a token for a country and its governance. Banknotes and coins are able to carry a symbol for a state. Cash, therefore, contributes as a universal means of payment to the representation of the state. No other transaction media can accomplish this task. If, however, official cash provision would trigger unofficial activities in a large amount, the fundamental role of the central bank could come under attack. So a central bank has to be very confident that her cash provision is not threatened by unofficial uses which could possibly endanger the economic system in total. Our aim was to show that this threat, albeit it is present to some extent, has and had no decisive or overwhelming material basis during the last decades in Germany. This holds both for the DM-regime and the first period of the Euro.

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Ruth Judson
Crisis and Calm: Demand for U.S. Currency at Home and Abroad from the Fall of the Berlin Wall to 2011[1]

Ruth Judson
Federal Reserve Board

Unlike the banknotes of most other countries, the U.S. dollar is used far beyond its borders as a medium of exchange and store of value. This international aspect of dollar usage has important implications for a wide range of Federal Reserve operational considerations, including its currency production, processing, and planning, the interpretation of currency figures as part of monetary analysis, daily open market operations, management of the Federal Reserve's portfolio, and

analysis and forecasting of the Federal Reserve's income.[2] In addition, currency
exports, like other exports, figure in the U.S. balance of payments and inter-
national investment position. Unfortunately, however, direct measurements of the
stocks and flows of U.S. currency outside U.S. borders are not available, and a
variety of indirect measurements and proxies must instead be used. From these
sources, though, a fairly consistent picture emerges.

Despite the disparate methods and data sources, the data consistently indicate
several trends. First, international demand for U.S. currency increased steadily over
the 1990s and into the early 2000s, a period that coincided with the fall of the
Berlin Wall, the collapse of the Soviet Union, and periodic crises in several Latin
American countries. Second, international demand for dollars began to stabilize or
decline around the time of the introduction of the cash Euro in 2002.[3] This decline
coincided with stabilization and financial modernization in many economies in and
around the Euro zone and the former Soviet Union and continued until late 2008,
when the global financial crisis appeared to spark renewed demand for U.S. bank-
notes that has shown no sign of abating.

In this paper, I present estimates of the stocks and flows of U.S. currency abroad
from the early 1990s through the end of 2011. Section 1 reviews the available data
sources, with a focus on their strengths and weaknesses for use in answering ques-
tions about the shares of banknotes held in the United States and abroad. Section
2 presents an overview of currency demand over the past several decades and
some stylized facts about the composition of U.S. currency levels and changes over

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2 Until late 2008, Federal Reserve notes, the dominant form of currency, were the primary liability on
the Federal Reserve's balance sheet. As a result, currency demand was thus a primary consideration in
the conduct of daily open market operations as well as in longer-range planning related to the Federal
Reserve's System Open Market Account portfolio. Appendix Figure 3 illustrates the major components
of the Federal Reserve's balance sheet since 2003.
3 The Euro currency was introduced as a unit of account in 1999; the physical currency was introduced
in 2002.

time. Section 3 builds on the stylized facts in Section 2 to present simple and direct estimates of stocks and flows of U.S. currency abroad. Section 4 presents updates of two indirect estimates of stocks and flows of U.S. currency held abroad; these estimates are based on the data sources from Section 1 as well as additional information. Section 5 presents estimates of a very simple currency demand equation for the United States, from which estimates of the impact of international demand on currency growth can be derived. Section 6 summarizes these findings and concludes with some general observations and directions for further work.

I. Data: An Overview

I.A. Total Currency in Circulation

I.A.1. Public Data

In general, the aggregate quantity of genuine currency in circulation is relatively easy to measure: it is physical, and it is produced, transported, and issued under very secure conditions.[4] Official currency statistics for the United States are reported by the Treasury and Federal Reserve, which collaborate to produce data on currency in circulation, generally defined as Federal Reserve notes, Treasury currency, and coin held outside of the vaults of the Federal Reserve and the Treasury.[5] Figures on total currency in circulation are reported weekly on the Federal Reserve's H.4.1 and H.6 Statistical Releases; the quarterly *Treasury Bulletin* provides additional detail on denominations of banknotes and coin in circulation.

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4 The quantity of counterfeit currency in circulation at any point is not known, but estimates suggest that circulating counterfeits are extremely small relative to genuine currency, on the order of one to three in 10, 000 (Judson and Porter (2010)).
5 Appendix table 1 provides a list of sources of currency data along with a description of the different definitions of currency.

I.A.2. Internal Data

The Federal Reserve's internal accounting and production processes require close
monitoring of currency production, processing, and movements; as a result, more
frequent and detailed data are available internally for Federal Reserve notes, which
constitute the vast majority of currency in circulation ($1.03 trillion of the $1.08
trillion total as of the end of 2011).[6] In particular, accounting data provide daily
updates by denomination on the quantity of Federal Reserve notes outstanding, or
on the books of each Federal Reserve Bank, and in the custody of each Federal
Reserve Bank. In addition, processing data provide monthly totals of Federal
Reserve note movements between each Federal Reserve office and circulation by
denomination.[7] As shown in section 3, these data and simplifying assumptions
about domestic and international movements of banknotes can be exploited to
obtain estimates of stocks and flows of U.S. currency abroad.

I.B.   Data on Cross-Border Flows of U.S. Currency

Movements of currency across U.S. borders cannot be easily or precisely measured
for several reasons. First, there is no legal requirement or mechanism to monitor
movements of $10,000 or less, and many individuals cross U.S. borders each year.[8]
The net movements of currency across U.S. borders through such nonbanking
channels are potentially significant. Indeed, as noted in U.S. Treasury (2006),
customs reporting for Mexico indicates substantial cash flows from the United
States to Mexico in the hands of tourists and migrants; these flows are not captured
in U.S. data. Second, even when there is a legal requirement to report currency
flows, mechanisms are not always in place to capture the data and reporters might

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6 H.4.1 Statistical Release, tables 1 and 8. http://www.federalreserve.gov/releases/h41/20111229/.
7 The locations and boundaries of the twelve Federal Reserve districts were set when the Federal Reserve
was established in 1913. Within each district, cash processing occurs at one or more cash offices. The
number and location of these offices varies over time. Processing data are reported separately for each
office.
8 In 2009, 151 million passengers arrived and departed on international flights at U.S. airports and
about 200 million border crossings occurred by land (U.S. Census 2012).

not comply with requirements. Despite these challenges, informative measurements do exist.

I.B.1. Federal Reserve Commercial Bank Shipment Data

The Federal Reserve provides currency on demand to all account holders, including those who provide banknotes to international customers. Many of these institutions, including most of the largest wholesale banknote dealers, report monthly, on a voluntary and confidential basis, the value and ultimate source or destination country of their receipts and payments of U.S. currency. While not all banks that deal in the international shipment of banknotes provide these reports, the banknote shipping business is highly concentrated and this dataset currently captures the vast majority of banknote shipments that cross U.S. borders through commercial banking channels.

This dataset begins in the late 1980s and covers virtually every country in the world. The quality of the data varies across time as the set of reporting dealers has evolved; for all practical purposes, the dataset begins in the early 1990s. For example, consider a shipment bound for Russia via Germany. The immediate source or destination of the shipment can be identified by the location of the counterparty. Thus, for a nonreporting dealer, the dataset would only indicate a shipment to Germany, but a reporting dealer would provide the ultimate destination, Russia. Conversely, consider a shipment from Cambodia back to the United States via Hong Kong. Data from a nonreporting dealer would indicate an inflow of dollars to the United States from Hong Kong, but data from reporting dealer would indicate the ultimate source of shipment as Cambodia. The level of detail in the reporting has generally improved over time as more dealers have begun to report, but the trend can reverse if, for example, a reporting banknote dealer leaves the banknote business and other nonreporting dealers begin providing banknote shipment services to the departing reporter's customers.

Two additional shortcomings of this dataset are that it covers only banknote flows
to and from the United States, and that it only covers flows through the banking
system. First, the dataset does not cover banknote flows among other countries,
which can be substantial, especially in areas where large volumes of cross-border
trade are conducted in cash.[9] The absence of such information complicates any
estimation of regional or country-level holdings outside the United States, but does
not affect global totals for commercial bank currency shipments flows into and out
of the United States. However, banknote flows through nonbank channels can also
be significant, and observations gathered in the course of the joint U.S. Treasury –
Federal Reserve International Currency Awareness Program indicate that several
countries receive dollar inflows through nonbank channels such as tourists or
migrant workers but return the currency to the United States through banking
channels.[10] As a result of these shortcomings and complications, the country-level
data must be interpreted with care and with an understanding of the institutional
arrangements in place through time.

I.B.2.   U.S. Customs Data

In principle, the most obvious direct source of information on U.S. currency flows
across U.S. borders should be the Currency and Monetary Instrument Reports
(CMIRs), which are compiled by the U.S. Customs Service. Individuals and firms
making almost any shipment of more than $10,000 in cash across a U.S. border are
required to file CMIRs, so these reports should be quite comprehensive and
informative. However, as noted in Treasury (2006), CMIRs are neither accurate nor
thorough measures of large cash shipments outside the banking sector due to a
three shortcomings: a generally one-sided system for collecting data, the omission
of some potentially large volumes of currency flows, and the inability to accurately
reflect flows to international custodial holding sites for U.S. currency. First, all

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9 Refer to U.S. Treasury (2006) for examples of such flows.
10 This phenomenon is addressed in more detail in the discussion of the flow data.

individuals entering or leaving the United States are required to complete a CMIR if they are carrying more than $10,000 in currency or monetary instruments. In practice, though, customs formalities, including a specific question about currency and monetary instruments, are required for individuals entering the United States, but not for individuals exiting the United States.[11] As a result, it seems plausible that underreporting is more likely for outbound travels. Second, even if all travelers were to report accurately, the CMIRs require no reporting for sums below $10,000; in aggregate, these sums could be considerable. As noted above, 151 million passengers arrived and departed on international flights at U.S. airports and about 200 million border crossings occurred by land in 2009 (U.S. Census 2012). Third, the CMIRs do not account properly for shipments to international custodial holding sites for U.S. currency. These sites, known as Extended Custodial Inventories, or ECIs, are secure locations outside the United States at which U.S. currency is held in custody for the Federal Reserve Bank of New York. Shipments to these sites are recorded in U.S. Customs data when they physically exit the United States, even though they remain in the custody of the Federal Reserve Bank of New York. Thus, for example, a shipment to an ECI in Switzerland will be recorded as a shipment to Switzerland on the day it occurs even though the currency is not in circulation.[12]

In addition, CMIR reporting requires only information about the immediate source or destination of currency flows, not the ultimate source or destination like the commercial bank shipment data. For example, if an institution ships currency to Russia via Germany, the commercial bank shipment data from a reporting institution would record the destination as Russia while the CMIR data would report the destination as Germany. We therefore consider the shipments data described

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11 Passengers on flights departing the United States are sometimes questioned or informed about this reporting requirement, but coverage is far from complete.
12 Refer to U.S. Treasury (2006), Chapter 5, for more details about ECIs.

above to be superior to the CMIR data, and hence we do not use the CMIR data in
this study.[13]

II. Stylized Facts about U.S. Currency in Circulation

II.A. Overall Currency Growth Has Been Strong

The death of cash has often been predicted, and it would seem that demand for
currency would thus grow somewhat more slowly than income. Despite a general
increase in the variety of payment media as well as increasing noncash means of
payment, though, U.S. currency in circulation has grown at an average rate of
about 6 to 7 percent annually over the past few decades, one to two percentage
points more rapidly than U.S. nominal GDP.[14] [15]

II.B. Overall U.S. Currency Movements are Dominated by $100s

In value terms, the driving force over this period has generally been growth in the
$100 denomination, as can be seen in Figures 1A and 1B.[16] Figure 1A presents
annual end-year data on U.S. currency in circulation by denomination from 1989
to 2011. At the end of 2011, U.S. currency in circulation totaled about $1 trillion,
of which nearly $800 billion, or just over three quarters, was in the $100 denomi-
nation.[17] Figure 1B presents annual growth rates for the same items, on a fourth-
quarter growth basis. The overall growth of currency, the wider red line, moves
closely with, though generally more slowly than, the growth of $100 notes, the

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13 For researchers who do not have access to the shipment data, the CMIR data can provide useful
insights. Refer, for example, to Feige (1996, 2012).
14 On a Q4-to-Q4 basis, over 1980-2011, currency growth averaged 7¼ percent and nominal GDP
growth averaged 5¾ percent. Over 1990-2011, currency growth averaged 7 percent and nominal GDP
growth averaged 4¾ percent. Over 1999 to 2011, currency growth averaged 6 percent and nominal
GDP growth averaged 4¼ percent.
15 Refer to BIS (2012).
16 In piece terms, however, U.S. currency is dominated by smaller denominations. As of late 2011, $1s
were 32% of notes in circulation, $2s to $10s were 16%, and $100s were 25%. Appendix Figures 1A
and 1B provide a breakdown of U.S. and Canadian currency by denomination in value and piece terms.
17 These figures are from the Treasury Bulletin: *http://www.fms.treas.gov/bulletin/b2011_1.pdf.*

U.S. currency levels and growth rates — Figure 1

Figure 1A — Figure 1B

1 Average of September and December currency in circulation. **2** Annual growth rates of fourth-quarter averages (average of end-September and end-December levels).
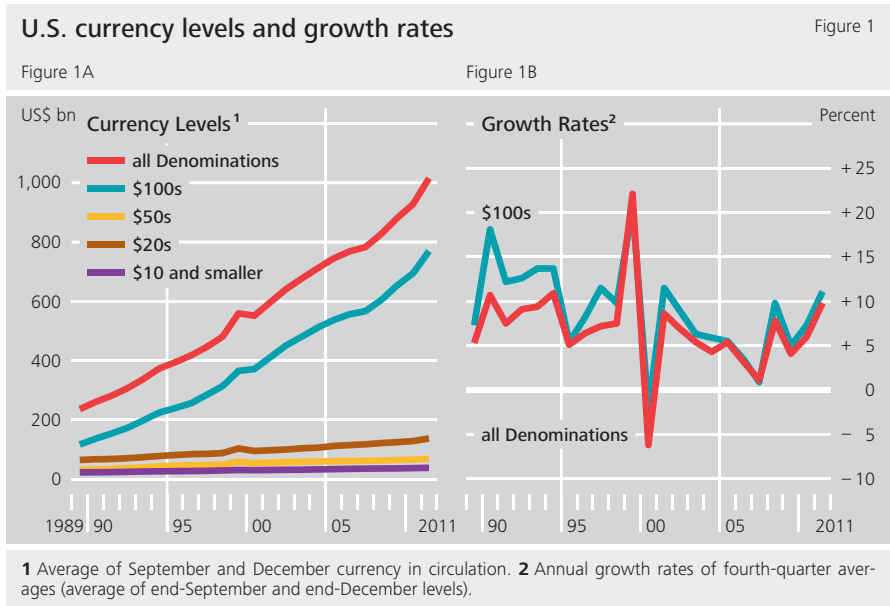
turquoise line. The correlation of overall currency growth with $100s over this period is over 0.9; correlations with the other denominations are generally decreasing in the denomination. The correlation for $1s is about 0.2.

II.C. Crises Are Reflected in Aggregate U.S. Currency Data

Figure 1B begins to reveal some general patterns in overall currency demand. In particular, currency growth was quite strong in the early 1990s, which coincided with the fall of the Berlin Wall and the collapse of the Soviet Union. After a brief lull in the mid-1990s, currency growth picked up again in the late 1990s, driven by crisis in Argentina in 1997 and then concern about Y2K in 1998 and 1999. Following a dip in currency demand in 2000, which largely reflected the return early in 2000 of precautionary stocks accumulated late in 1999, demand was boosted in the early 2000s by the events of September 11, which, judging by outsized commercial bank shipments, led to strong overseas demand for currency in the short

run and, in the longer run, the apparent accumulation of precautionary stocks at home and abroad. Demand then slowed over the mid- to late-2000s until the sharp reversal seen in late 2008.[18]

II.D. Canadian Patterns of Currency Demand Are Likely Similar to U.S. Domestic Currency Demand

One might look to Canada for evidence of what U.S. currency demand would look like without a foreign component. Canada has similar income levels, payments technologies, holiday patterns, and GDP growth rates to those in the United States, but little Canadian currency is believed to circulate externally. Figures 2A and 2B display Canadian currency in circulation by denomination in levels and growth rates from 1989 to 2011. As can be seen in Figure 2A, $100s are also prevalent in Canada, though less dramatically than in the U.S., accounting for just over half of Canadian currency in circulation at the end of 2011.[19] Overall currency growth rates for Canada are, not surprisingly, driven less strongly by $100s and more strongly by $20s and $50s (not shown), the primary transaction denominations in Canada. Over the full half-century, the simple correlation between overall currency growth and growth by denomination is 84% for $100s, 86% for $20s, and 75% for $50s. More recently, however, the role of $100s has apparently declined, possibly as electronic payments have become more common. Correlations over this period are, respectively, 63%, 87%, and 70%.

II.E. U.S. and Canadian Currency Growth Relative to Income Diverged Beginning in the 1980s

As noted earlier, U.S. currency growth has been strong even relative to nominal GDP. Figures 3 and 4 display the ratios of total currency to nominal GDP for the

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18 Hellerstein and Ryan (2011) find systematic relationships between currency shipments and inflation and other factors.
19 Both the United States and Canada have notes of denominations above $100 in circulation, but in both cases, these notes have not been issued to circulation for some time.

Canadian currency levels and growth rates

Figure 2

Figure 2A

Figure 2B

1 Average of September and December currency in circulation. **2** Annual growth rates of fourth-quarter averages.

U.S. currency to U.S. nominal GDP ratios

Figure 3

in %

Canadian currency to Canadian nominal GDP ratios   Figure 4

in %
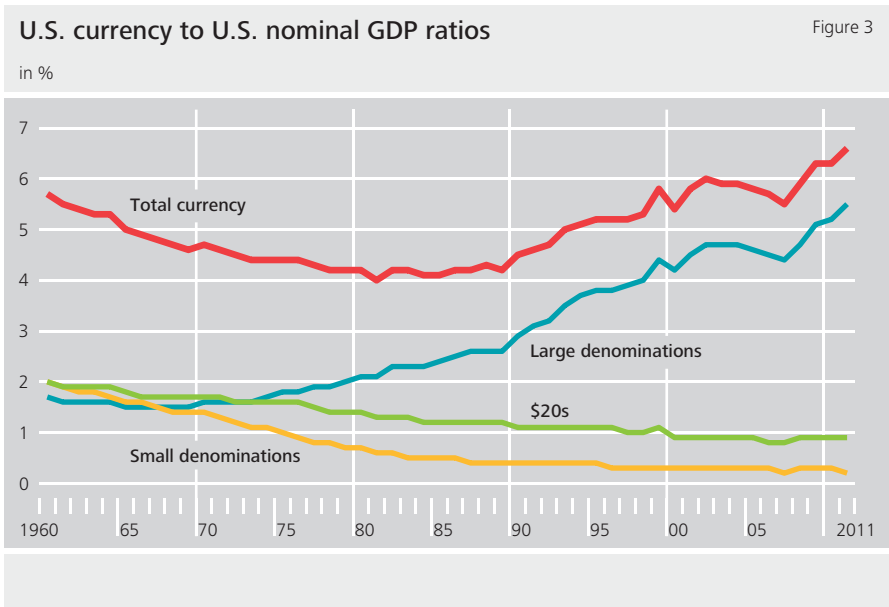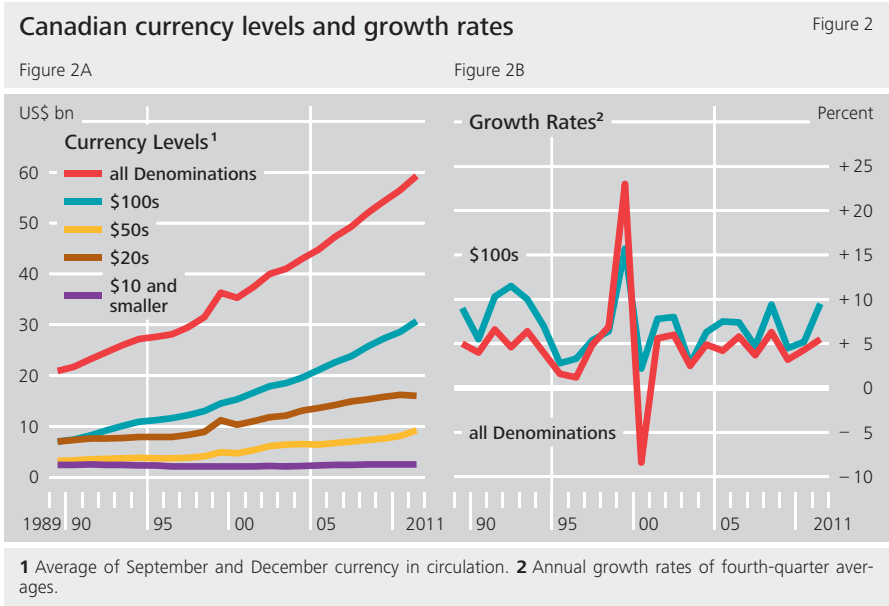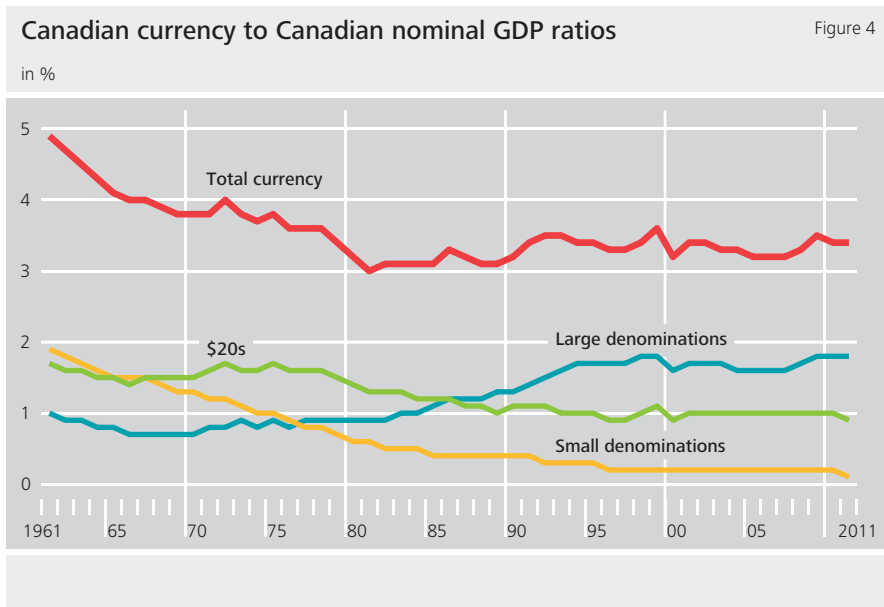
United States and Canada over the past half-century. Ordinary theories of money demand would predict that the ratio of income to currency, or velocity (the inverse of the ratio shown here) should vary positively with the opportunity cost of holding money. That is, in terms of these charts, higher opportunity cost would be associated with lower demand for currency relative to income. As cashless payments become more common and, presumably, more cost-effective, one might expect that, abstracting from movements in market interest rates, demand for currency relative to income should decline. Indeed, that pattern prevailed in the United States until about 1985, and in Canada generally for the period. The upturn in the U.S. ratio of currency to nominal GDP beginning in 1989 is thus anomalous and is consistent with substantial and growing external use of U.S. currency.

In the next section, I present a very simple estimate of overseas demand for U.S. currency based on these patterns and the assumption that patterns of domestic

demand for currency are the same in the United States and Canada. I then juxtapose
these estimates with direct measurements of cross-border currency flows.

III. Simple Estimates of Stocks and Flows of
U.S. Currency Held Abroad

III.A. Two Estimates Based on Money Demand and
Comparisons with Canada

III.A.1. A Very Simple Estimate
Taken together, the difference between the patterns seen for the United States and
for Canada in Figures 3 and 4 suggest a simple estimate of the share of U.S.
currency abroad. As noted above, and as displayed in Figure 5, U.S. and Canadian
nominal GDP growth rates have been similar over this period. The observed U.S.

Growth rates of U.S. and Canadian nominal GDP Figure 5

in %
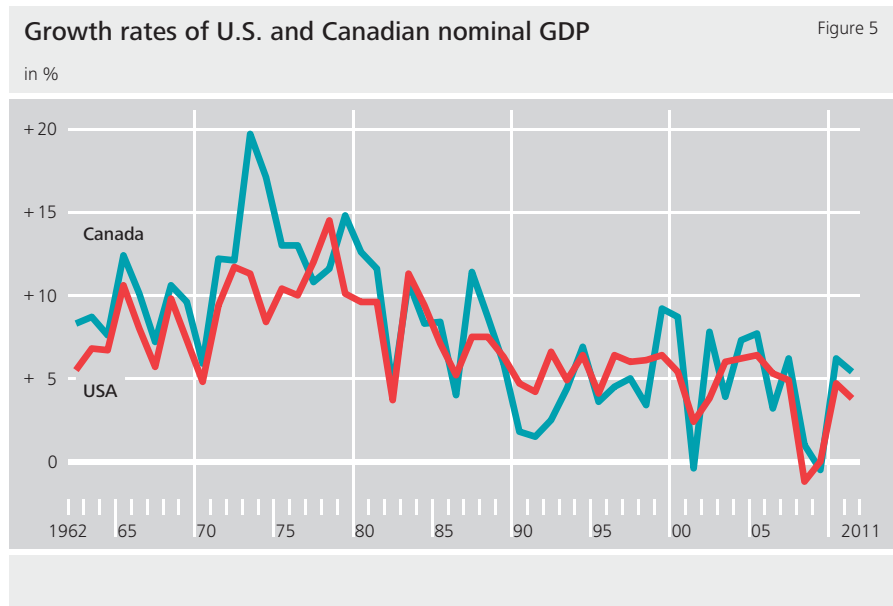
ratio of currency to nominal GDP is the sum of domestic and foreign demand. If we
assume that the Canadian ratio of currency to nominal GDP is the same as its U.S.
counterpart for domestic demand, then the foreign share of U.S. demand can be
estimated as follows.

Define

$$(1) \ CURRGDP_{Canada} = \frac{CURR_{Canada}}{GDP_{Canada}}$$

$$(2) \ CURRGDP_{USA} = \frac{CURR_{USA}}{GDP_{USA}} = CURRGDP_{USA\_Dome} + CURRGDP_{USA\_For}$$

Replacing CURRGDP$_{USA\_Dom}$ with CURRGDP$_{Canada}$ in the equation above and rear-
ranging to solve for CURRUSA_For / CURRUSA_Tot, gives

$$(3) \ ForShare_{VerySimple} = \frac{CurrUSA_{For}}{CurrUsa_{Total}} = 1 - \left(\frac{CurrGDP_{Canada}}{CurrGDP_{US}} \right)$$

III.A.2. A Simple Estimate

The approach above carries with it the assumption that Canadian and U.S. domestic
demand for currency are the same at the same point in time. However, the level of
Canadian per capita income, while similar to that of the United States, has gener-
ally been a bit lower. Thus, an alternative assumption would be that Canadian and
U.S. domestic demands for currency relative to income are the same at the same
levels of per capita income. In order to construct an estimate of the share of U.S.
currency abroad using this assumption, we proceed as follows. First we regress the
ratio of Canadian currency to GDP on the log and level of Canadian per capita GDP,
denoted GDPC:

$$(4) \ CURRGDP_{Cananda} = \alpha_{Cananda} + \beta_1 \ lnGDPC_{Cananda} + \beta_2 \ GDPC_{Cananda} + \varepsilon_t$$

To be sure, this specification is a very simple reduced form based on the chart
shown; it effectively assumes a log-linear structure for demand for currency
as a function of income and assumes no other factors. We then construct the
estimated domestic share of U.S currency for a given level of GDPC as

(5) $CURRGDP_{USDom} = \alpha_{Cananda} + \beta ln\ (GDPC_{US} * X_{CanUS})$

where X_{CanUS} is the U.S.-Canadian dollar exchange rate. The simple estimate is then
constructed as before, replacing $CURRGDP_{USADom}$ with $CURRGDP_{CUSDom}$ in Equation 2
and rearranging to solve for $CURR_{USAFor}$ / $CURR_{USATot}$, which gives

(6) $ForShare_{Simple} = \dfrac{CurrUSA_{For}}{CurrUsa_{Total}} = 1 - \left(\dfrac{CurrGDP_{Canada}}{CurrGDP_{US}}\right)$

**Simple estimates of the share and the value
of US currency abroad**

Figure 6
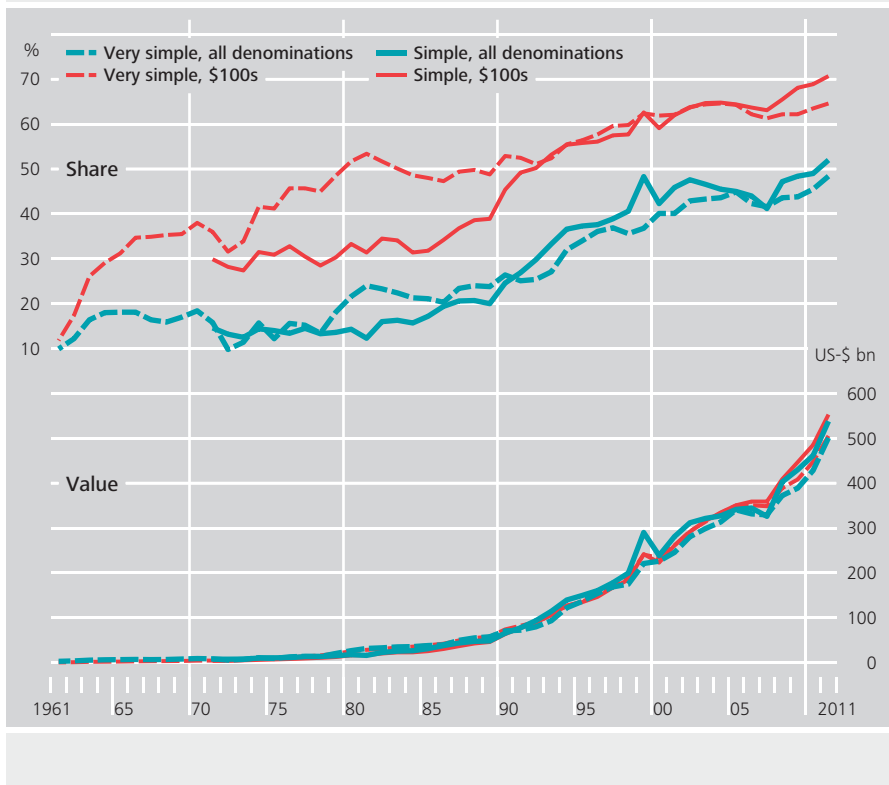
These two estimates of U.S. currency abroad are displayed in Figure 6. The GDP-
based estimates, the solid lines, suggest that about half of all U.S. currency, and
about 65 percent of $100s, were held abroad as of the end of 2011, for a total
value of about $500 billion. Over the past two decades, these estimates point to a
sharp runup in external demand for U.S. currency beginning in the late 1980s, a
brief pop in 1999, a decline beginning in 2003, and a resurgence in 2008, all
patterns consistent with the overall growth of U.S. currency.

III.B. Measurements of Cross-Border Flows of U.S. Currency

We now turn to the information provided by direct measurements of currency
flows. Figures 7 through 11 display annual data on the primary measurements of
cross-border currency flows in dollars. Beginning with Figure 7, the green line
indicates net commercial bank shipments and the purple line indicates the total

**International commercial bank shipments and
total change in U.S. currency flows abroad**

Figure 7

US$ bn

Total change in currency in circulation

All commercial bank shipments
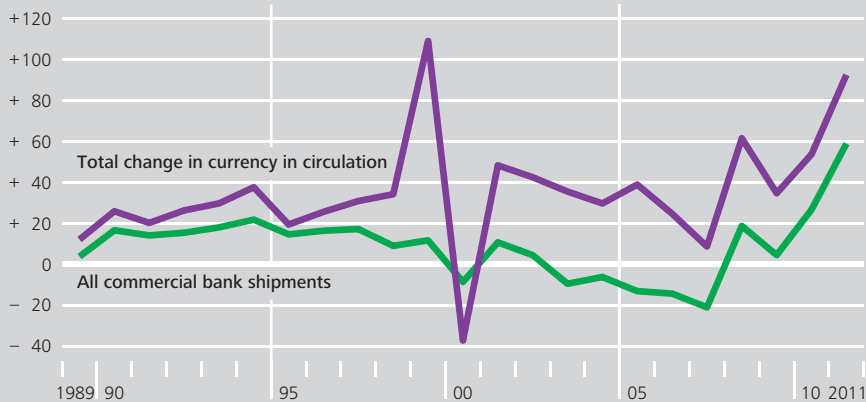
change in currency in circulation each year.[20] Focusing only on the blue and gray
lines, several features of the data stand out. First, reflecting the strong influence
that international demand has on overall U.S. currency demand, the two series
generally move in parallel, though the gap widens in the early 2000s and narrows
in the most recent years. Second, the spike seen in total currency in circulation, the
gray line, is absent in the shipment flows. This feature of the data reflects the fact
that a large share of the runup in holdings of currency immediately prior to the
century date change (that is, in the final weeks of 1999) was held in commercial
bank vaults and was then returned to the Federal Reserve early in 2000. Thus,
while the currency was technically "in circulation" in the sense that it was held
outside the Federal Reserve, the bulk of it never went to bank customers.[21]

While U.S. currency is used in, and is shipped to and from, many countries, a few
areas stand out because of their size and their appetite for dollars in times of crisis.
In Figure 8, the purple line indicates net commercial bank shipments to the two
leading markets in this category, the former Soviet Union and Argentina. For all but
the first and last few years of the period shown, or from about 1995 to 2008, these
shipments more than fully accounted for all net commercial bank shipments. This
phenomenon might also have been the case in the early part of the sample, but
reporting in that period was not as detailed. As a result, shipments recorded with
a destination of Europe might well have been sent to the former Soviet Union.
In the early 2000s, net shipments to these markets declined as the financial
conditions stabilized and as the need to use cash for saving and transactions has
faded. In the past two years, though, global conditions as well as crisis and political

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20 Net commercial bank shipments are defined as shipments out of the United States to other countries
(exports) less shipments from other countries into the United States (imports).
21 For many internal calculations, we typically smooth through this spike because of its extremely
transitory and peculiar nature. The currency component of the money stock excludes currency held in
the vaults of depository institutions. We would ordinarily prefer to use this currency component measu-
rement, but data are not available by denomination on that basis.

Total commercial bank shipments and shipments to a selected group of countries

Figure 8

US$ bn

All commercial bank shipments

Shipments to Former USSR and Argentina
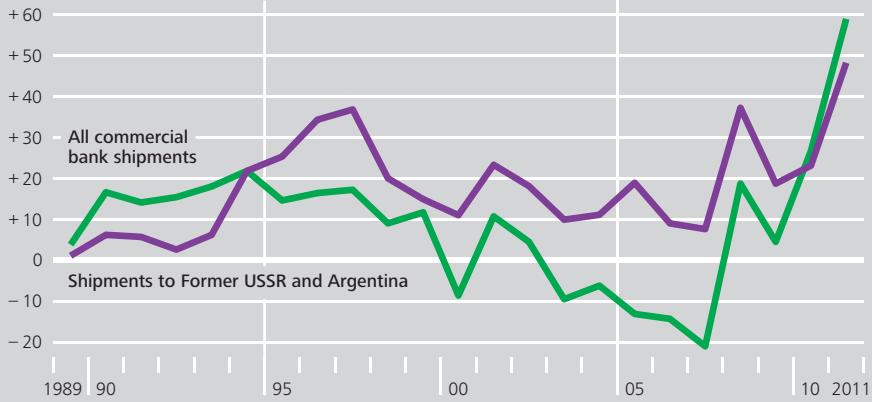
Total shipments, the shipment proxy, and adjusted shipments

Figure 9

US$ bn

All commercial bank shipments
Shipments adjusted for negative flows
Net payments of $100s from selected offices
Net payments of $100s from NY only
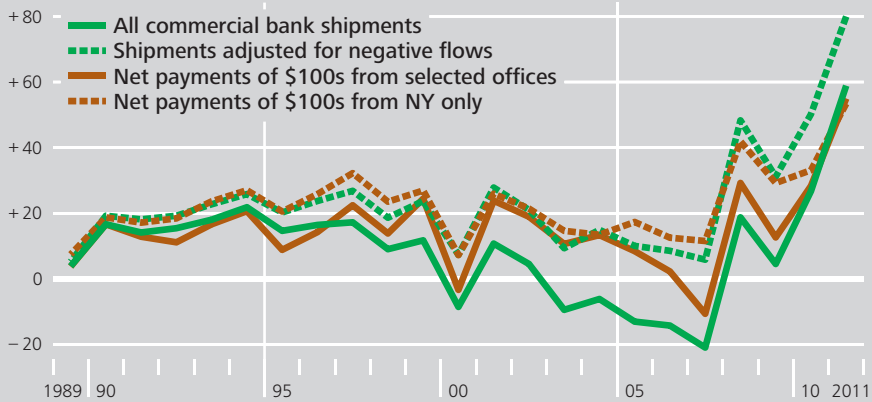
uncertainty in these regions appears to have coincided with an upswing in demand
for dollars.[22]

Figure 9 displays a proxy for commercial bank shipments based on currency pro-
cessing data, the solid purple line. Commercial bank shipments are reported on a
confidential basis, and monthly data are not always available on a consistent
schedule. In order to have data for operational and publication purposes, Federal
Reserve Board staff developed this proxy, which is the sum of net payments of
$100 notes from three Federal Reserve offices known to handle substantial volumes
of deposits and withdrawals sent from or to international destinations: New York,
Los Angeles, and Miami.[23] This proxy is based on two assumptions, which differ
from the true net shipments series in two offsetting ways. The first assumption,
which likely results in an overestimate, is that all payments and receipts at these
offices are to or from international counterparties and that all payments and
receipts at other offices are to or from domestic entities; in fact, every Federal
Reserve office serves domestic and international customers. The second assump-
tion, which would generally result in an underestimate, is that only $100s are sent
to or received from international destinations. This proxy moved very closely with
the total shipments data in the 1990s, but was considerably higher than shipments
over most of the 2000s, perhaps suggesting that domestic demand for $100s was
stronger in that period.

The two dashed series in Figure 9 indicate two experimental series. As noted above,
one shortcoming of the shipment dataset is that it captures only cross-border flows
carried through commercial banking, or "wholesale" channels. However, as

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22 Work on disentangling the relative importance of internal and external economic and political crisis
for currency demand in these countries is currently underway.
23 The Federal Reserve System has 12 regional Banks, whose locations are fixed. Many Federal Reserve
Banks also have one or more branches, whose number and location can change over time as opera-
tional needs dictate. The Miami office is a branch of the Federal Reserve Bank of Atlanta and the Los
Angeles office is a branch of the Federal Reserve Bank of San Francisco.

reported in U.S. Treasury (2006), many countries receive large dollar flows through nonbank, or "retail" channels and return dollars to the United States through banking channels. In the commercial bank shipment data, this phenomenon emerges in the form of persistent negative net shipment figures. That is, the shipment figures indicate large flows of dollars out of the foreign country into the United States and much smaller flows in the opposite direction.

For some such countries, the net commercial bank shipments figures are likely accurate and reflect dollar banknote inflows from third countries. For example, if tourists from Country A routinely carry dollars to Country B and the residents of Country B have little other use for dollars, the dollars might be shipped from Country B to the United States. All other factors equal, this pattern would result in negative net shipments figures, and shipments figures summed across Country A and Country B would give an accurate indicate of flows into and out of the United States. For some countries, however, it is likely that dollars arrived in the country from the United States through nonbank channels. In such cases, the commercial banknote flows would not give an accurate indication of net flows to and from the United States.

The first experimental series imposes a very rough adjustment for this phenomenon as follows. First, a group of countries known to have significant tourism or significant populations of immigrants or migrant workers in the United States is identified. Second, a group of countries whose total net shipments is substantial and negative is identified. Third, for each year and for each country in both groups, the assumption is imposed that total net currency shipments to these countries, including the observed net commercial bank "wholesale" flows and nonbank "retail" flows, were zero.

As with the shipments proxy, this approach embodies two assumptions. First, this approach implicitly assigns a value of zero for net currency flows to these coun-

tries. This assumption could be erroneous in either direction: actual net flows could be positive or negative. Second, this approach assumes that other countries' flows in aggregate are accurately measured by net commercial bank shipments. The blue dashed line shown here displays an adjustment that imposes this assumption for about a dozen countries. While this approach is admittedly crude, it is suggestive of the magnitude of flows that could be occurring through nonbank, or "retail" channels. Ideally, we could refine this measure by constructing series of "retail" (nonbank channel) banknote flows from the United States to other countries. While this type of data is not available universally, it is collected by some countries, including Mexico.[24] This measure, the dashed blue line, also tracks the shipments proxy for most of the sample, though it becomes implausibly large in the last few years of the sample. To the extent that this adjustment it useful, it is probably more applicable for cumulative, or stock estimates, than it is for flow estimates, because the nonbank flows likely occur at different times than the measured banking-channel flows back to the United States. For example, currency might be brought from the United States to another country through nonbanking channels over time and then return quickly in the event of a regulatory or other political or economic change.

Finally, the dashed purple line is an adjusted shipment proxy series. Along the lines of the adjusted commercial bank series, this series includes only payments of $100s from the Federal Reserve Bank of New York, which are generally positive, and omits payments from the Miami and Los Angeles cash offices, which are generally nega-

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24 Mexico is the largest single contributor to this adjustment, and it was the case of Mexico that inspired this approach. In the 1990s, Mexico collected customs data on cash imports from all travelers with no lower bound on the reporting threshold. This reporting is, of course, subject to the same problems of underreporting as other customs data, but the magnitudes were substantial and of a magnitude similar to reported commercial bank inflows. More recent customs reporting requires only declaration of amounts above $10,000. Regardless, Mexican statistics on tourism flows indicate substantial volumes of people and revenue, though the form of the revenue (cash, credit card, or other) is not specified. Refer to Banco de Mexico (2012).

tive and might reflect reflows of currency that moved across U.S. borders through
nonbank channels.

Figures 7 through 9 display nominal values, which can be misleading even in a
period with relatively low inflation. Figure 10, therefore, displays all of the same
series as in Figures 7 through 9, but scaled by the stock of currency in circulation at
the end of the previous year, or the approximate percentage-point contribution to
currency growth that would be implied by each of these measures. While the
measures certainly vary, they generally point to strong contributions from foreign
demand in the early to mid-1990s, a slowing in the mid-2000s, and a resurgence
beginning in 2008.

**Flows of U.S. currency shipped abroad relative to
currency in circulation***

Figure 10

US$ bn
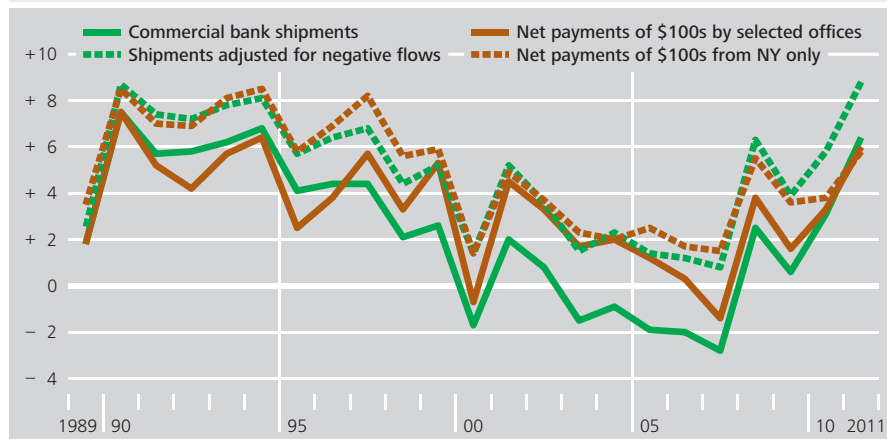
* Note. Annual totals divided currency in circulation at end of previous year.

III.C. Using Cross-Border Flow Estimates to Construct Estimates of the Stock of U.S. Currency Abroad

While tracking movements in currency in circulation is the major object of operational interest, having an estimate of the stock of U.S. currency abroad is also important for various analytical and operational questions faced by the Federal Reserve. Figures 11A and 11B chart the stocks of currency in circulation implied by the flow measures presented earlier. In Figure 11A, each line represents the cumulative change in the item since the end of 1988, when currency in circulation was about $230 billion. As indicated by the black line, currency in circulation has increased by just under $800 billion since 1990. The most direct measurement, commercial bank shipments, suggests that $200 billion has moved abroad since 1990, which would put the total at between $200 billion and $400 billion, depending on the assumed initial value. The shipments proxy, the blue line, suggests that about $350 billion moved abroad over the period, putting the total at $350 billion to $550 billion.[25] Finally, the adjusted shipments and proxy figures suggest that about $550 billion moved abroad over the period, putting the total at $550 billion to $750 billion. These ranges are, of course, large, though the simple method proposed above produces an estimate very close to the center of the range.

Finally, Figure 11B displays the cumulative flow measurement and estimates as a share of the cumulative increase in currency in circulation at each point in time. Again, the estimates are disparate, but indicate some common trends, including a strong role for international demand in the 1990s, a waning role in the early 2000s, and a resurgence in 2008. In this Figure, as earlier, the role of the former Soviet

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25 The proxy is the only measurement available before 1988. It indicates that $40 billion moved abroad over the period from 1974 to 1989; during that time, currency in circulation increased by about $180 billion.

Measures of cumulative flows of U.S. currency abroad

Figure 11

US$ bn

Figure 11A

- All commercial bank shipments
- Comm. bank shipments adjusted for negative flows
- Net payments of $100s by selected offices (NY, MIA; LA)
- Net payments of $100s from NY only
- Total change in currency in circulation

Figure 11B

Cumulative flows of U.S. currency shipped abroad
relative to cumulative changes in currency in circulation

Share

- All Commercial bank shipments
- Comm. bank shipments adjusted for negative flows
- Net payments of $100s by selected offices (NY, MIA, LA)
- Net payments of $ 100s from NY only

Union and Argentina is likely understated because of poor data coverage in the
shipment data in the early 1990s.

IV. Indirect Estimates of the Share of U.S. Currency

Earlier work on estimates of the stock of currency abroad has developed and
provided estimates from two methods, known as the seasonal method and the
biometric method.[26] Updates to these methods continue to indicate that a
substantial share of U.S. currency is abroad, but technical factors and shifting
patterns of currency demand have made their use more challenging.

IV.A.   The Seasonal Method

IV.A.1. Key Assumptions
The seasonal method extracts an estimate of the share of U.S. currency abroad by
working from four key assumptions. First, we assume that the seasonal pattern in
domestic demand for U.S. dollars is similar to the seasonal pattern of demand with-
in Canada for Canadian dollars (similar holidays, vacations, customs, and denomina-
tions). More specifically, we assume that the seasonal amplitude, or the percentage
difference between the seasonal peak and seasonal trough, is similar for U.S. and
Canadian currency demand. Second, we assume that foreign demand for U.S. dol-
lars has no significant seasonal pattern, or, correspondingly, that the seasonal am-
plitude for the foreign component of demand for U.S. dollars is zero. Third, we as-
sume that circulation of Canadian dollars outside of Canada is negligible, so that the
demand for Canadian dollars can be attributed solely to domestic demand. Finally,
we assume that U.S. currency is not used to a substantial degree inside Canada.

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26 Refer to Porter and Judson (1996), Judson and Porter (2001), U.S. Treasury (2006).

IV.A.2. Model

Based on these assumptions, we can express the seasonal model as follows:

Define:

S_i^j = seasonal amplitude for country i, component j

β_t = fraction of currency held abroad at time t

The overall seasonal amplitude in U.S. currency, S_{US}^T, can be expressed as a weighted sum of domestic (d) and foreign (f) components:

(S1) $S_{US,t}^T = \beta_t S_{US,t}^f + (1 - \beta) S_{US,t}^d$

We cannot separately identify $S_{US,t}^f$ and $S_{US,t}^d$ but, using the assumptions above, we replace $S_{US,t}^f$ with 0 and $S_{US,t}^d$ with $S_{Can,t}^T$ to obtain:

(S2) $S_{US,t}^T = \beta_t * 0 + (1 - \beta) S_{Can,t}^T$

Or, solving for β_t:

(S3) $\beta_t = 1 - \dfrac{S_{US,t}^T}{S_{Can,t}^T}$

IV.A.3. Application and Estimates

We estimate the share of all currency abroad and the share of $100s abroad using X-12 ARIMA and an alternative shorter smoothing window to obtain seasonal factors for U.S. and Canadian currency in circulation. Once the seasonal factors are estimated, the seasonal amplitude must be calculated.

In earlier estimates using this method, the peak month was December and the trough month was February of the following year. However, it seems that seasonal factor patterns have changed in the past several years, as illustrated in Figure 12. December remains the clear peak, though its relative magnitude has varied over time. In particular, February is no longer the trough for U.S. currency in circulation. Rather, September is now the trough, though January seems to track the lower envelope of September and February. Moreover, January's seasonal factor is near the trough for Canada as well.

X-12 seasonal factor estimates
Total currency in circulation

Figure 12

Monthly seasonal factor −1
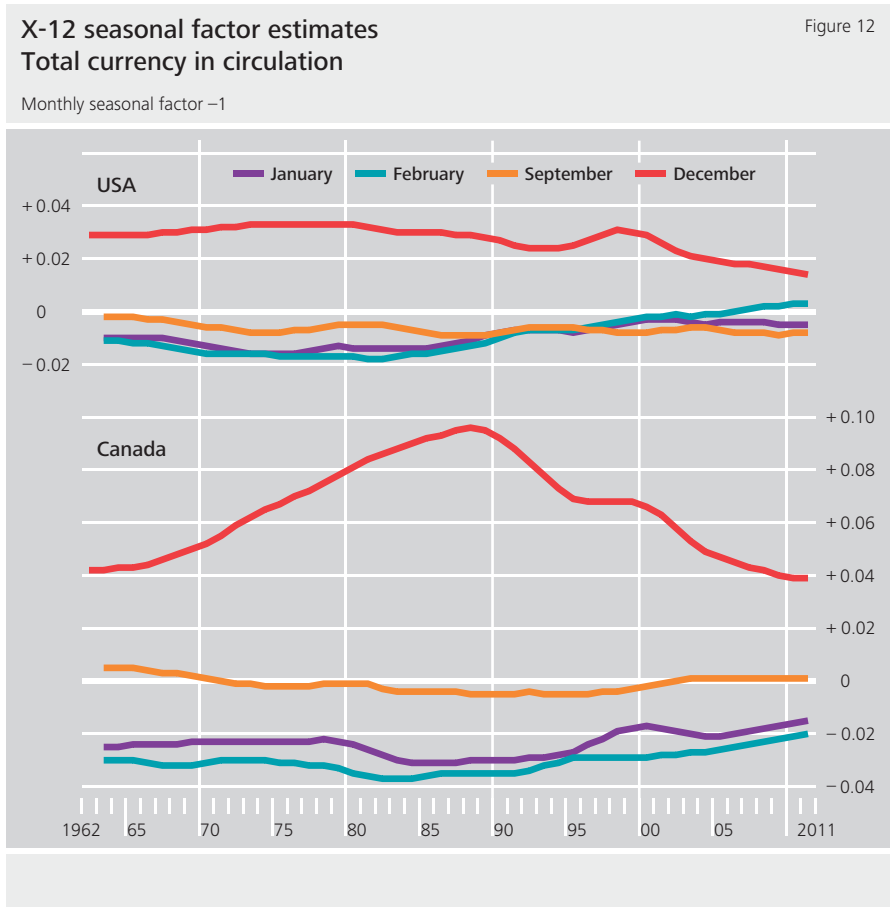
Because of these shifts over time, I propose three approaches to measuring the seasonal amplitude. The first approach, estimates the annual amplitude as the difference between the seasonal factor for December of one year and January of the next year. This estimate is associated with the year in which December falls and is shown in Figure 13 as the "annual" estimate, the dotted lines. A second approach is to estimate the seasonal amplitude each month as the difference between the maximum and minimum seasonal factors over the most recent twelve months, and then to estimate

Seasonal method – estimated share abroad — Figure 13
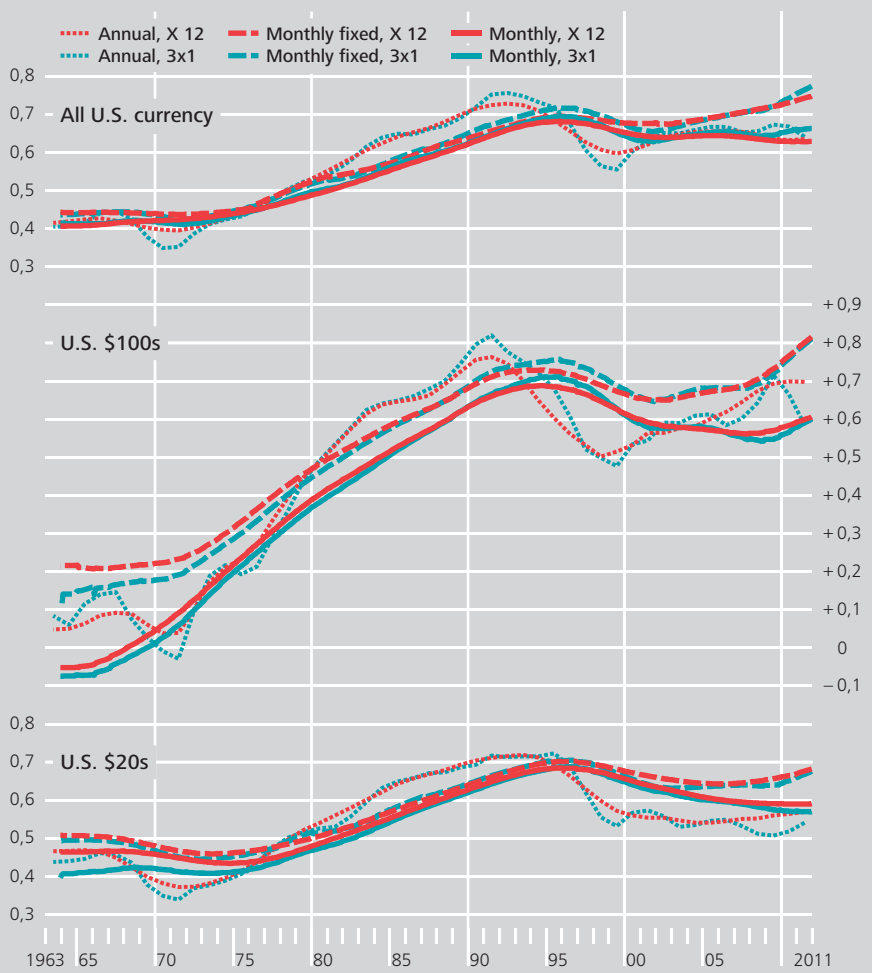
the monthly share of currency abroad as the trailing average of the estimates for the past twelve months. The estimates from this approach are shown in Figure 13 as the "monthly" solid lines. Finally, one might choose to fix the months used to calculate the U.S. seasonal amplitude so that they are the same as the months used to calculate the Canadian seasonal amplitude for a given observation. For these "monthly fixed" estimates, shown as the dashed lines, the Canadian seasonal amplitude for a given month is calculated as the difference between the maximum and minimum seasonal factors calculated for the most recent twelve months. The U.S. seasonal amplitude for the same month is calculated as the difference between the seasonal factors in the same months as for the Canadian seasonal amplitude, and the monthly share of currency abroad is then estimated as the trailing average of the estimates for the past twelve months.[27]

The results of the seasonal estimates for all currency abroad, for $100s, and for $20s through December 2011 are displayed in Figure 13 respectively. As was the case in earlier work, these estimates are on the high end of the range. These estimates also show a quite different time series pattern relative to one another as well as relative to other flow-based measures, though the monthly measures generally indicate an upswing in the share of U.S. dollars held abroad.

IV.B. The Biometric ("Fish") Method

IV.B.1. Background: Use for Estimating Wildlife Populations
The biometric method, also known as the "fish" method, applies a method developed by Petersen (1893) to estimate fish populations to cash processing data to

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27 In the last two methods, one could just as easily use the unsmoothed seasonal amplitude estimates. These estimates, though, show a step-function-like shape because the seasonal maximums and minimums generally change once per year. It seems unlikely that the share of currency abroad follows such a step function, and so the moving average imposes a smooth trend. Notably, this averaging does not affect the level of the share estimates on average over time.

obtain estimates of the "populations" of notes in the United States and the rest of the world.[28] In the biological application, populations are estimated by capturing some animals, tagging them, releasing them, and then recapturing another sample of animals later. Assuming that both samples are representative, the share of tagged animals in the general population should be the same as the share of tagged animals in the second sample, and the population can thus be estimated. More formally, suppose M animals are captured and tagged. Next, suppose that in the second sample, m tagged animals are found out of n captured. Assuming that both samples were representative, the share of tagged animals in the second sample, m/n, should be equal to share of all tagged animals, M, in the general population, N, or $m/n = M/N$. Since M, m, and n are known, N can be estimated as $N=(n/m)*M$.

IV.B.2. Application to Estimates of Banknote Populations

We apply this method to banknotes by using monthly cash processing data from Federal Reserve offices, changes in banknote design, and background information about international banknote shipping patterns. Specifically, we estimate the "population" of notes in the rest of the world by estimating the "population" of notes in the area served by the Federal Reserve Bank cash offices in New York, Los Angeles, and Miami. Although banknotes are not tagged, new designs are introduced from time to time, and processing statistics distinguish between new-design and old-design notes in some cases.

The Federal Reserve introduced new-design $100 notes in 1991 and in 1996; a further redesign for the $100 note has been announced, but the issuance date has not yet been announced.[29] From the moment each new design was issued,

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28 LeCren (1965) notes that Petersen did not use the method for counting but that others properly credit him with the method.
29 For more information on these changes to U.S. banknote design, refer to Allison and Pianalto (1997).

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all new banknotes paid out were of the new design. These notes were defined
as the "marked" or "tagged" notes. Following the analogy to the biologists'
technique, the second sample of notes occurs when notes are returned to the
Federal Reserve for processing. Notes returned to Federal Reserve Bank cash offices
are authenticated and evaluated for fitness for further use; data on these process-
ing operations are kept by series.[30] We focus on $100 notes here because they are
the most significant in dollar value and in the international market.

The assumption that the "marked", or new-series, notes are just as likely to be
returned to Federal Reserve offices as older-series notes is quite strong. It is likely
more accurate for the 1990-series notes than for the 1996-series notes because
the 1996 series was a much more obvious design change: to the extent that dollar
users might prefer one series to another, that preference might be stronger for the
series with a more significant design change. As with other assumptions, though,
the sources of error for this assumption could affect the estimates in either direc-
tion: older notes might be underrepresented in Federal Reserve receipts if they are
hoarded, or out of active circulation, or they might be overrepresented if dollar
users prefer to retain newer notes.[31] Much more detailed processing data would be
needed to analyze these questions.

IV.B.3. Adjustments and Updates

These estimates provide an update as well as some adjustments to previous esti-
mates. The updates currently extend through the end of 2011. The adjustments
are the result of corrections to anomalies in the processing data detected in the
process of calculating the updates. In particular, recall that a key variable is the

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30 For operational reasons, it is important for Federal Reserve analysts to be able to assess the longevity
and other features of notes by their design or series.
31 The 1990-series notes incorporated microprinting and a security thread but retained the same
portrait and the same size and location for the portrait. The 1996-series design changes included a
larger portrait moved off the center of the note.

share of "tagged", or new-series notes in notes received at Federal Reserve Bank offices. In reviewing the data, we noticed that the processing data for some offices and months implied shares that were anomalous: The values were zero, one, or far away from either values in adjacent months or from values reported by other offices for the same month.

We adjusted the data by identifying anomalous observations and assigning estimated share values. For all offices, a value of zero or one was defined as anomalous. For all but two Federal Reserve Bank cash offices, an office's monthly figure on the share of new-series notes processed was defined as anomalous if the figure was more than one standard deviation above or below the mean processing share reported by all offices for that month. For the remaining two Federal Reserve Bank cash offices, Miami and Los Angeles, observations were defined as anomalous if they were more than three standard deviations above or below the mean processing share for the month. For all offices, the estimated share was assigned the previous month's value for that office.

After these corrections, we estimated the "population" of notes in two "pools", domestic and foreign. The foreign "pool" includes either the New York and Los Angeles offices or the New York, Los Angeles, and Miami cash offices; the domestic "pool" includes all other offices.[32] In addition, we produce two sets of estimates for the share of notes held abroad, one using the actual total quantity of notes in circulation, which is known, and one using the estimated total quantity of notes in circulation. By necessity, these estimates are calculated separately for 1990-series and 1996-series notes. Figure 14 displays the estimated share of $100s

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32 In the original formulation of this estimate, the foreign pool included only New York and Los Angeles. Subsequent large volumes of activity attributable to international demand prompted the addition of the Miami office to this group. The estimate based on just the New York and Los Angeles offices is analogous to the adjustment commercial bank shipments estimate: it assumes that receipts at the Miami office reflect unmeasured outflows and assigns a net value of zero.

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Estimated share of U.S. $100s in circulation abroad (NY+LA)

Figure 14

Monthly

Total U.S. $100s in circulation (NY+LA)

Figure 14A

Monthly
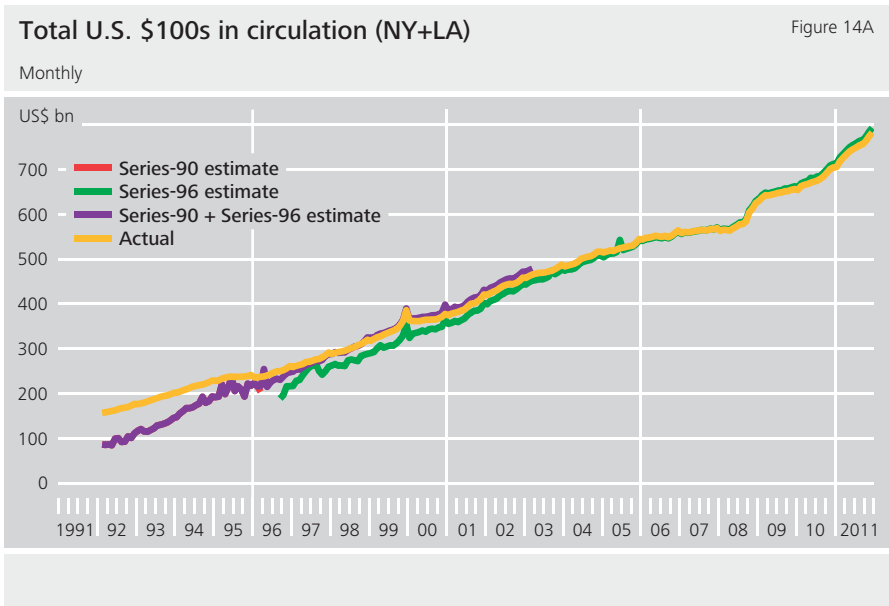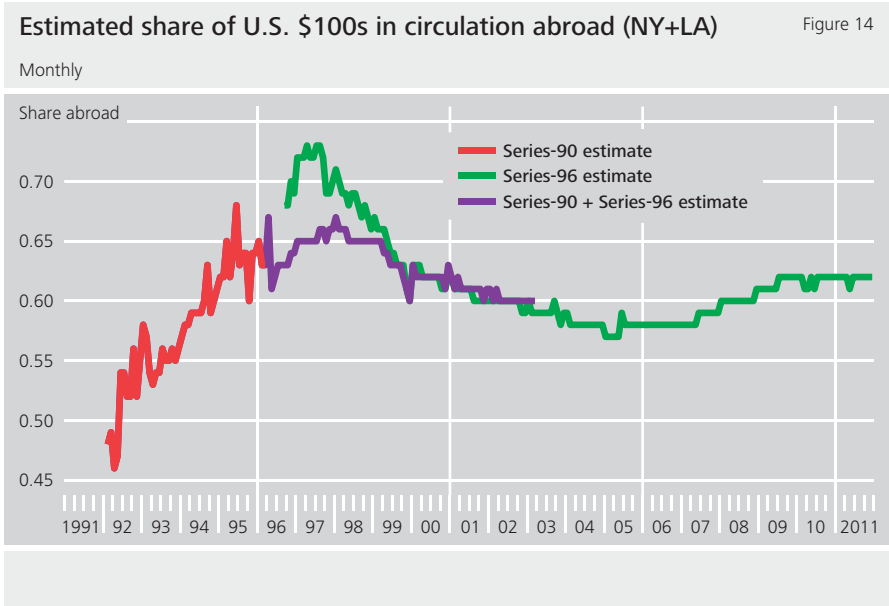
in circulation abroad for 1990-series notes, the red line, for 1996-series notes, the green line, and for both types of notes, the blue line, based on the estimated total stock of notes and based on the assumption that the foreign "pool" is the New York and Los Angeles offices. The estimates using the actual (known) total stock of notes are similar and converge over time, suggesting that the biometric method is better able to estimate the true total quantity of notes in circulation only after the design has been in circulation for a few years. Indeed, as shown in Figure 14A, the biometric method's estimates of total notes in circulation converge to actual figures and remain close.

Because of the timing of the introduction of the series of notes, it is difficult to assess the trend in the share of $100s abroad in the late 1990s, but both sets of estimates show a general decline in the share of $100s abroad beginning in the late 1990s, from somewhere between 65 and 72 percent to a bit under 58 percent by about 2007. As in the flow data, the biometric method indicates a sharp turn-around in late 2008; this method now indicates that about 62 percent of $100 notes were in circulation abroad at the end of 2011. Estimates using the New York, Los Angeles, and Miami offices as the foreign pool are about 5 to 10 percentage points lower; however, as with the shipment flows discussed earlier, it is difficult to know how to interpret consistently negative inflow data.

Estimates using this method for $50 notes indicate similar patterns over time with somewhat lower shares abroad—about 40 percent at the end of 2011. When combined with the estimates for $100s, these estimates suggest that about $510 billion, or just over half of all U.S. currency in circulation was held abroad at the end of 2011: about $480 of the $780 billion in $100s and about $30 billion of the $70 billion in $50s in circulation.

V. Estimating a Currency Demand Function

Finally, we return to the idea of a currency demand function, which was briefly
explored in Section 3 with reference to Canada. Here, the approach is to specify a
demand function for U.S. currency that allows for foreign shipments as well as
domestic factors. Our general assumption has been that currency demand consists
of two components: a domestic component, which should be correlated with the
typical determinants of money demand; and an international component, which is
driven by routine as well as crisis-related fluctuations in demand for U.S. currency.

Quarterly Regression Results   Table 1
Dependent variable: Growth of SA currency component of M2
Quarterly, 1988:1 – 2011:4

	Coefficient	T-Stat
Foreign Payment Proxy	0.88	13.66
Nominal GDP growth, average of previous two years	0.38	3.09
Change in 3-month T-bill rate, average of previous two years	−0.68	−3.86
Dummy: 1999:Q4	0.57	1.27
Dummy: 2000:Q1	7.33	17.5
Dummy: 2008:Q4	−1.62	−2.24
Constant	−1.14	−0.87
R-squared = 0.75		
Number of obs = 96		
Root MSE = 1.73		

Table 1 presents a simple regression model estimated quarterly beginning in 1988,
a date chosen for two reasons. First, 1988 marks the beginning of availability of
the commercial bank shipment data as well as an apparent upshift in international
demand for U.S. currency. Second, preliminary testing (not shown) indicates a
distinct structural break in 1988. Figure 15A displays overall currency growth, the
heavy line, the proxy measurement, the purple line, and nominal GDP growth, the
gray line, for the regression sample period, and Table 1 reports the regression

Figure 15

Figure 15A

Growth of currency, nominal GDP and proxy for foreign demand

%

- Currency
- Nominal GDP
- Foreign Proxy[1]

Figure 15B

US$ bn

**Estimated foreign and domestic contribution
to U.S. currency increases**

- Domestic factors
- Foreign factors
- Shipment proxy alone

US$ bn

Figure 15C

Scale reduced

**Estimated cummulative contributions of domestic and
foreign factors to U.S. currency increases**

1988   90   95   00   05   10 2011

1 Foreign proxy is annual sum of two-month moving average of net payments of $100s from NY, LA and Miami
cash offices divided by currency stock at the end of the previous year.

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results. After controlling for the estimated contribution of overseas demand,
currency demand is correlated not with contemporaneous income growth and
interest rate movements, but with those over the past two years, lags similar to
those observed for broader aggregates. Moreover, proxy receives a weight of
nearly one in the regression. Finally, Figures 15B and 15C display the quarterly and
cumulative contributions to currency growth from foreign demand implied by the
regression in table 1. In both figures, the black and gray lines are calculated from
fitted values with the residual and the effects from the constants and dummy
variables applied equally to the two components; the blue line indicates the
cumulative effect of the shipment proxy alone. The gray line indicates that inter-
national shipments, as measured by the $100s proxy, are responsible for a bit more
than half of the growth in currency.

Notably, even the highest of these estimates suggests that currency holdings
by U.S. residents are significant – at least $1,000 per person – a finding at
odds with survey work on currency holdings.[33] Feige (1996, 2012) suggests that
underground economic activity could account for this discrepancy, though
underreporting, especially by individuals with large cash holdings, is also likely a
substantial problem.

VI. Summary, Conclusions, and Directions for Future Work

In sum, much as in earlier work, the currently available data do not allow for
precise estimates of foreign holdings of U.S. currency, and the available estimates
are somewhat disparate. Nonetheless, direct measurements, regression-based
estimates, and indirect estimates all point to strong international demand in the
1990s, a falloff in the early 2000s, and a recent resurgence that coincided with the
collapse of Lehman Brothers.[34] Collectively, these methods collectively suggest that
half or a bit more than half of U.S. currency circulates abroad.

There are many promising avenues for future investigation, including the follow-
ing. For the biometric method, what might we be able to learn about hoarding of
notes? Will biometric estimates change when the new $100 note is issued? For the
seasonal method, what is the significance, if any, of the shift observed in seasonal
patterns of demand for U.S. currency? For the regression-based methods, would a
more rigorous and sophisticated regression framework yield more precise or very
different estimates? Finally, are there quantifiable indicators of market tension that
show a systematic relationship with external demand for U.S. dollars, and can any

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[33] The most recent Survey of Consumer Payment Choice, conducted in 2009, indicates holdings of less
than $100 per person (Foster et al., 2011).
[34] Indeed, weekly data, reported in Appendix Figure 2, show an unmistakable turnaround in demand
patterns in the middle of September 2008.

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of those indicators be forecasted? Some work along these lines shows promise, but
is in the early stages.[35]

Appendix: Currency data sources and definitions

Several agencies and publications carry data on U.S. currency in circulation, and
several additional sources are available internally in the Federal Reserve. The publi-
cations and the level of detail provided by each source are summarized in table 1.
None of these sources provides any information about domestic and international
movements of U.S. currency.

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[35] Thus far, analysis along these lines has appeared only in internal Federal Reserve documents.

Appendix: Public data sources on U.S. currency in circulation

Publication name	Source	URL
H.4.1	Federal Reserve	*http://www.federalreserve.gov/* releases/h41/
H.6	Federal Reserve	http://www.federalreserve.gov/ releases/h6/
Treasury Bulletin	Treasury	http://www.fms.treas.gov/ bulletin/index.html
Annual Report	Federal Reserve	http://www.federalreserve.gov/ boarddocsfs/rptcongress/ default.htm#ar
Z.1 (Flow of Funds)	Federal Reserve	http://www.federalreserve.gov/ releases/z1/
Banking and Monetary Statistics and Annual Statistical Supplement (various years)	Federal Reserve	http://fraser.stlouisfed.org/
Online	Federal Reserve	http://www.federalreserve.gov/ paymentsystems/coin_data.htm
Statistics on payment, clearing and settlement systems in the CPSS countries	Bank for International Settlements	http://www.bis.org/ publ/cpss99.htm http://www.bis.org/ publ/cpss99.pdf

Notes
Currency in circulation includes Federal Reserve notes, Treasury notes, no longer issued notes, and coin held outside the Federal Reserve and Treasury.
Federal Reserve notes, net includes Federal Reserve notes outstanding less Federal Reserve notes held at the Federal Reserve.
The currency component of the money stock includes currency (including coin) outside the U.S. Treasury, Federal Reserve Banks, and the vaults of depository institutions.

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Table 1

Frequency	Date Range	Definition	By denom?
Weekly average and Wednesday	1914; Time series data online starting in December 2002.	Table 1: Currency in circulation Tables 9 and 10: Federal Reserve notes, net	No
Weekly average	1989	Currency component of the money stock	No
Quarter-end	Current year	All types of currency outstanding, held by the Treasury and Federal Reserve, and in circulation.	Yes
Annual. Data are reported for month-end and month average for previous year and year-end and year average for earlier years.			No
Quarter-end	1996	Currency in circulation	
Weekly average and Wednesday; monthly average and month-end; Annual average and year-end	1914-1990	Currency in circulation	Yes, for selected dates.
Annual, year-end	1990	Paper currency (Federal Reserve notes, U.S. notes, and currency no longer issued)	Yes
Annual, year-end		Notes and coin "issued" (held outside the monetary authority)	Yes

Shares of U.S. currency in circulation by value and pieces
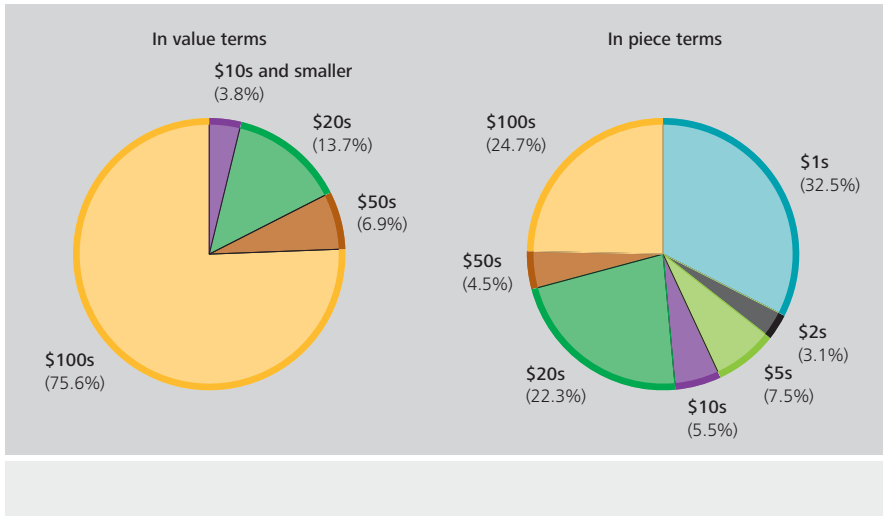
2011 Average

Shares of Canadian currency in circulation by value and pieces

2011 Average

Cumulative change in currency in circulation, recent years

Appendix Figure 2

Wednesday data

Source: H.4.1 Statistical Release. Cumulative totals divided by value for last Wednesday of prior year.
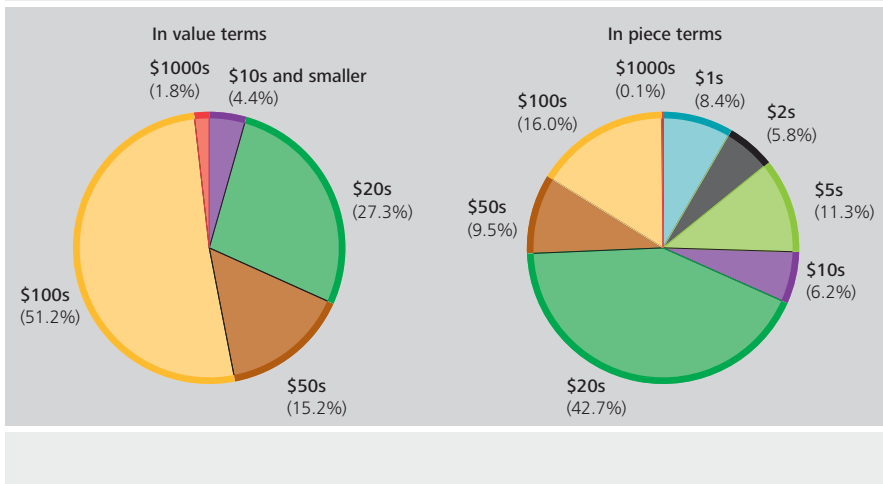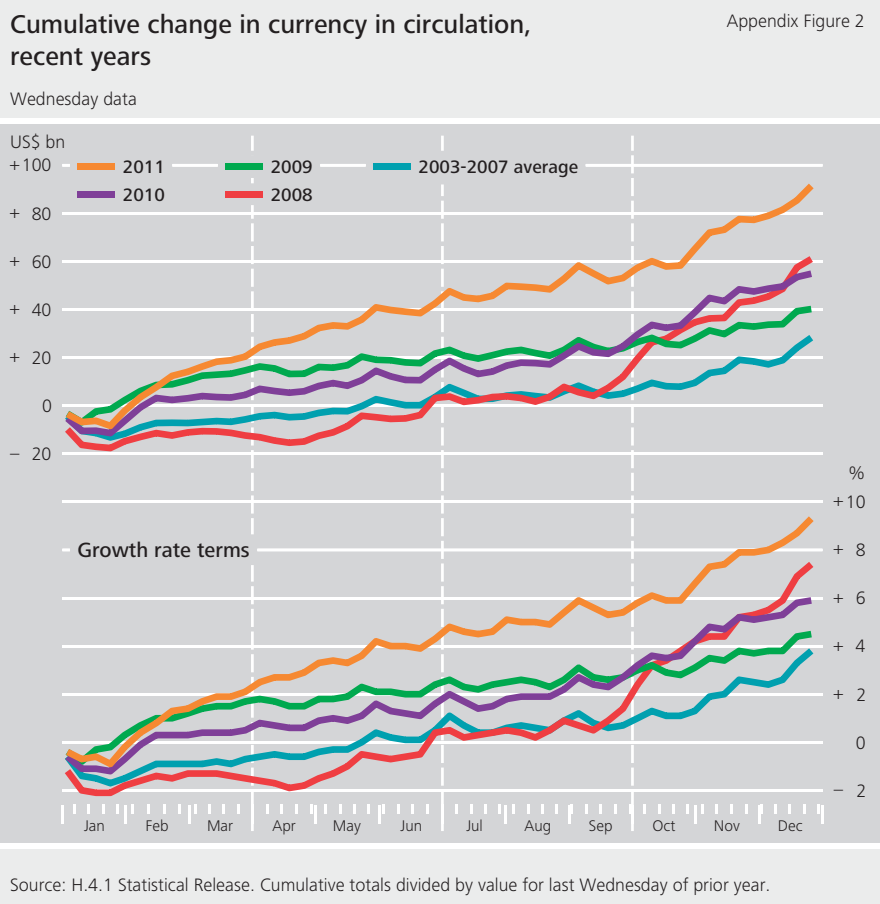
Federal reserve bank assets and liabilities and capital   Appendix Figure 3

US$ bn, Wednesday data

Source: H.4.1 Statistical Release (http://www.federalreserve.gov/releases/h41/).

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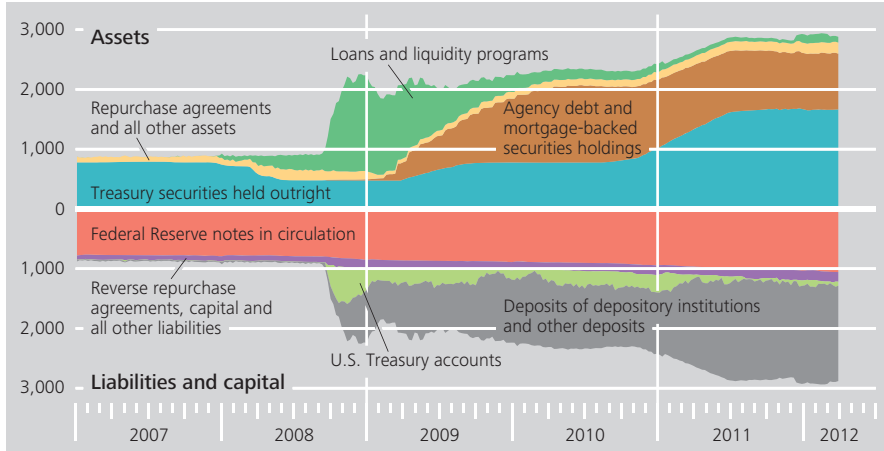
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Edgar L. Feige
The myth of the "cashless society": How much of America's currency is overseas?

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Edgar L. Feige[1]
The myth of the "cashless society": How much of America's currency is overseas?

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1 Introduction: The Currency Enigma

Over the past decades, we have witnessed a host of cash-saving financial innovations, leading to widespread predictions of the advent of the "cashless society". However, contrary to these expectations, the demand for U.S. dollars continues to rise and we remain awash in cash. As revealed by Figure 1, by the end

of 2011, U.S. currency in circulation with the public[2] had risen to $1 trillion dollars, amounting to more than $3000 for every man, woman and child in the country. Over the last twenty years, real *per capita* currency holdings increased by 82 percent and currency as a fraction of the M1 money supply increased from 30 percent to 45 percent.

Currency and real per capita currency   Figure 1

US-$ (Billions)   US-$
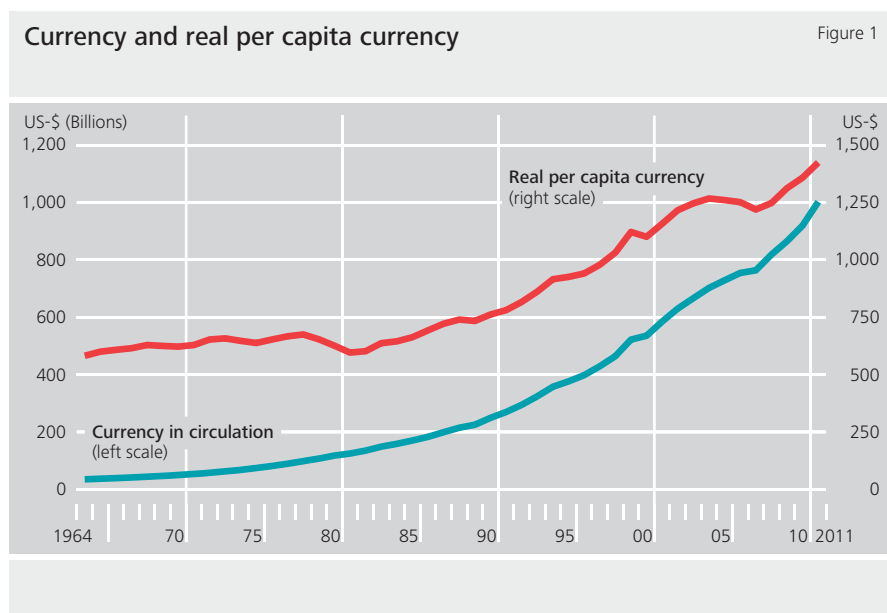
To put these figures in perspective, they imply that the average American's bulging wallet holds roughly 91 pieces of U.S. paper currency, consisting of: 31 one dollar bills; 7 fives; 5 tens; 21 twenties; 4 fifties and 23 one hundred dollar bills. Few of

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2 The currency data used in the paper is the currency component of the M1 money supply defined as currency outside U.S. Treasury, Federal Reserve Banks and the vaults of depository institutions. (Not seasonally adjusted). *(http://www.federalreserve.gov/releases/h6/hist/h6hist4.pdf)*. The "currency outside banks" series from the Flow of Funds Accounts of the United States Z.1 (Table L 204, line 6) (not seasonally adjusted) is typically somewhat larger than the currency component series. .

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us will recognize ourselves as "average" citizens. Clearly, these amounts of currency are not normally necessary for those of us simply wishing to make payments when neither credit/debit cards nor checks are accepted or convenient to use. Yet as shown in Figure 2, these surprisingly high U.S. per capita currency values were exceeded by per capita currency values for Europe ($3274); Hong Kong ($3963), Switzerland ($6335) and Japan ($7562).

Per capita currency in circulation with the public

Figure 2

Dollars per capita

Source: Bank for International Settlements. 2010 Data.
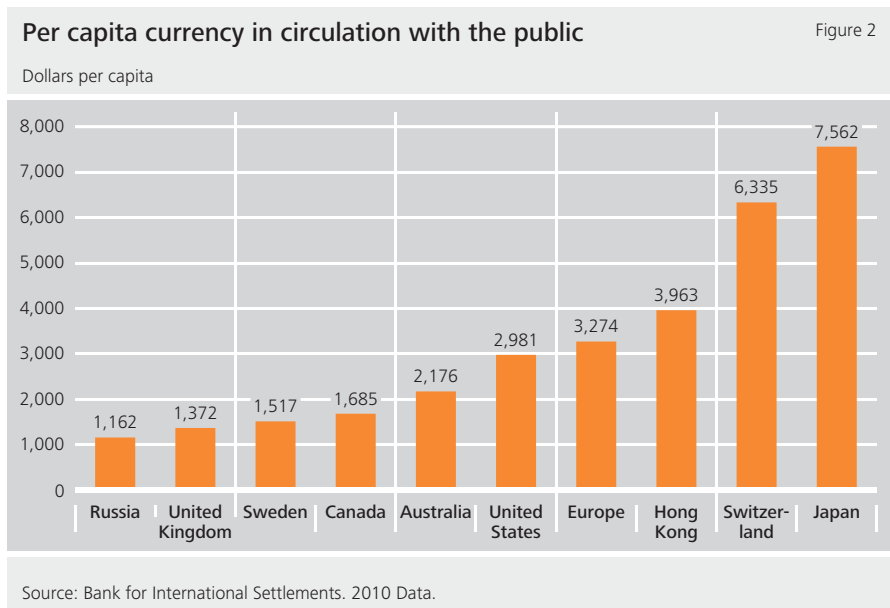
Federal Reserve surveys (Avery et al. 1986, 1987) of household currency usage found that U.S. residents admitted to holding less than 10 percent of the nation's currency supply. Businesses (Anderson, 1977; Sumner, 1990) admitted to holding only 5 percent.

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An even greater puzzle emerges from the Japanese Survey of Household Finances. In 2007, Japanese households admitted to holding only 10 percent of the nation's cash in circulation. [3] Yet Japan's per capita currency holdings are two and a half times larger than those in the U.S. These surveys suggest that the whereabouts of 85 -90 percent of some nation's currency supplies are unknown, suggesting that the "currency enigma" (Feige 1989, 1994) is still very much with us.

A growing body of evidence suggests that portions of some national currencies are held outside of the issuing country. Leung et. al. (2010) estimates that 50-70 percent of Hong Kong dollars circulate outside of Hong Kong and the European Central Bank (2011) estimates that 20-25 percent of euro banknotes circulate outside the euro area. The amount of Swiss currency in circulation outside of Switzerland is unknown and very few Japanese Yen circulate outside of Japan. The whereabouts of the U.S. currency supply is the key issue this paper seeks to address.

2 The controversy over the location of U.S. currency.

Research in the early nineties witnessed a number of studies attempting to estimate the fraction of U.S. currency held abroad, resulting in an empirical controversy that persists to this day. Examining direct data sources [4] on net outflows of U.S. currency (Feige, 1994), and indirect methods, (variants of monetary demography models) Feige (1996) concluded, "that roughly 36 percent of U.S. currency is held abroad". Examining the veracity of alternative methods of estimating overseas currency holdings, Feige (1997) suggested that the most plausible range of

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3 Fujiki and Tanaka (2009)
4 These included both Currency and Monetary Instrument Reports (CMIR) and the Federal Reserve Bank of New York's (FSN) confidential wholesale currency bulk transport data.

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estimates was between 25-45 percent. Doyle (2000) subsequently estimated that in 1995, 30 percent of U.S. currency was abroad.

Porter and Judson (1996) obtained very different results. Their main finding, based on an innovative, albeit fragile, indirect "seasonal" method was that 70 percent of the nation's currency was abroad. Taking account of alternative estimation methods, Porter and Judson reported a "median flow estimate" for 1995 of 55 percent abroad, similar to the estimate produced by Anderson and Rasche (1997) of 53.2 percent. Porter and Judson concluded, "that between 55 percent and 70 percent of the U.S. currency stock" was "held outside the country".[5]

Most recently, Feige (2012) revisited the question of how much of America's currency was held abroad, and brought to light the fact that the Federal Reserve publishes an "official" estimate of the amount of currency held abroad as part of its regular statistical reporting in its Flow of Funds Accounts.[6] The U.S. Department of Commerce's Bureau of Economic Analysis also employs this estimate and regularly publishes it in the U.S. Balance of Payments Accounts.[7] The official Flow of Funds/Bureau of Economic Analysis (FOF/BEA) figure[8] reveals that at the end of 2010, 37 percent of the nation's currency supply held outside of banks was overseas ($342 billion) and the comparable estimate for 2011 was 39 percent or ($397 billion). Yet despite these official published figures, various Federal Reserve sources continue to cite the much higher figure reported in the fifteen-year-old Porter/Judson (1996) study.

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5 Porter and Judson (1996), p. 899.
6 Federal Reserve Statistical Release Z.1 Flow of Funds Accounts of the United States. The estimated amount of U.S. currency held abroad appears on line 25 of Table L.204.
7 Bureau of Economic Analysis, (2008)
8 Federal Reserve Statistical Release Z.1 Flow of Funds Accounts, June 7, 2012, p. 93.

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For example:

"Roughly 75 percent of hundred-dollar notes, 55 percent of fifty dollar notes, and 60 percent of twenty-dollar notes are held abroad, while about 65 percent of all U.S. banknotes are in circulation outside the country. Approximately $580 billion in physical U.S. currency outstanding was circulating overseas at the end of March 2009" – Goldberg (2010a)

"More than 70% of hundred-dollar notes and nearly 60% of twenty- and fifty-dollar notes are held abroad, while two-thirds of all US banknotes have been in circulation outside the country since 1990" – Goldberg (2010b)

"The Federal Reserve estimates that as much as two-thirds of currency in circulation is held abroad." – Roseman (2010)

"Nearly two thirds of U.S. currency is held outside our borders." – Federal Reserve Bank of San Francisco (2012)

"Recent estimates show that between one-half and two-thirds of the value of U.S. currency in circulation is held abroad." – Board of Governors of the Federal Reserve System, (2012)

One cannot readily dismiss the confusion caused by the contradictions between Federal Reserve assertions and their own published data since an accurate estimate of the fraction of U.S. currency held abroad and the frequency of its use (currency turnover) have important implications for a variety of economic issues. From the perspective of conducting domestic monetary policy, the relevant monetary aggregates to consider are the *domestic* money supply and the *domestic* monetary base (Feige, 1994). In order to determine the *domestic* monetary aggregates, the Federal Reserve needs to have an accurate estimate of the fraction of U.S. currency held abroad and an estimate of the annual net outflow of U.S. currency

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going abroad. This knowledge is also required for operational decisions regarding the production, provision and maintenance of the U.S. currency supply. Similarly, foreign monetary authorities need to know the extent to which their nations are "*de facto* dollarized" (Feige et. al., 2003), and the magnitude of net inflows of foreign currencies into their economies. *De facto* dollarization reduces the effectiveness of exchange rate stabilization policies and reduces seigniorage revenues. The volatility of foreign demand for U.S. currency increases the difficulty of formulating appropriate domestic monetary policy.

Accurate estimates of the amount of U.S. currency circulating abroad are also essential for calculating the net seigniorage benefit to U.S. taxpayers obtained by virtue of the fact that the U.S. government effectively obtains an interest free loan from foreigners holding U.S. dollars. According to the 2010 annual report of the Board of Governors, the Federal Reserve obtained $667 billion dollars in total seigniorage income between 1990 and 2010. Domestic seigniorage earnings (based on the fraction of U.S. currency held at home) simply represent a redistribution of income from U.S. currency holders to U.S. taxpayers. On the other hand, seigniorage earnings on currency held abroad represent a net transfer of real resources from foreign currency holders to U.S. taxpayers. Based on official (FOF/BEA) estimates of overseas holdings, American taxpayers experienced a cumulative seigniorage windfall of $244 billion since 1990 from the overseas holdings of U.S. currency. However, based on the foregoing assertions of Federal Reserve officials who claim that two thirds of the U.S. currency supply was abroad during this period, we would conclude that U.S. taxpayers had obtained a cumulative seigniorage benefit of $434 billion since 1990. Discrepancies of this magnitude suggest that resolution of this empirical conflict requires serious attention.

Feige (2012) demonstrates that accurate estimates of the fraction of U.S. currency held abroad also have important implications for assessing counterfeiting dangers; for our ability to forecast changes in prices and output; and for estimating the

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magnitude of the unreported economy and tax evasion. The widespread use of U.S. currency abroad increases the likelihood of counterfeiting, since foreign users are less familiar with the dollar than domestic users, making the passing of counterfeit notes abroad easier than at home. The whereabouts of America's cash also has fiscal consequences. U.S. currency is a preferred medium of exchange for facilitating clandestine transactions, and for storing illicit and untaxed wealth. Knowledge of its location and usage is required to estimate the origins and volume of illicit transactions. These include the illegal trade in drugs, arms and human trafficking as well as the amount of "unreported" income, that is, income not properly reported to the fiscal authorities due to noncompliance with the tax code. The fiscal revenue lost to the government creates a "tax gap" that measures the extent to which taxpayers do not pay the amount they legally owe to the Federal Government in a timely manner. The problem of tax evasion is even more salient in times of severe fiscal deficits. Improved tax compliance reduces fiscal deficits.

In short, our understanding of a number of key monetary and fiscal issues depends upon answers to two key empirical questions: 1) What fraction of the U.S. currency supply is held abroad and 2) how has the amount of U.S. currency held abroad changed over time? Earlier answers to these questions have relied on two distinct approaches: direct measures of inflows and outflows of U.S. currency and indirect methods employing various versions of monetary demography models.[9] We first update earlier direct estimates of currency abroad with newly acquired direct source data on net bulk currency shipments overseas. This data has been reported to the New York Federal Reserve Bank by wholesale currency shippers since 1988 but was regarded as confidential until Judson (2012) recently released it. To anticipate our results, these newly released aggregate data suggest that only 25 percent of U.S. currency is abroad. Further investigation of informal channels of currency flows abroad due to travel and immigrant remittances reinforces this conclusion.

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9 Feige (1996; 1997; 2012) presents detailed information concerning each of these approaches.

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We then reexamine the indirect approaches that were responsible for the initial Porter/Judson (1996) claim that between 55 and 70 percent of U/S. currency was held abroad. We find that some key assumptions of their monetary demography models are grossly violated by available information and that the results of the "seasonal" model are so sensitive to specifying assumptions as to raise serious doubts concerning their reliability.

3 Direct Measures of Net Currency Outflows Abroad

A Net bulk shipments of U.S. currency abroad

The most direct method for estimating the fraction of currency held abroad relies upon data systems designed to track currency outflows and inflows to and from abroad. Two such information systems are the U.S. Customs Service Currency and Monetary Instrument Reports (CMIR)[10] and the New York Federal Reserve Bank's (FSN) records of net international wholesale currency shipments abroad.[11] The CMIR data are no longer readily available and their accuracy has been diminished since the mid 1990's because of the establishment of Federal Reserve Extended Custodial Inventory (ECI) sites abroad.[12] As such, The New York Federal Reserve Bank's data on net bulk shipments of U.S. currency abroad (FSN) are the best measure of net currency flows abroad.

Specialist wholesale bulk banknote dealers handle most of the U.S. currency that flows into or out of the country and they report the amount, origin and destination of their currency shipments to the New York Federal Reserve. These bulk shippers satisfy the overseas demand for U.S. currency by overseas commercial banks that in turn make the U.S. currency available to exchange bureaus, firms and individuals

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10 Currently known as the Report of International Transportation of Currency or Monetary Instruments (FinCEN Form 105).
11 Both of these data systems are described, compared and evaluated in Feige (1996, 1997, 2012).
12 See Feige (2012) and Judson (2012) for an elaboration of the present deficiencies of the CMIR data.

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abroad. Similarly, when overseas banks find themselves with excess U.S. currency, they return the banknotes to the U.S via wholesale banknote shippers who report the transactions to the New York Federal Reserve Bank. Unfortunately, the New York Federal Reserve Bank has historically regarded this critical data set as confidential. As a result, the official Federal Reserve Flow of Funds estimates of U.S. currency flows abroad[13] are based on a proxy variable (NYLAM) designed to mimic the confidential series (FSN) of net bulk shipments of U.S. currency. A recent paper by Judson (2012) presented at this conference, finally disclosed these previously confidential aggregate annual net currency shipments (FSN).

Actual recorded net bulk currency outflows (FSN) and the Federal Reserve (NYLAM) proxy

Figure 3

Dollars (Billions)

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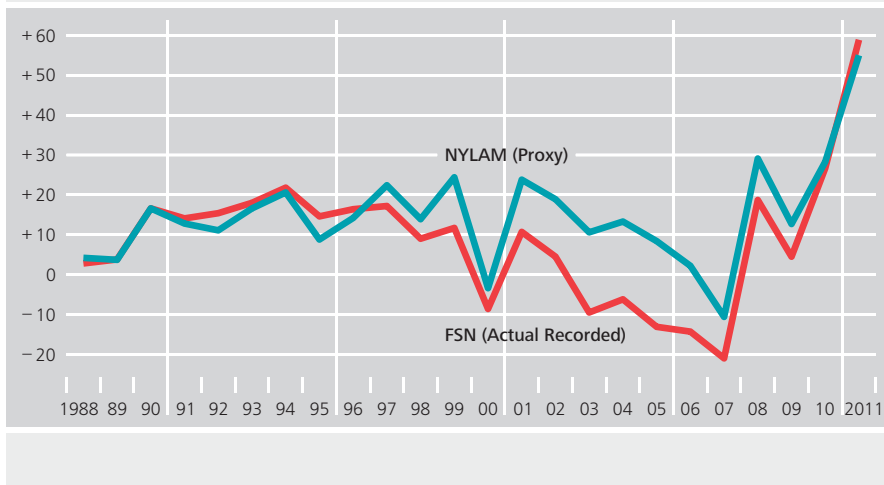
13 Federal Reserve Flow of Funds Accounts, Z.1 Table F -204

Figure 3 reveals that although the official Federal Reserve (NYLAM) proxy is highly correlated (.87) with the actual recorded bulk shipment (FSN) data it attempts to mimic, between 1997 and 2010 the (NYLAM) proxy consistently overestimated actual net currency outflows.

Estimated cumulative amount of U.S. currency held abroad Figure 4

Dollars (Billions)
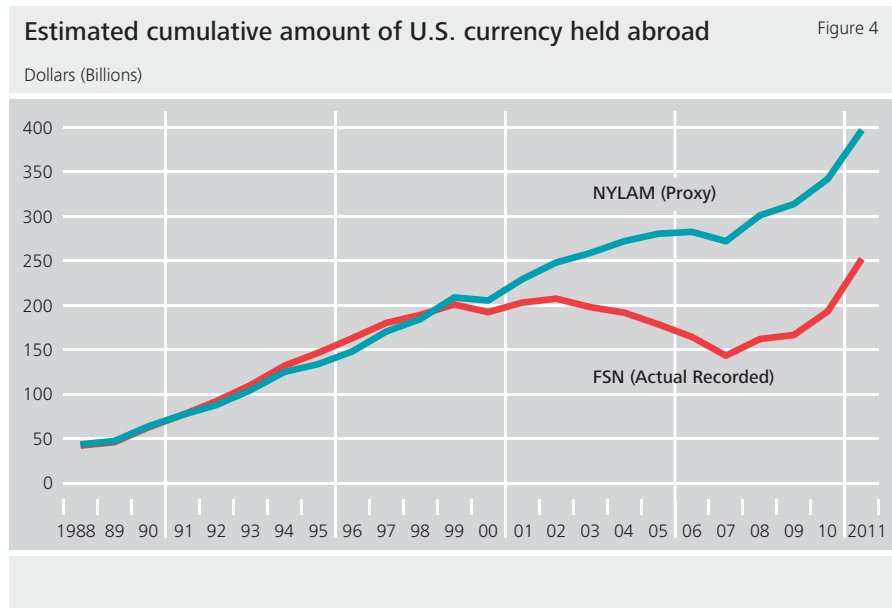
Figure 4 shows that by 2011, the NYLAM proxy (which the Federal Reserve employed as its "official" published figure) estimated the cumulative amount of U.S. currency overseas to be $397 billion, whereas the cumulative amount overseas estimated by the actual net bulk shipment series (FSN) amounted to only $252 billion. Moreover, the temporal pattern suggested by the two series is quite distinct. According to the actual reported FSN data, overseas demand for U.S. currency declined substantially between 2003 and 2007 by roughly $50 billion and rose again in the aftermath of the financial crisis of 2008. This pattern is entirely consistent with the findings of the European Central Bank (2011) and Augustin (2011),

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which suggest that the demand for euros outside the euro area increased substantially during the period that the demand for dollars fell. In short, the decline in overseas demand for dollars is entirely consistent with the hypothesis that the euro substituted for the dollar as a second currency in countries on the periphery of the euro area. Conversely, shipments of euros to regions outside the euro area ceased to grow after 2008 while the demand for U.S. currency abroad resumed its upward trend, suggesting that U.S. currency replaced euros in periphery countries because of the growing debt crisis in Europe.

Estimated share of U.S. currency held abroad

Figure 5

in %
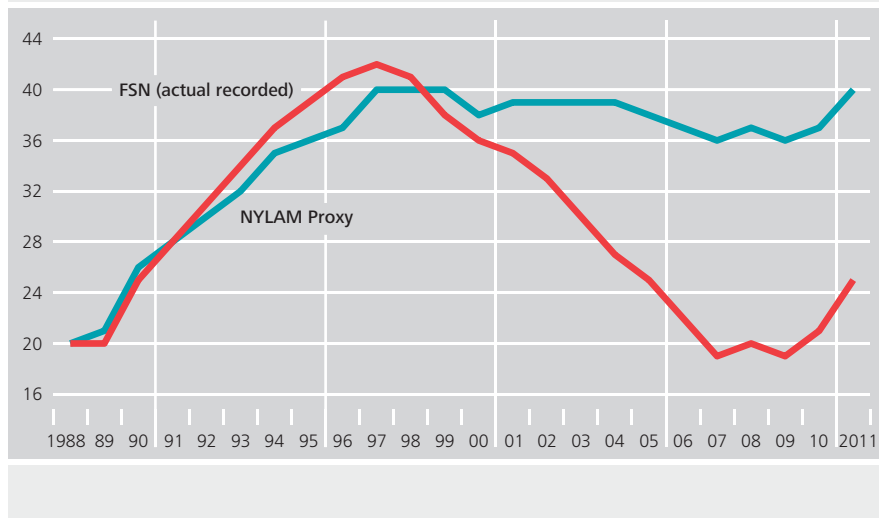
Figure 5 displays the alternative estimated shares of U.S. currency held abroad. According to the "official" FOF/BEA published NYLAM proxy based figures, the share of U.S. currency held abroad remained within the narrow range of 35-40 percent between1994 and 2011. The newly released bulk shipment data (FSN) suggest that the share of currency held abroad peaked at 42 percent in 1997 and then fell

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dramatically to a low of 19 percent in 2007, recently increasing to a share of 25 percent by the end of 2011. The dramatic rise in U.S. cash shipments to the former USSR and Argentina between 1989 and 1997 and the equally dramatic fall in such shipments between 1997 and 2008 explains this pattern.[14]

To summarize, the newly released New York Federal Reserve data on recorded net bulk shipments of U.S. currency abroad indicate that the "official" FOF/BEA estimates of overseas currency based on the NYLAM proxy have overestimated the amount of U.S. currency abroad since 1998. By 2011, it appears that $150 billion of U.S. cash previously believed to be abroad was in fact in circulation domestically. Moreover, the current share of U.S currency held abroad is closer to 25 percent than the officially published estimate of 40 percent. The recorded decline in the demand for U.S. currency abroad between 2002 and 2007 appears to be the result of euro substitution for the dollar in countries outside the euro area.

B Informal net flows of currency abroad due to travel and immigrant remittances

The foregoing estimates of U.S. held abroad based on net bulk wholesale shipments are incomplete insofar as they do not reflect currency hand carried or mailed in to or out of the country by travelers or guest workers in the form of immigrant remittances. They may also exclude some currency shipments into or out of the country by non-reporting shipping entities and may include errors due to some deliberate falsification of reports by bulk shippers.[15] However, we have no a priori way of knowing whether such omissions lead to an over or under estimate of the amount of currency held abroad.

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14 See Judson (2012) Figure 8.
15 In 2003, the Federal Reserve terminated its Extended Custodial Inventory (ECI) agreement with UBS and in 2004 followed with a $100 million civil penalty after discovering that UBS had falsified its reports of overseas shipments to the Federal Reserve over an eight year period. (Pasley, 2005)

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Judson (2012) makes the highly implausible claim that informal or "retail" channels of net U.S. currency outflows could exceed recorded wholesale net shipments (FSN) by more than $300 billion.[16] If her "admittedly crude"[17] approach is taken seriously, it implies that 52-53 percent of U.S. currency is presently held abroad, more than double the estimate based on the FSN data. Rather than attempt to directly estimate the impact of travel and immigrant remittances on the amount of U.S. cash held overseas, Judson arbitrarily selects a group of countries "known to have significant tourism or significant populations of immigrants or migrant workers in the United States" and " a group of countries whose total net shipments is substantial and negative".[18] Without identifying the countries she has thus selected, nor indicating the amounts of net shipments of cash to or from those countries, she simply assumes that the currency flowing back into the U.S. from each of these unspecified countries was zero. This is tantamount to throwing out over $300 billion dollars of net currency inflows reported to the Federal Reserve Bank of New York by bonded professional wholesale currency shippers. This "very rough adjustment" [19] is both arbitrary and implausible. Similarly, Judson's use of the "adjusted shipment proxy series" lacks credibility since the Federal Reserve and the Bureau of Economic Analysis[20] abandoned it fifteen years ago precisely because it took no account of reflows of currency known to be received by the Miami cash office from Latin America and from the Los Angles cash office from Asia.

Judson's general observation that "retail" or informal channels of currency flows may affect our estimates of the amount of U.S. currency held abroad is indisputable, as is her suggestion that the primary informal currency flows are likely to arise

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16 Judson (2012) Figure 11A.
17 Judson, (2012) p. 16.
18 Judson (2012) p. 15.
19 Judson (2012) p.15.
20 Bach (1997)

due to immigrant remittances and travel. The challenge is therefore to estimate the net size of these flows from the available evidence.

We obtain estimates of immigrant remittances from the U.S. Balance of Payments records of "private remittances and other transfers",[21] the relevant component of which are remittances representing "personal transfers by foreign born population". In order to estimate the fraction of these transfers made in cash, we rely on survey information provided by the Banco de Mexico of remittances by type of transfer payment.[22]
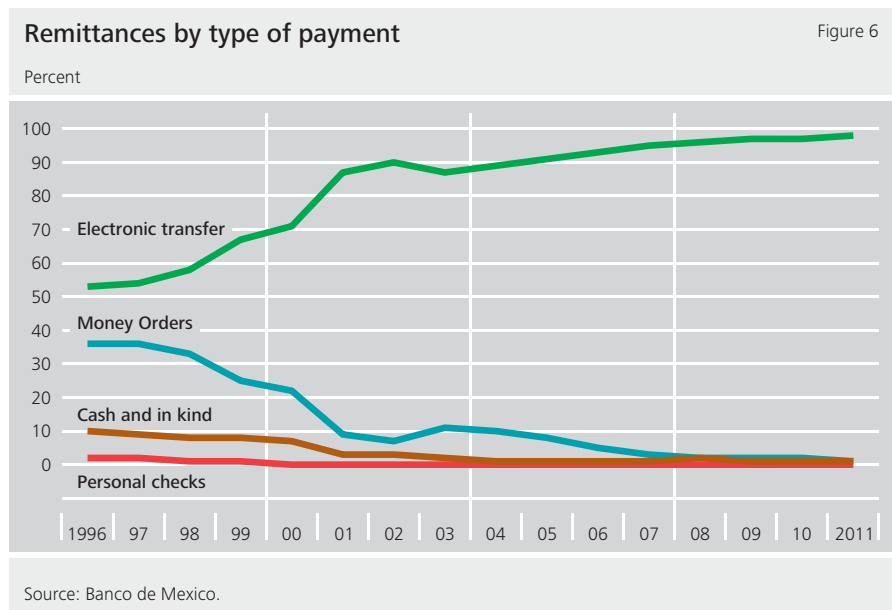
Remittances by type of payment   Figure 6

Percent

Source: Banco de Mexico.

Figure 6 reveals that the vast majority of immigrant remittances are transferred by electronic means, which presently amount to 98 percent of all transfers. Cash payments, which in 1996 accounted for roughly 10 percent of all remittance transfers now account for just 1 percent. We obtain our annual estimate of total cash outflows of U.S. currency due to immigrant remittances by multiplying the personal transfers of foreign born by the fraction of remittances transferred in cash. We find that cumulative cash remittances made since 1988 amount to roughly 11 percent of cumulative wholesale shipments as recorded in the FSN data.

The U.S Balance of Payment Accounts also records travel and tourism expenditures of inbound (exports) and outbound (imports) travelers. [23] Moreover, the Commerce Department's Office of Travel and Tourism conducts annual surveys of overseas travelers to the U.S. and of U.S. resident travelers visiting overseas destinations. These inbound and outbound survey profiles include estimates of the fraction of total travel expenditures made in cash by incoming and outgoing travelers. We are therefore able to estimate the volume of cash expenditures made by inbound and outbound travelers. A sizable and growing portion of these cash expenditures are made with currency obtained from ATM machines or exchange bureaus in the destination country. Assuming that foreign travelers to the U.S. bring U.S. currency into the country for twenty percent of their cash expenditures and American travelers going abroad make twenty percent of their cash expenditures with dollars taken out of the U.S. and, we can estimate the magnitude of informal "retail" inflows and outflows of U.S. currency due to travel. We find that the net effect of travelers transferring cash is to reduce the estimate of currency abroad

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23 The data source is U.S. Department of Commerce, (2012)

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since inbound travelers bring more cash into the country than outbound travelers take out.[24]

Estimated U.S. currency overseas: Wholesale and retail channels Figure 7

Dollars (Billions)
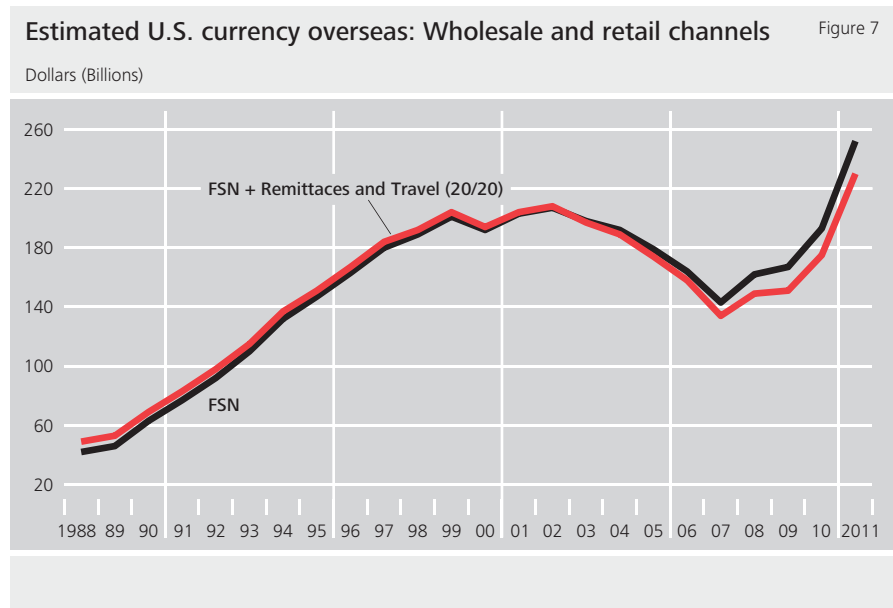
Figure 7 summarizes our estimates of the amounts of U.S. currency held abroad taking account of both net wholesale shipments as reported to the New York Federal Reserve (FSN) and estimates of "retail" or informal channels of cash transfers arising from immigrant remittances and travel. By 2011, these direct measurements suggest that U.S. currency abroad amounts to roughly $230 billion, or 23 percent of the outstanding currency supply held by the public. The most significant conclusion resulting from our review of direct measures of overseas currency is that

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24 It should be noted that if we alternatively assume that inbound travelers pay 20 percent of their cash expenditures with U.S. currency obtained abroad and that U.S. travelers going overseas pay for 15 percent of their cash expenditures with dollars taken abroad, this reduces our estimate of overseas currency by an additional $20 billion.

far less currency appears to be circulating overseas than was previously thought to be the case.

Direct and proxy estimates of share of currency abroad

Figure 8

in %
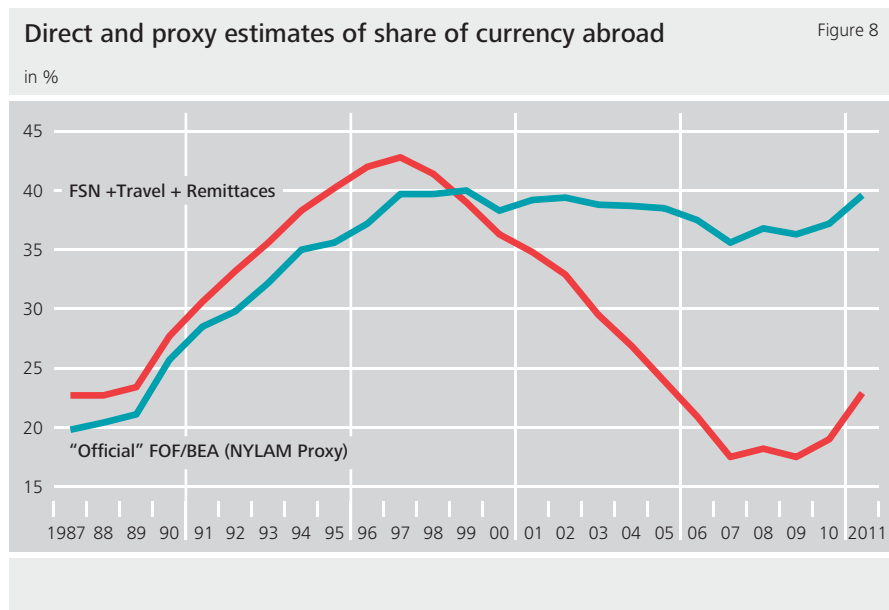
Figure 8 compares the share of U.S. currency held abroad as measured by direct estimates of wholesale and retail cash flows to the "official" published FOF/BEA estimates that relied on the NYLAM proxy. It appears that from 1987-1998, the NYLAM proxy underestimated the share of currency abroad, whereas in the most recent decade, the proxy appears to have overestimated the share of currency abroad. The direct measurement approach reveals that the share abroad rose abruptly from 23 percent in 1987 to a high of 43 percent in 1997 and then sub-sequently declined reaching a low point of 18 percent at the end of 2007. Note that both series suggest that the amount of currency held abroad was significantly less than the oft-cited claim that between 55 to 70 percent of U.S. currency was abroad. We now turn to an investigation of the indirect methods of estimating overseas currency that are the basis of this latter claim.

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4 Indirect Measures of Currency Abroad

A The simple monetary demography model.

A simple indirect means of estimating currency abroad employs some variant of the monetary demography model[25]. The monetary demography model (MDM) basically assumes that any observed characteristic of the U.S. currency supply (X) can be decomposed into an unobserved domestic component (X^d) and an unobserved foreign component (X^f) such that $X = X^d + X^f$. Now assume that there exists a country very similar to the U.S. (say Canada) except that it must neither import foreign currency nor export its own currency to other countries. Since its own currency (Y) is assumed to have no foreign characteristic, Y might then be assumed to behave like the domestic component of the U.S. currency supply such that, $Y \approx X^d$.

Then, if $X = Y + X^f$, one can obtain an estimate of the unobserved fraction of X made up by its foreign component since, $X^f/X = 1 - Y/X$. Often some observable Canadian characteristic related to Canadian currency is taken to represent the comparable unobserved domestic characteristic of the U.S currency supply. For example, we can consider the currency/GDP ratio (Judson, 2012), currency per capita, or the ratio of currency to wages and salaries (WS) as possible characteristics.[26]

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25 Feige (1996,1997)
26 Feige (1996, 1997), Porter, and Judson (1996) also employ age, note quality, coin/note ratios and seasonal characteristics.

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Simple indirect MDM estimates of the share of U.S. currency abroad

Figure 9

in %
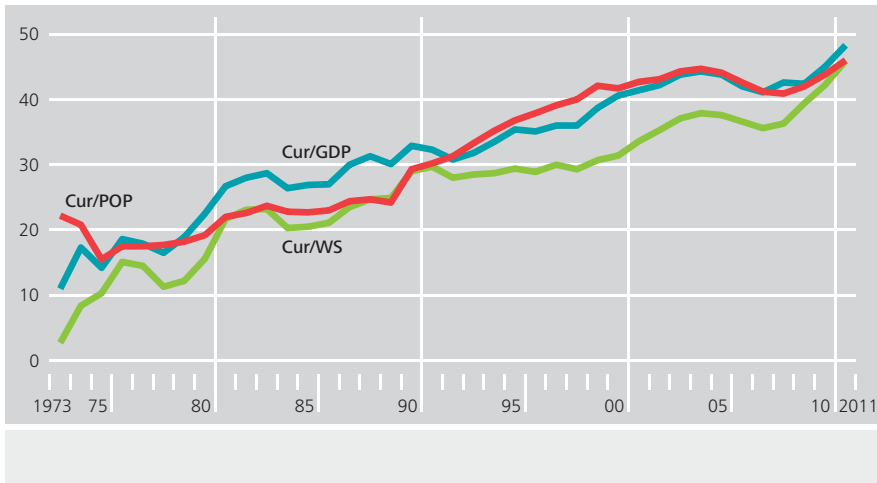
Figure 9 presents the results of some simple variants of the MDM model.[27] First, we note that the temporal path is highly sensitive to the particular characteristic chosen; hence, the estimates are not robust to simple changes in the model specification. The results also suggest that 46 percent of U.S. currency is currently overseas, roughly double the figure obtained by the direct estimation procedure.

This discrepancy is likely due to a serious violation of one of the key assumptions underlying the simple MDM model, namely, that Canada does not import any foreign currency. If for example, Canadians at various times employed U.S. dollars as a substitute currency, this would violate the assumption that $Y \approx X^d$, because the observed Canadian currency supply would be abnormally small, resulting in an

27 Judson (2012) p.11–12 obtains similar results.

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overestimate of the share of U.S. currency held abroad (X^f/X). Murray and Powell (2002) present evidence that demonstrates that this key assumption is violated.

"CMIR data suggest that the amount of U.S. dollars in circulation at their peak in 1994 was more than 30 percent of the outstanding stock of Canadian notes and coin in circulation." (P.23) "Fed data for 1990-2001 generally corroborate the CMIR data, although the cumulative net inflows are roughly double those of the CMIR" (p. 21)

U.S. dollars in circulation in Canada as percent of Canadian currency in circulation
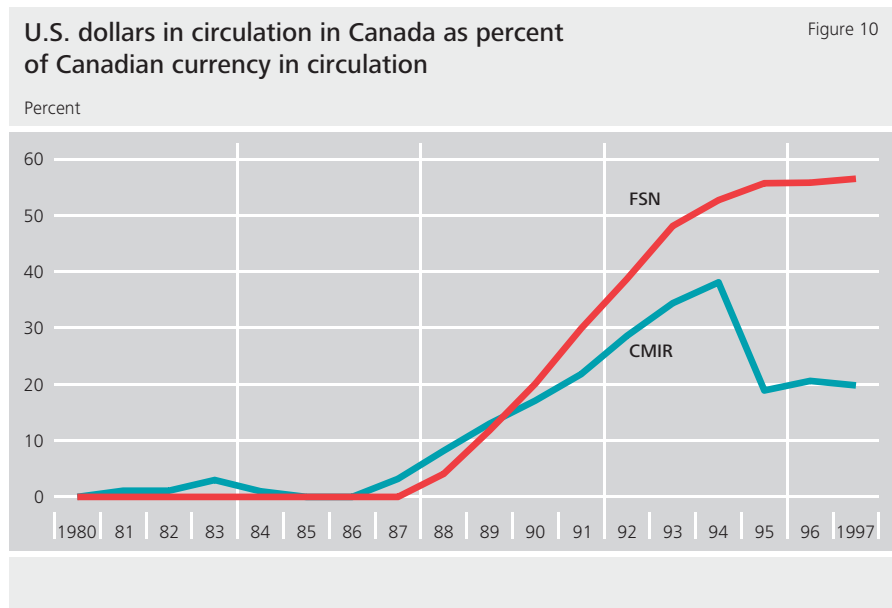
Figure 10

Figure 10 displays the extent of the use of U.S. dollars in Canada based on the actual CMIR and Federal Reserve (FSN) data for the period 1980 – 1997. According to the CMIR data, by 1994, U.S. currency amounted to 38 percent of Canadian currency in circulation, whereas the FSN data suggest that this percentage had risen to 57 percent by 1997. The fact that between 28 and 36 percent of all currency in circulation (U.S. plus Canadian) was in the form of U.S. dollars implies

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a gross violation of the key assumptions of the MDM models and hence makes the results presented in Figure 9 and the similar ones presented by Judson (2012) highly suspect. Since neither the CMIR data nor the FSN data are available on a country basis for the period of the past decade, it is impossible to tell whether the demand for U.S. currency increased or decreased during this period.

B The "seasonal" variant of the monetary demography model.

At the outset, it is important to note that the repeated assertions that as much as two thirds of the U.S. currency supply circulates abroad is almost entirely based on the results reported by Porter and Judson (1996) derived from the "seasonal" variant of the monetary demography model. The seasonal variant of the monetary demography model requires a set of highly restrictive assumptions. Porter and Judson (1996) and Judson (2012) assume that:

1) "the seasonal amplitude, or the percentage difference between the seasonal peak and trough of the domestic demand for U.S. currency is virtually identical to the demand within Canada for Canadian dollars";

2) "that the foreign demand for U.S. dollars has no significant seasonal pattern, or correspondingly, that the seasonal amplitude for the foreign component of demand for U.S. dollars is zero";

3) "that the circulation of Canadian dollars outside of Canada is negligible."

4) "that U.S. currency is not used to a substantial degree inside Canada."

As demonstrated in section 3A above, the fourth assumption is grossly violated, thereby invalidating empirical results based on it. Furthermore, as demonstrated by Feige (1997, p 91) the estimation procedure is highly arbitrary, and the results can fluctuate substantially depending upon which seasonal metric is employed.

Figure 11 illustrates the sensitivity of the seasonal results to alternative specifications concerning which seasonal characteristic the researcher chooses to employ. The first estimate labeled (Porter/Judson (1996) [Dec-Feb] is simply an updating of

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the seasonal model originally proposed and estimated by Porter/Judson (1996) employing the difference between the December and February seasonal.[28] This seasonal model suggests that in 2011, $790 billion of U.S. currency was abroad, 79 percent of the total U.S. currency in circulation.

Alternative seasonal model estimates of U.S. currency abroad

Figure 11

Dollars (Billions)
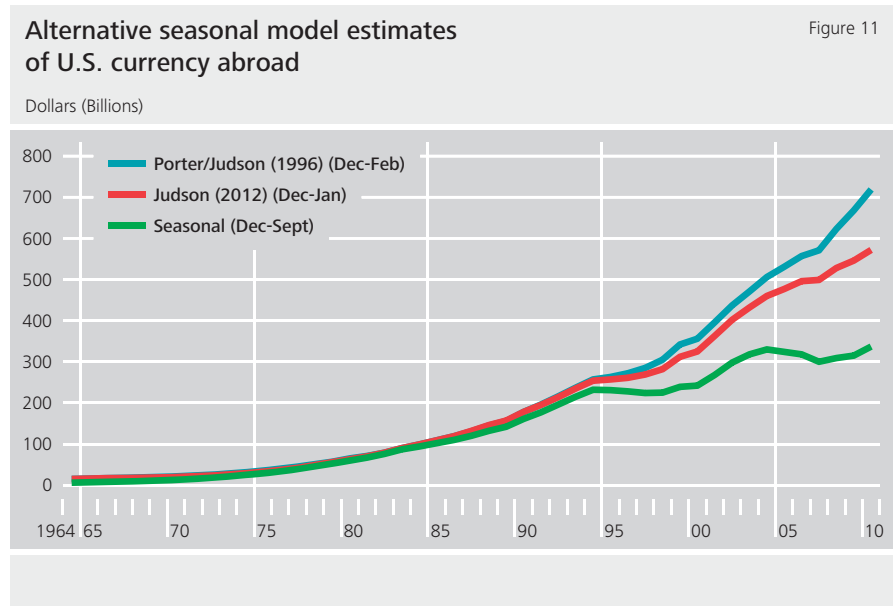
Judson (2012) finds that the seasonal trough has shifted from February to September but changes the model's specification to the difference between the December and January seasonal. The results are charted in Figure 11 (labeled Judson (2012) [Dec-Jan]. This alternative specification reduces the estimated amount of U.S. currency abroad by $170 billion, and lowers the share abroad to 64 percent. However, had Judson employed the same criterion for choosing the seasonal characteristic

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28 Porter and Judson (1996) claim that the "best estimate of the model is obtained by measuring the seasonal variation around Christmas, specifically from the seasonal high that is reached in currency in December to the seasonal low in February."

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as used in the 1996 paper, namely the difference between the seasonal peak and the seasonal trough, she would have calculated the model employing the difference between the December peak and the new September trough. Figure 11 also displays these results (labeled Seasonal [Dec–Sept]). Not only does this seemingly minor modification drastically change the entire estimated temporal pattern of the estimates, it lowers the estimated amount of U.S. currency abroad to $368 billion, or to 37 percent of the U.S. currency supply.

Estimated share of U.S. currency abroad: Seasonal model sensitivity analysis

Figure 12

Percent abroad

Porter/Judson (1996) (Dec-Feb)
Judson (2012) (Dec-Jan)
Seasonal (Dec-Sept)
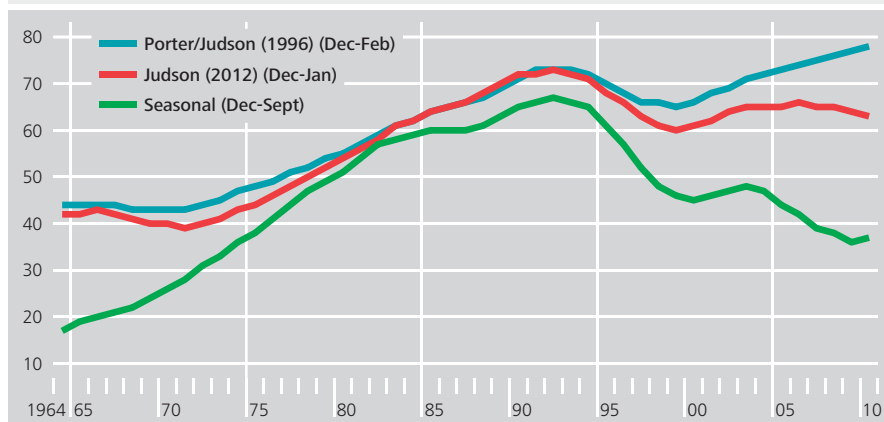
The sensitivity of the share results to minor alternative specifications of the seasonal model are displayed in Figure 12. Given the radical changes in both the temporal pattern and the magnitude of the estimated shares resulting from these alternative specifications of the model, we conclude that this indirect approach is unfit for estimating the share of U.S. currency abroad. This conclusion is bolstered

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by the empirical finding that one of the key assumptions of the model is violated, namely, that U.S. currency is not used inside Canada.

5 Summary and Conclusions

Even a cursory examination of the growth and magnitude of the U.S. currency supply in circulation with the public reveals that predictions of the advent of the "cashless society" are unfounded. Despite financial innovations giving rise to convenient substitutes for cash, per capita cash holdings continue to increase and by the end of 2011, amounted to $3000 for every man woman and child residing in the U.S. While this figure does not comport with our common sense notion of how many dollars the average person holds in her wallet, we show that Europeans and Japanese citizens hold even larger amounts of cash. Two explanations are offered for these large cash holdings. The first posits that a large fraction of U.S. currency is held abroad, the second that large amounts of cash are employed to undertake transactions that individuals and firms prefer to hide from the government either to avoid taxes, regulations or punishment for illegal activities. Cash, being an anonomous medium of exchange leaving no paper trail, is the logical choice for undertaking such transactions.

Feige(2012) employed the official estimates[29] (FOF/BEA) of the amount of U.S. currency believed to be overseas, to derive estimates of U.S. seiniorage earnings, the *domestic* money supply, and estimates of the unreported economy and the "tax gap". This official FOF/BEA estimate of the share of U.S. currency abroad is based on a proxy measure (NYLAM) that was designed to mimic a confidential data series controlled by the New York Federal Reserve (FSN) that tracks bulk shipments of U.S. currency by wholesale currency dealers into and out of the U.S. This confi-

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29 As published by the Federal Reserve in its Flow of Funds Accounts and by the Bureau of Economic Analysis in the U.S. Balance of Payment Accounts.

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dential aggregate shipment data was recently published in a paper by Judson (2012), enabling researchers to reexamine the veracity of the official FOF/BEA (NYLAM) proxy estimates of the amount of U.S. currency held abroad.

Alternative estimates of currency abroad

Figure 13

Dollars (Billions)
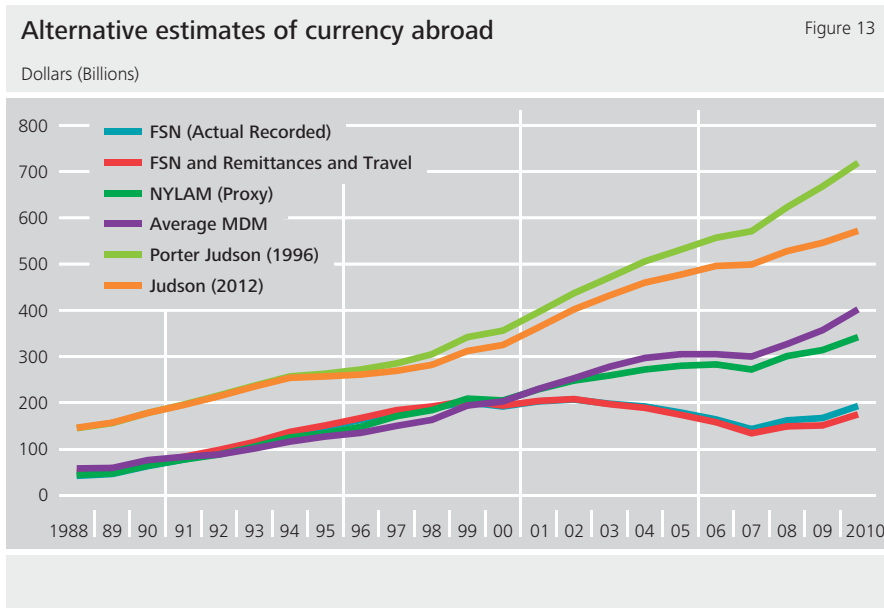
As displayed in Figure 13, the NYLAM proxy appears to track the formerly confidential FSN series reasonalby closely between 1988 and 2001, after which time the proxy begins to substantially overstate the series it is supposed to mimic. By 2011, the official FOF/BEA (NYLAM) estimate of overseas currency is roughly $150 billion larger than the amount reported to the New York Federal Reserve (FSN) by wholesale bulk shippers of currency. Judson (2012) suggests that the the FSN series may be an understatement of the amount of U.S. currency abroad because it omits net currency shipments abroad through informal channels such as immigrant remittances and travel. We therefore directly estimate cash flows through these informal channels and find that taking account of immigrant remittances and cash

transported by inbound and outbound passengers leads to a slight increase in our estiamte of U.S. cash held abroad between 1988 and 2002. Thereafter, informal flows reduce our estimates of currency abroad. We conclude that by the end of 2011, the best direct estimates of U.S currency held abroad suggest that $230 billion is held overseas, that is, 23 percent of the currency in circulation with the public. This estimate implies that per capita *domestic* cash holdings amount to roughly $2300. We strongly suggest that the Federal Reserve and the Bureau of Economic Analysis downward revise their official estimates of overseas currency to bring them into conformity with the New York Federal Reserves (FSN) series and the available estimates of immigrant remittances and travel flows.

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We then turn to a reexamination of "indirect" means of estimating the amount of U.S. currency abroad. These indirect methods, based on varients of monetary demography models, are the basis for the oft cited claims, that as much as 55−70 percent of the nation's currency supply is held overseas. While these indirect methods are admittedly innovative, we demonstrate that they require highly restrictive assumptions that can be shown to be significantly violated by available empirical data. Figure 13 reveals that an average of simple monetary demography models suggests that $470 billion of U.S. currency (47 percent) is currently held abroad. We also update the "seasonal" models proposed by Porter and Judson (1996) and Judson (2012) also displayed in Figure 13. If taken at face value, they suggest that between $620−$790 billon (62−79 percent) of U.S. currency is held abroad. As such, the indirect approaches produce estimates exceeding the direct estimates by an astounding $390−550 billion. They also suggest a temporal path at variance with that of direct estimates. The direct estimates reveal that the introduction of the euro led to a substitution of euros for U.S. dollars until the financial crisis. The seasonal models suggest a continual upward trend in the demand for U.S. dollars abroad. We not only demonstrate that a key assumption underlying these indirect models is false but also show that the results from these models are highly sensitive to slight variations in their specifying assumptions. We conclude that these indirect models, particularly the seasonal models, are unfit methods for estimating the amount of U.S. currency held abroad.

It is beyond the scope of the present paper to examine many of the interesting implications that follow from our finding that the amount of currency overseas is less than 25 percent of the nation's cash in circulation with the public. We do however, strongly urge Federal Reserve officials to come to some agreement concerning the amount of currency held abroad so that the current discrepancies between their published data, their internal data and their public pronouncements can finally be put to rest.

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Estimating cash usage
in the euro area

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1. Introduction

It is widely known that overall use of cash and banknotes in particular is difficult to measure precisely (cf. e.g . Boeschoten, 1992). Basically, this arises from the unique property of cash being an anonymous means of payment. Cash payments do not require cash registers and are not always registered by electronic point-of-sale account systems like retailers' cashier desks. Another key problem is related to the dual role of cash as both a payment means and a store-of-value means, the latter relating especially to the high denomination banknotes. The latter type of cash holding makes it difficult to measure the active use of cash accurately. High denomination banknotes can be held for very long periods and are not necessarily used in cash transactions. To make the measurement problem even more complicated, different banknote denominations are typically used for different purposes. Nowadays a major part of the cash in euro countries is withdrawn from Automated

Teller Machines (ATMs). Over-the-counter (OTC) withdrawals in bank branches occur mainly where larger amounts of cash or high denominations are needed.[1] The smallest banknote denominations and coins are usually used only as change and end users of cash get them from retailers, which cannot always be regarded as the primary use of cash.

These measurement problems further complicate the modelling of cash usage because euro currency migration across the euro area has greatly affected the circulation and return frequencies of euro banknotes.[2] In many euro countries, the cumulative net issuance of certain banknote denominations is negative, which means that these banknotes are imported in greater amount to the issuing country than are issued by its domestic national central bank (NCB). Therefore the use of common euro banknotes is more difficult to measure as accurately than the previous national legacy currencies of euro countries. It has been estimated, based on bank bulk transports outside the euro area that at least 20-25 percent of euro banknotes have migrated outside the euro area. Euro banknotes have been heavily exported to Eastern-Europe and Russia, in particular from Germany and Austria, which may further distort the measurement of active use of banknotes within the euro area. It is also very likely that large amounts of high denomination euro banknotes have been stored in these non-euro countries. The reason for this seems obvious, since euro currency is regarded as better secured against inflation (ECB's inflation target), especially in the light the depreciation of their national currencies.

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1 Of course in this respect there are quite large differences across euro countries. It should be also remembered that the typical ATM denominations of banknotes are usually the middle-value denominations 50 euro and 20 euro banknotes. In few euro countries (DE, LU and AT) also 100 euro banknotes are frequently available in ATMs. Quite a many euro countries offer also smallest banknotes denominations (10 € and 5 €) in the ATMs, which helps NCBs to maintain the quality of the banknotes in circulation.
2 Return frequency here is the number of times banknotes return to the national central bank within a year. The distribution of ATM banknotes is not usually greatly disturbed by migration, since they are mainly used in domestic cash consumption spending.

However, it is in many respects important to evaluate the total amount of cash transactions. One reason is to compare the development of different means of payment. We may also want to estimate the unit costs of payments, to obtain information on cost efficiency in retail payments. The total volume of cash payments is also significant for evaluating the overall societal costs of cash and for planning optimal cash services for the economy. The organisation of cash services also feeds back to the demand for cash services of the public. In principle, national central banks are planning the extent to which cash services should be provided for the economy or at least these plans are closely related to the division of tasks in cash services between NCBs and private professional cash handlers. Central banks have the obligation to analyse, innovate, guide and suggest improvements to the cash cycle operations of the national economy and in the euro area. Central banks can also affect the popularity of cash as a means of payment by setting various restrictions on the handling of cash or providing different mixtures of free-of-charge and chargeable services regarding cash etc.[3] It should be remembered however that the eurosystem position is neutral towards the different means of retail payments (cash, cards or other electronic forms of payment).

This study investigates the estimation of cash usage in the euro area. In section 2, we briefly compare the different ways available for estimating and evaluating cash usage. In section 3, we investigate the possibility to estimate the value of cash payments in the euro area based on ATM and OTC distributions of cash.[4] Since we want to estimate cash usage, we have to track the cash distribution from the different sources to the end use of cash at the points-of-sale. For our calculations we try to obtain for each euro country the best available information for estimating cash usage in that country. The use of cash in this cash line can be measured since

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3 Within the euro area NCBs offer as minimum basic services free for professional cash clients for six hours a day in at least one location.
4 These channels of cash distribution are also reviewed in a recent ECB (2011) study.

cash usage is not mixed with electronic payments. Cash is put in wallets as ATM or OTC withdrawals until it runs out and the wallets are filled again, and even if the particular means of payments (banknotes and coins) are changed during this process the original cash value withdrawn from the bank account is not exceeded. Cash can be transferred also to somebody else for use, e.g. to spouses or children, but this does not increase the original amount of cash to be spent. Only cash transactions (cash recycling) between consumers or between companies can increase cash usage.

For all euro countries, the ATM distributions of cash are available, but OTC distributions of cash are available only for some euro countries. The so called cash back – cash advances at POS terminals – are also available only in a few euro countries, but their significance as a primary source of cash is minimal. We present a simple framework for a typical euro area cash cycle, where recycling of cash is also taken into account. In practice however it is hard to assess the recycling parameters of credit institutions (CI), cash-in-transit (CIT) companies and the public. Actual cash payments (not transfers) can take place also between consumers or companies, which are not registered as cash payments in any statistics. These payments will increase the use of cash apart from that registered for ATM or OTC withdrawals.

The calculation scheme based on cash distribution flows tries to incorporate the stylized facts about the cash cycle for estimating the value of cash usage.[5] Even if this cannot be completely exhaustive, we can always fine tune to the system later with recycling parameter adjustments. This is investigated in section 4.

In section 5, we compare results from the calculation scheme for questionnaire studies and other studies available on cash usage by euro country. Other rough

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5 Even if cash cycles in the euro area differ e.g. in cash distribution shares, CIT companies have an increasing role in cash cycles between NCBs and Credit Institutions in most of the euro countries.

comparisons of the use of cash can be done also e.g. by applying the return frequency of banknotes to the banknote stock put into circulation. These comparisons for a few countries are presented in section 6. Microeconomic evidence of ATM and OTC distributions are briefly analysed in section 7. There we focus on both size distribution and frequency of withdrawals, which allows us to evaluate the usefulness of our estimates of cash usage.

Finally in section 8 we summarize the findings. To be realistic, we also address the caveats of the procedure to evaluate cash usage. Our intention here is to start an easily available, simple and inexpensive approach to cash usage calculations, an approach that will see further improvements in the future.

2. Possible ways to measure the use of cash

There are at least four different ways to reveal the total (transaction) use of cash. We compare the following procedures:

2.1 Cash register estimates of cash usage. In principle the use of cash and card payments are registered separately by retailers' cashiers at shop desks that use modern electronic point-of-sale devices. In most cases, retailers acknowledge at least the total amount of sales and, as the card payments are known by retailers of bank accounts, the amount of cash payments can be calculated by subtraction. This information is however rarely separated e.g. by banknote denomination, and so is mostly available only in value terms. Partly this information could be derived also from the CIT company returned cash information. So even though this way of estimating cash usage is the most accurate in single retail shops, it does not necessarily help much in finding out the total aggregate use of banknotes by denomination. In most cases it may be very valuable in assessing the overall use of cash in value terms if a large sample is used.

2.2 The income and consumption statistics approach to cash usage. The national income statistics include estimates of private or household consumption by consumption item on the national level, and by applying cash payment shares for these different items one can calculate the final use of cash. From consumption statistics, we have to follow those household consumption items, which are based on monetary transactions. This means that imputed consumption items (like imputed rents on owner-occupied housing), which are not paid in money terms, are excluded. Currently, consumer statistics may also include an estimate of the monetary consumption, and if the value of card payments is deducted, we get an estimate of cash payments.[6]

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[6] Some items in household consumption are not paid for by either cash or cards, but with credit transfers or direct debits. These items could be reduced directly before allocating payments to cash and cards.

For a few euro countries, studies exist that include estimates of cash-purchase shares by consumption item. For example an Austrian study by Mooslechner, Stix and Wagner (2006) provides very detailed information about the different means of payment including cash by institutional sector.[7] Similar type questionnaire information on cash payments used in purchasing different consumption items can be found in the DBB study on retail payments (2009). These approaches can also help in estimating the number of cash transactions if the average size of payment is estimated.

2.3 Cash usage estimates based on statistics on the distribution of cash. In this paper, we study the possibility to calculate the use of cash based on the sources that the public receives the cash.

Eurosystem currency in circulation statistics contains the information on NCB issuance of banknotes. Other sources of collected ECB statistics on ATM withdrawals and data on bank branch OTC withdrawals can be used to estimate the use of cash for each euro country.[8] In this methodology, ATM and OTC distribution of banknotes are seen as the primary sources of cash for the public. In most euro countries, ATM distribution of cash is the major source of banknotes, but high denomination banknotes (defined usually as 500 € and 200 €) are exclusively distributed from bank branches as OTC withdrawals. Cash advances at POS terminals (cash back at retailers' cashier desks) could be added into the estimates as well, though that channel of withdrawing cash from the bank account is currently insignificant in the euro area.

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7 In Austria cash payments share in early 2005 was as high as 70 % of total household payments by value, which is among the highest in the euro area.
8 ATM and OTC withdrawals of cash and cash advances at POS terminals are available from ECB Blue Book publications on ECB's web-page http://sdw.ecb.europa.eu/reports.do?node=1000001964.

2.4 Cash usage estimates based on cash questionnaires. Questionnaires can also be helpful, especially in assessing the share of cash payments by consumers. Direct questions proposed to the public easily provide information about payment-environment changes that cannot be approached via statistics. The problem is that they have only limited value in assessing aggregate payment variables. The main reason is that the total amount of cash crucially depends on "big cash users", who have both large cash balances and may also use a lot of cash. By contrast, those who withdraw cash very frequently and have very small cash balances are quite irrelevant from the point of view of aggregate cash balances and cash usage. For obvious reasons, the "big cash users" represent only a tiny portion of total population (of households and firms) and at least small survey studies may completely fail to include (correct) responses from these agents. Questionnaires can also be quite expensive and burdensome to arrange.

Pros and cons of different ways of measuring cash usage				Table 1
	Cash register method	Consumption statistics	Distribution of cash statistics	Questionnaires
Population transaction measures available	no estimate	no estimate	only indirectly available with add. assumptions	only sample based estimates
Population spending data available	not possible	best estimate	quite reliably estimated	
Reliability at source	best accuracy	very good	good	moderate
Accuracy in individual payments	very good	not available	not available	fairly good
Accuracy in aggregate payments	no relation	very good	good	no relation
Appropriate in studying	retailer payment behaviour	macroeconomic relations	overall trends and development	special topics
Misclassification	small probability	very reliable	reliable/based on banks accounts	possible
Cost of study	moderate	small	small	large
Timeliness: response rate	very high	perfect	very good	very good
Sampling error	some	no	no	can be large for small samples
Timeliness of statistics	good	good	rather good	good
Coverage error	medium	no	small	large
Measurement error	small	not much	moderate	moderate

3. The distribution approach to estimating the use of banknotes

For most consumers in the euro area, the primary source of cash and banknotes is ATM withdrawals. Roughly 2/3 of the cash in the euro area is distributed through ATMs to the public. In Finland, around 85 % of cash is delivered to consumers via ATMs. In Southern Europe (IT, GR, PT) banknotes are still more frequently distri-

buted from bank branches. The distribution of cash via ATMs – with domestic cards within the euro country – is also known for all EU countries and published in the ECB's Blue book. The exact distribution of banknotes by denomination is known for only a few countries, but the collection of ATM banknote denominations is known. In most of the euro countries 20 euro and 50 euro banknotes are available in ATMs, and they usually form the largest share of the banknotes issued from the NCB.[9] Smaller 5 euro and 10 euro 'change' denominations are available in ATMs at some range in a few euro countries, and 100 euro banknotes are available in ATMs only in Germany, Austria and Luxembourg (see Table 2a). It should be emphasized that different banknote denominations are used for different purposes, which should be taken into account in the analysis for the use of banknotes.[10]

High denominations (500 € and 200 €) are not available in ATMs, and therefore they must be withdrawn from bank branches as over-the-counter (OTC) withdrawals. Besides being used in payments, these high denomination banknotes (HDBs) are frequently used as a store-of-value (hoarding) means, which complicates the analysis of their usage. The return frequency of HDBs is lower than those used frequently in daily purchases. It is possible that the holding time of HDBs is bimodal or has a very long right hand tail, as these banknotes are used partly for specific purposes quite rapidly, e.g. within a week for a transaction, while some of these banknotes are held for longer time periods as a form of liquid asset. The store-of-value motive for holding HDBs is in principle sensitive to the level of interest rates as a cost of investment. The general public usually holds only very small amounts of banknotes in their possession, which makes the transaction demand for cash inelastic to the interest rate. As HDBs can be taken into and out of these cash stocks, this will also complicate the analysis based on the flows of cash. As

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9 For instance in 2010, for the 12 original euro countries (EU12), the ATM denominations of banknotes accounted for 83.8 % of the value of banknotes issued by the NCB.
10 This difference is also emphasized in Fischer, Köhler and Seitz (2004).

mentioned earlier, high denomination euro banknotes are frequently used as a store-of-value also outside the euro area; this part of HDBs is probably even more immobile.

Consumers load their cash holdings into their wallets mostly from ATMs and for larger transactions and more specific purposes they have to go to bank branches for larger amounts of cash or high denominations. The banknotes loaded from ATMs are usually spent during several payment occasions until they run out, after which the wallets are re-loaded. The exact number of transactions made by each banknote is usually unknown, but for most people the amount of cash spent mostly coincides closely with ATM withdrawals. Again most people seldom use high denomination banknotes or withdraw smaller change banknotes from bank branches.[11]

As the euro currency is a very international currency and the euro area is very wide as such, it should be remembered that the largest ATM banknotes are also frequently used in other euro countries. This migration of euro banknotes is significant although the main bulk of the euro banknotes are used in domestic purchases. In many countries the largest ATM denominations were also withdrawn heavily during the financial crisis, probably due to their easy availability, even though the main increase was witnessed in high denominations.

The cash spending trail in retail stores and shops is easy to follow, as for cash payments change is almost always given in smaller banknotes and coins. Card payments are made mostly in exact amounts, and only rarely is cash given as cash back, because the customer needs cash for other payments. Basically, the use of

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[11] In the latest Bank of Finland consumer survey in January 2012 about 75 % of consumers said that they hardly ever withdraw cash from bank branches. In this respect, however, there is some discrepancy between different euro countries.

cash can be seen as an alternative to spending purchasing power (resources) from overnight deposit accounts similar to the use of the card payments. If cash and card spending were more mixed in the spending, it would be impossible to follow cash spending from cash distribution.

Like ATM distribution of cash the OTC withdrawals of cash are also spent until cash runs out. In some cases OTC withdrawals of cash are simply for making credit transfers between bank accounts because it is faster and mostly free of charge, but we cannot separate these cash transfers from the statistics. Therefore simply by summing up the ATM and OTC withdrawals of cash, a minimum amount of cash usage can be estimated. In addition to these professional channels of receiving cash, the public can make cash payments among themselves. If retailers (companies) use cash payments among themselves or individuals pay for transactions between themselves, these uses of cash are not recorded by ATM or OTC distributions of cash. In many euro area countries, these cash payments between companies are important (around 20-25 % of corporate payments), whereas e.g. in Finland these payments are currently very rare.[12] The bulk of cash purchases between retailers and consumers are on the other hand recorded by electronic points-of-sale, but usually these statistics are not collected by National Statistical Offices. Mostly only turnover or sales is available.

Ordinary consumers recycle cash between themselves by paying for person-to-person purchases, small private loans etc. between them. This is actual cash recycling, but if parents give income transfers in the form of cash to under-aged children or to the spouse, this may not be a true recycling of cash, but rather transferred cash spending. In practice we do not have much data on these income transfers, but their share in the total cash spending might be rather limited.

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12 See also the ECB (2011). In 8 major euro countries 62 % of companies had cash income and AT, ES and DE companies received more than 50 % of their income as cash.

A rough guess could be that this public recycling cannot be higher than 15 percent of the total cash distribution.

To summarize there are 3-4 channels by which economic agents can get banknotes in their possession:

ATM distribution: Usual assumption is that banknotes dispensed through ATMs form more than half of total consumer cash distribution. Recent rough estimates suggest that ATM distribution of cash in the euro area accounts for around two-thirds of banknote distribution. However, the selection of ATM banknotes is often limited to the middle denominations, as ATMs provide banknotes for ordinary daily expenses.

Bank branches (OTC) distribution: High denomination banknotes and larger single amounts of cash are mostly distributed to the public from bank branches. In some euro countries, a significant part of the smaller banknotes (change banknotes) is also distributed to smaller private companies (retail shops, small entrepreneurs etc.) from bank branches.

Cash back (cash advances at POS terminals): Distribution of cash directly from retail shop counters is available in some euro countries. The importance of cash back is mostly very limited and it accounts less than 2 percent of the total distribution of cash in the euro area.

Income transfers within the public (between consumers and companies B2B): Ordinary cash payments between consumers and companies are recorded by the ATM, OTC or as cash back as these transactions are performed across institutional sectors, but recording the final usage of cash is complicated by the recycling of cash within each sector. Cash payments between individuals are often performed e.g. within the family, but these transactions cannot always be regarded as a

primary source of cash, rather they are merely secondary spending of the received cash originally from deposit account withdrawals or other sources. These transfers are mostly unregistered. However occasionally cash payments are used between individuals for exchange of goods or services. These payments are not registered by the above mentioned sources of cash, and not necessarily in taxation either. Similarly cash payments between companies are not included in the ATM, OTC or cash back sources of distributing cash for payment use, if the origin of the cash is for instance cash payment made by consumers. The cash payments for other companies for production inputs are mostly tax deductible and no value added is generated at this point for the buying company. In any case, the recycling of cash among the consumers and partly among companies could be included in cash usage. As no official or other statistics are available on this recycling, we may have

to assume something about the size of this 'public recycling'. Partial answers could be also obtained from consumer (public) questionnaires. One further complication in the basic cash cycle model is that firms can pay wages partly in cash from the cash flow they receive from their sales. In our stylised model these payments are included into the public recycling.

Banknotes in ATM distribution by Euro country (EU12)							Table 2a
	500	200	100	50	20	10	5
Austria			x	X	X	x	
Belgium				X	x		x
Finland				X	x	x	
France				X	x	x	
Germany			x	X	x	x	x
Greece				X	x		
Ireland				X	x	x	
Italy				X	x	x	x
Luxembourg			x	X	x	x	x
Netherlands				X	x	x	x
Portugal				X	x	x	x
Spain				X	x	x	x

In Finland, 10 euro notes have been in limited distribution from Eurocash Finland 27 ATMs while the banks' unified Otto network distributes only 20 and 50 Euro notes.

The value of ATM withdrawals of cash (with domestic cards inside the country) in EU12

	BE	DE	GR	ES	FR	IE	
2000	20.95	253.87			66.00	12.00	
2001	22.43	260.53	23.58		71.00	16.00	
2002	24.87	265.03	28.44	77.19	76.00	15.00	
2003	27.13	303.57	32.44	85.82	81.00	22.00	
2004	27.51	340.24	35.03	90.46	85.20	22.32	
2005	27.58	361.67	37.18	95.87	98.18	21.90	
2006	29.57	381.35	41.56	101.81	100.28	24.90	
2007	34.05	298.77	44.02	107.40	106.78	28.10	
2008	38.79	311.19	46.88	109.94	114.84	28.74	
2009	43.45	317.43	47.66	107.17	120.86	24.42	
2010	45.32	315.48	47.17	107.98	123.35	22.32	

Source: ECB Bluebook, Table 13 1a.

4. The effect of recycling on the measurement of cash usage

In order to measure the use of cash, it is useful first to form a description of the cash cycle in the euro area countries. Even if the cash cycles in the euro area are somewhat different, they have many similarities, and we can draw up a stylized version of the cash cycle that can be used in calculating the cash usage. This model is also helpful in understanding the points where cash is recycled by the professional cash handlers (banks or CITs). By knowing the cash flows between professional cash handlers, the cash usage can be evaluated. A description of the German cash cycle is available in the DBB (2011a) Monthly Report for year 2009.

Table 2b

IT	LU	NL	AT	PT	FI	EU12
71.02	.58	40.72	13.50	15.29	16.80	510.73
73.25	.63	44.59	14.90	16.80	17.40	537.53
94.29	.69	52.96	14.60	18.80	17.30	656.73
71.69	.66	50.91	14.70	20.22	17.40	727.33
76.97	.67	51.01	15.70	21.95	17.20	784.11
79.07	.70	55.34	15.88	24.28	16.90	855.51
83.33	.72	55.71	16.83	26.29	16.60	787.23
91.08	.74	55.88	17.84	28.10	16.40	829.16
97.91	.75	55.16	16.60	29.17	16.60	866.57
91.87	.76	53.77	17.80	20.57	16.40	872.16
122.9	.77	52.00	17.80	30.33	15.70	901.13

The ATM distribution of banknotes by euro value in the euro area (12 original countries) is presented in the Table 2b. Here we have not included this in the recycling due to the recently introduced banknote-recycling ATMs (CRMs) since their significance is so far limited in size. We see that ATM distribution of cash already exceeded 900 million euro in 2010 in the EU12.

Even though the described 'cash distribution based' approach may seem clear to follow, the practical problem lies in the fact that not much publicly available official data exist on bank branch withdrawals (OTC distribution) for the euro countries. ECB Blue Book statistics provide data on OTC cash withdrawals (and deposits) for

Germany, Spain, Italy, Netherlands, Portugal (up to 2008) and in principle for Greece. Germany, Spain and Italy also were cash-prone countries, while Netherlands and France were classified as cash-averse according to the TNS public survey on the use of high denomination banknotes done in September-October 2008. Finland and other Nordic countries have also been card dominated payment countries since the mid-2000's.[13]

It is also worthwhile to consider the adequacy of the data from OTC withdrawals, as small entrepreneurs and other self-employed persons withdraw change banknotes from bank branches. Cash is partly recycled directly over the bank counter immediately, and bank accounting does not register this fully. For this reason some euro countries do not publish OTC withdrawals. In most euro countries change cash (small denominations and coins) is however provided also by CIT companies directly to retailers. As mentioned previously, very rarely do detailed data exist on the denomination composition of OTC withdrawals. The important aspect in using cash is the value of the payment.

To circumvent these difficulties, i.e. the absence of direct OTC banknote distribution data, one can estimate OTC withdrawals using data either from CIT deliveries of banknotes to bank branches or NCB issuance of high denomination banknotes.

If direct bank branch counter data is unavailable, CIT companies' deliveries could be used with the credit institutions (CI) recycling rate to account for the total OTC distribution of cash. Credit institutions recycle part of the banknotes that they receive from the public as deposits, which must be taken into account in making calculations on the use of banknotes.

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13 These questionnaires are broadly summarized in the ECB (2011) study.

1. Proxy for missing data on OTC banknote withdrawals =
CIT deliveries of banknotes to CI * (1 + CI recycling rate of banknotes over the bank counter)

If this substitute for the OTC withdrawals of banknotes does not exist, then we must go one step further back in our calculations and rely on the national central banks' (NCB) deliveries of banknotes to the CIT companies. There most likely is some recycling of banknotes between CIT companies and credit institutions. However, this recycling does not affect ATM distribution of banknotes. In many cases the bulk of ATM banknote denominations are supplied only through ATMs, which are usually the middle denominations of banknotes, like 20 euro and 50 euro banknotes.

The ATM loading of banknotes is normally done by either CIT companies or credit institutions. Quite recently also private ATM companies have started the ATM distribution of banknotes with lighter portable small convenience ATMs, which are usually located in shops and other stores.

2. Proxy for missing data on OTC banknote withdrawals =
NCB deliveries of banknotes to CIT * (1 + CIT recycling rate of banknotes from their customers)* (1 + CI recycling rate of banknotes over the bank counter)

To perform the calculations for the missing OTC withdrawals, we also need estimates of CI and CIT recycling rates. If statistics or expert opinion does not exist, these recycling rates can be calculated for reasonable ranges of recycling rates such as $0 - 0.5$. There is no direct statistical basis for these recycling rates, and these rates are by and large the most uncertain aspect of these calculations. In the euro area, the ECB decision on the recycling framework of banknotes was made in 2007, and the collection of biannual data of CIT recycling of banknotes was also initiated.

With these options for calculations, we can obtain estimates of the total usage of cash. These estimates can be compared with cash usage estimates derived e.g. from the retail sector or other statistics received from national statistics. From other studies it has been found e.g. that cash is especially heavily used in the hotel and restaurants business, wholesale and retail trade plus in addition in the trade and repair of motor vehicles.

There are rather wide differences in the organisation of the cash cycles among euro area countries. In a few countries, the NCB performs only wholesale sorting (NL, FI, IE, LU), while other NCBs provide also sorting services for a wide range of clients (BE, DE, FR, GR, ES and IT). In most of the euro countries, CIT companies perform the sorting for retailers and credit institutions' bank branches. The involvement of central banks in the euro area also varies widely e.g. the number of NCB branches varies from 1 (LU, NL and IE) to close to 100.

The calculations based on available cash distribution statistics from ATMs and over-the-counters (OTC) distribution at bank counters plus assumptions of the recycling rates can be found in Tables 3, 5a and 5b. For countries like Germany, Spain, Italy and Portugal the estimates of banknotes usage must be quite reliable, as they depend only on the assumption of the public recycling rate. Given that the statistics on ATM and OTC distribution of cash is accurate. In the case of Finland, the CIT company deliveries to banks are known precisely, but CI recycling rate, i.e. the recycling that banks apply to banknotes returning from the public, is close to the actual magnitude.

Stylized cash cycle with ATM and OTC withdrawals and recycling

Figure 1

CIT centered cash cycle
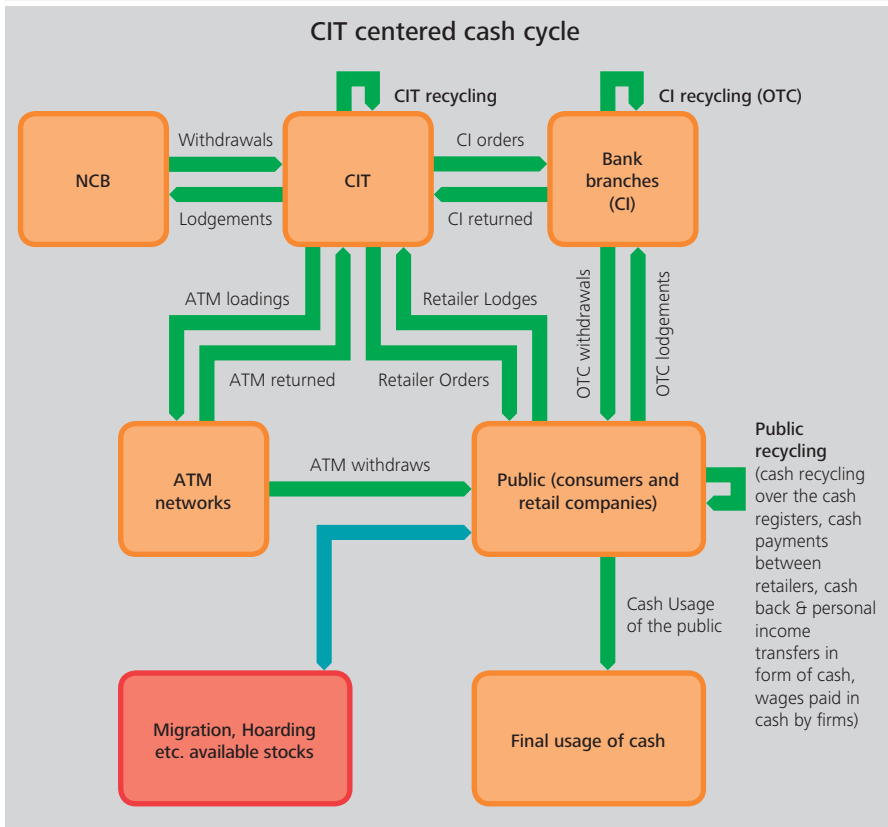
OTC distribution of cash from bank branches in the EU12, 2002–2010

	BE	DE	GR	ES	FR	IE	
OTC withdrawals							
2002							
2003							
2004			1050.70	254.19			
2005			1051.16	208.47			
2006			1245.35	249.96			
2007		394.48	1548.95	236.81			
2008		379.47	614.55	252.35			
2009		369.43	574.00	249.19			
2010		336.39	582.88	248.94			
OTC deposits							
2002							
2003							
2004			1088.27	544.58			
2005			1161.67	251.95			
2006			1422.14	315.17			
2007		677.45	1934.74	428.35			
2008		653.13	1066.49	417.70			
2009		606.62	1327.51	385.54			
2010		580.69	848.15	386.75			
OTC advances at POS terminals							
2002							
2003			.01				
2004			.01				
2005			.01				
2006			.03				
2007			.03			.49	
2008			.05			.60	
2009			.05			.61	
2010			.03			.55	

Source: ECB Bluebook Table 8.

Table 3

IT	LU	NL	AT	PT	FI	EU12
365.32				21.94		387.3
328.43				24.55		353.0
339.10				19.69		1663.7
205.08		15.74		133.37		1613.8
210.66		15.11		138.07		1859.2
213.23		16.04		122.62		2352.1
206.08		15.94		65.21		1533.6
270.17		11.24				1474.0
149.07		6.26				1323.5
324.84						324.8
326.51						326.5
325.94						1938.8
330.46						1962.5
350.36		68.35		150.1		2318.9
381.72		65.11		166.14		3632.0
399.95		68.48		141.24		2701.6
521.39		68.15		96.16		2905.8
499.18		64.78				2370.2
					.11	
					.13	
					.16	
				.01	.18	
				.01	.15	
				.01	.13	
				.01	.08	
				.01	.32	

Summary of the assumptions related to the distribution model approach

Table 4

	Assumption	Relevance of assumption
1	ATM withdrawals of cash are mainly used for domestic purposes	Almost 98 % of ATM withdrawals are made with domestic-issued cards; however these banknotes could be used outside the home country
2	If OTC withdrawals are not available, they can be approximated by CIT deliveries of banknotes to banks with recycling	CIT deliveries to bank branches can be recycled in Credit Institutions over the counter
3	If even CIT deliveries of cash is not available, then OTC cash distribution can be based on NCB withdrawals of banknotes, which is also subject to CIT cash centre recycling	In most euro countries CIT companies handle transports from NCBs to CIT cash centres and distribute cash to ATMs, CI branches also deliver change cash (small denominations and coins) to retailers
4	Both ATM and OTC withdrawals are subject to public cash recycling	Personal payments between individuals and B2B cash payments are rarely recorded in statistics, but these are assumed to be rather limited
5	Cash back has not been taken directly into account in these calculations	Cash back and wages in cash are public cash recycling
6	High denomination banknotes are available only from bank branches	500 euro and 200 euro banknotes are not available in ATMs in the euro area
7	Cash bulk transfers outside the euro area could be deducted from NCB cash issuance, as they are not used in the euro area	Banknote migration outside the euro area complicates the estimation of the cash usage and banknote deliveries for hoarding purposes outside the euro area
8	Smallest change banknote deliveries can be taken out of OTC distribution since this part of cash is mainly withdrawn by retailers from bank branches to be used as change in consumer payments and does not represent primary cash usage by end-users of cash	OTC withdrawals are concentrated on high denominations and small denominations, as high denominations cannot be obtained elsewhere and small entrepreneurs can get change cash from bank branches. The share of ATM denominations from OTC withdrawals is usually low
9	ATMs that only distribute banknotes have begun to be replaced by cash recycling machines (CRM), which can deposit and authenticate banknotes and recirculate them to other customers	In these calculations we have not taken CRMs into account, since the volume of this recycling is still rather limited

5. Empirical results of cash usage estimation for the EU12 area

The calculations based on available cash distribution statistics of ATMs and over-the-counter (OTC) distribution at bank counters and the assumptions for recycling rates for the EU12 countries can be found in tables 5. Tables 5a-5b present the cash usage calculations for years 2009 – 2010. Where OTC distribution was not available, we used NCB issuance of banknotes (excluding the smallest change banknotes) as a substitute. This data has been taken from the ECB CIS2 statistics. For Finland only did we use, CIT companies' deliveries of banknotes to bank branches instead of the NCB withdrawals of banknotes, the former being regarded as more precise data than NCB issuance for this estimation.[14] In these cash usage calculations, we used mostly a 15 % assumption for the public recycling rate of cash and 25 % for the CIT recycling rate.[15]

From these calculations, we see that the estimates of cash usage vary quite steadily around 2 400 billion for the first three years with some lower ones for 2010. For countries like Germany, Spain, Italy and Portugal, the estimates of the use of banknotes are likely to be slightly more reliable, as they depend only on the assumption about the public recycling rate. However, if we were trying to assess domestic cash spending, it would be necessary to investigate the extent of banknote migration and foreign demand for banknotes. Certainly, it is usually the case that cash distributed from ATMs is mostly spent in the home country. Regarding OTC distribution of high denomination banknotes the migration to other euro countries and to non-euro countries may well be more extensive. Change banknotes withdrawn by entrepreneurs are most likely used in domestic purchases as change cash, similar to coins. Migration of euro cash within the euro area has certainly affected cash

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14 This data was obtained from *Automatia*, which is responsible for cash services for all banks operating in Finland. For Finland an estimate of around a 33 % CI recycling rate for banks in their OTC cash operations was used.

15 Country specific tables of the cash usage calculations can be asked from the authors.

distribution in some of the euro countries. In some euro countries, the net issuance of a few denominations of banknotes has turned negative. NCB net issuance of the main ATM banknotes is still generally strongly positive, as these banknotes are mostly used for domestic cash purchases. The tourist net migration of some denominations is stronger in southern Europe, which affects also NCB issuance of these banknotes. In the case of Germany, the bulk transfers abroad of banknotes via German banks do not directly affect ATM or OTC distribution.[16]

Given that, the statistics on ATM and OTC distribution of cash should be accurate. The ATM distribution of banknotes seems to have increased quite steadily, except for the drop in the German ATM withdrawals from 2006 to 2007 by around 100 million Euro (see Table 2b). The overall trend in ATM distribution has been increasing, partly because in the euro area bank branches have been replaced by ATMs. Signs of a slight decrease in the ATM distribution of cash can be seen in recent years only in IE, FI and NL. Total ATM withdrawals in the EU12 reached 900 million Euro in 2010. Cash recycling machines (CRM) are still of modest importance, so we have not yet included this recycling in the calculations.

OTC distribution is a bit more problematic, as only for 5 or 6 countries (IT, ES, DE, NL, PT and GR) have given systematic information on it, and even here there seems to be problems in the figures even if we leave out Greece's figures altogether.[17] It is however fortunate that many of the biggest countries are among the respondents. The OTC distribution of cash in these five countries (excluding Greece)

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16 Or at least we assume that the bulk transports of high denomination banknotes are not included in banks' OTC withdrawal statistics.
17 Greece figures of OTC distribution of cash exceed usually multiple times the annual GDP, which seems a bit strange; for instance in 2010 OTC withdrawals were 582.9 billion Euro, while the Greek nominal GDP was 227.3 billion Euro (see Table 3). Greek OTC withdrawals of cash also exceeded for instance German OTC withdrawals, yet Greek ATM withdrawals of cash were only 47.2 billion Euro. Therefore in the case of Greece we used NCB withdrawals of cash as a basis for distribution calculations. Most likely OTC withdrawals in Greece include some transactions other than just cash withdrawals.

comprises around the same magnitude of cash distribution as ATM distribution of banknotes for the entire EU12.

It is also worthwhile to compare OTC withdrawals with OTC deposits (see Table 3). Regarding our aim to measure cash usage, one may well ask whether OTC deposits would better represent the use of cash by the public. However, we feel that OTC withdrawals better represent the assessed demand for cash by banks than does the returned cash from the public. OTC deposits also include gone payments of bills by entrepreneurs that have received cash in payments, which would have complicated the interpretation. It is however interesting that in all the countries that have gathered OTC data for the ECB, deposits are usually significantly higher than OTC withdrawals. It can be argued however that OTC deposits are not totally

useless, and if we add ATM withdrawals and OTC deposits, we arrived at an upper bound for cash usage.[18]

Table 5 presents the calculations of cash usage based on ATM and OTC distribution. The figures show quite steady estimates for cash usage, maybe partly because ATM and OTC distribution are substitutes. As bank branches have been replaced by ATMs this may not be surprising. The biggest empirical problem in these calculations is of course that we do not have convincing or reliable data on the recycling rates. We might guess from everyday observations and experience that public recycling is quite limited, but CI and CIT recycling rates certainly vary from one euro country to another. CIT recycling is also increasing in the euro area, as the Eurosystem framework for recycling banknotes has been in operation from the beginning of 2007. NCBs have also been closing branches, and CIT banknote sorting has been supported by expanding NHTO deposit schemes, which has led to increased cash handling by private professional cash handlers.

Due to the migration effect, it can be argued that lodgements might be regarded as a better measure of high denomination banknote usage within the euro area. Another fact speaks in favour of using lodgements instead of withdrawals in the case of HDBs: which is the tendency of credit institutions to order too many HDBs for safety reasons, to meet any unexpectedly high demand for HDBs by the public.

Recycling is the most common for ordinary banknote denominations that are available in ATMs and which are mostly used in retail shops and other similar points-of-sale. Even though HDBs are not available in ATMs, these banknotes are

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18 In Finland cash deliveries (CI cash orders) to almost all bank branches (except S-Bank) are available via Automatia's information system, and they have been quite close to cash returned from bank branches to CIT centres. In the case of Finland, CIT deliveries to banks are known precisely, but the CI recycling rate, i.e. the recycling that banks apply to the cash returning from the public at bank counters, is partially recycled.

in some cases recycled by CIT companies or by banks over-the-counter as well. An individual may also make large cash payments with HDBs e.g. credit transfers from one bank to another with HDBs, as cash withdrawals are free while other types of credit transfers may be costly or may take too long because of banking days. Recycling (CIT, CI or by the public) somewhat complicates the calculations on the use of HDBs and cash for making payments in general.[19]

High denomination banknotes excessively emigrate from Germany, Ireland, Luxembourg and Austria, while countries like Belgium, Portugal and Spain had net immigration of HDBs. For all of five euro countries were OTC distribution figures are available (DE, ES, IT, PT, NL), OTC lodgements are larger than withdrawals, but only for Italy are these sums roughly of the same size. A plausible interpretation is that in the other countries private companies (smaller retailer shops) return cash out from sales through bank branches, and this cash does not go directly through other channels for CIT companies for counting and sorting. The cash usage estimations may be more reliable for OTC withdrawals than for lodgements, as lodgements include return of ATM banknotes from consumers.

On average, bank counter (OTC) withdrawals are roughly three times as large as ATM withdrawals (see ECB, 2009). High denomination banknotes are preferred in cash transactions only rarely, when larger amounts of cash payments are involved. The user profile of HDB users is somewhat more likely to be males aged 25 to 54, and more frequently also self-employed than workers. The HDB public survey also revealed that almost half of HDBs are spent within a week, even though a larger part of these banknotes is likely to be hoarded than smaller denominations. It may be reasonable to assume that a larger part of HD banknotes are withdrawn more

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19 In a number of euro countries e.g. second market sales of used cars are expected using high denomination banknotes, especially if the buyer is from another euro country or is living outside the euro area, as credit transfers are a slow, risky and offer unavailable means of payment in these cases.

for specific purposes than are other denominations, which are more likely to be spent on ordinary daily purchases.

According to the ECB survey, around a fourth of consumers have also withdrawn high denomination banknotes apart from regular ATM withdrawals (ECB, 2011). The country-specific differences seemed to be large among euro countries related to national conventions and payment habits. For instance the Dutch had the largest average OTC withdrawals while in the Netherlands the share of ATM distribution of banknotes was the highest (78 %) among those euro countries where both ATM and OTC withdrawals are possible. In Germany, the amounts of cash withdrawn from ATM and OTC are roughly of the same magnitude.

According to an earlier Belgium study about cash payments at POS in 2003, the cash transactions were estimated to be only 52.2 billion Euro, which is only somewhat larger than the ATM distribution of cash (NBB, 2005). OTC withdrawals or deliveries of cash to banks are not available for Belgium, but cash usage could be significantly larger than ATM distribution, since wages are partly paid in cash and also cash hoarding could be higher, since the issuance of high denomination banknotes is higher in Belgium than in most of the euro area countries. In the distribution model wages paid in cash are included in the public recycling. According to the TNS-opinion study (ECB, 2009) highest proportion of cashless incomes seem to appear in Germany, France and Netherlands, but otherwise considerable part of people receive at least part of their income in form of cash.

Cash usage in the euro area (EU12) in 2009

Estimated use of cash in euro area (EU12) countries in 2009, billion Euro

	ATM distribution	OTC distribution			Recycling rates (0−1)[4]	
		First option	2. alternative	3. alternative	Assumptions	
	ATM withdrawals of banknotes	OTC withdrawals of banknotes excl. change banknotes[1]	CIT deliveries to CI	Banknote gross withdrawals of banknotes from the NCB (excl. change banknotes)	Public recycling rate[2]	CI recycling rate at the bank counter
	(a)	(b)	(c)	(d)	(e)	(f)
BE	43.45			41.1	0.17	
DE	317.43	318.5		437.5	0.15	
GR	47.66	573.3		42.9	0.15	
ES	107.17	242.5		81.8	0.15	
FR	120.86			153.2	0.15	
IE	25.42			31.7	0.15	
IT	91.87	266.5		78.4	0.15	
LU	0.76			11.1	0.15	
NL	53.77	9.3		20.8	0.14	
AT	17.80			55.5	0.15	
PT	29.57			9.4	0.15	
FI	16.40		2.4	12.6	0.16	0.32
EU12	872.16	1410.1		976.0		

Assumptions:
1 Here it is assumed that 5 and 10 Euro banknotes distributed over the bank counters are mostly received by retailers and other companies that use these banknotes as change, which therefore cannot be regarded as final use of cash by consumers or companies. OTC withdrawals data on these change banknotes was taken from NCB gross issuance.
2 Public recycling (between different households and between companies) is applied to both ATM and OTC distribution of cash

Sources: ATM and OTC withdrawals are available in the ECB's Blue Book statistics, and NCB withdrawals of banknotes are available in the ECB's CIS2-statistics.

Table 5a

	Alternative estimates of the public's total usage of cash				
CIT cash centre recycling rate [3]	Minimum estimate without recycling	Mininum estimate with public recycling	ATM distribution plus CIT deliveries and CI recycling	ATM distribution plus NCB distribution and CIT recycling	Best available estimate
(g)	$(a+b)$	$(1+e)*(a+b)$	$(1+e)*a+(1+e+f)*c$	$(1+e)*a+(1+g)*d$	
0.15				98.1	**98.1**
	635.9	731.3			**731.3**
0.25				108.4	**108.4**
	349.7	402.1			**402.1**
0.25				330.5	**330.5**
0.25				68.9	**68.9**
	358.4	412.1			**412.1**
0.25				14.7	**14.7**
	63.1	71.9			**71.9**
0.25				89.9	**89.9**
0.25	29.6			45.8	**45.8**
			22.6	31.7	**22.6**
					2396.3

3 Credit Institution (CI) recycling is applied only to OTC distribution (withdrawals) of banknotes
4 Recycling rates are here based on a rough assumption only. The sensitivity of these assumption on the calculations can be tested with the formulas in the alternative estimates row.

Cash usage in the euro area (EU12) in 2010

Estimated use of cash in euro area (EU12) countries in 2010, billion Euro

	ATM distribution	OTC distribution			Recycling rates (0−1)[4]	
		First option	2. alternative	3. alternative	Assumptions	
	ATM withdrawals of banknotes	OTC withdrawals of banknotes excl. change banknotes[1]	CIT deliveries to CI	Banknote gross withdrawals of banknotes from the NCB (excl. change banknotes)	Public recycling rate[2]	CI recycling rate at the bank counter
	(a)	(b)	(c)	(d)	(e)	(f)
BE	45.32			36.2	0.17	
DE	315.48	285.2		435.4	0.15	
GR	47.17	582.2		48.6	0.15	
ES	107.98	241.5		93.4	0.15	
FR	123.35			153.5	0.15	
IE	22.32			29.5	0.15	
IT	122.91	145.3		84.1	0.15	
LU	0.77			9.6	0.15	
NL	52.00	4.8		17.6	0.14	
AT	17.80			54.5	0.15	
PT	30.33			10.5	0.15	
FI	15.70		2.4	12.5	0.16	0.32
EU12	901.13	1259.00	2.41	985.30		

Assumptions:
1 Here it is assumed that 5 and 10 Euro banknotes distributed over the bank counters are mostly received by retailers and other companies that use these banknotes as change, which therefore cannot be regarded as final use of cash by consumers or companies. OTC withdrawals data on these change banknotes was taken from NCB gross issuance.
2 Public recycling (between different households and between companies) is applied to both ATM and OTC distribution of cash

Sources: ATM and OTC withdrawals are available in the ECB's Blue Book statistics, and NCB withdrawals of banknotes are available in the ECB's CIS2-statistics.

Table 5b

| | Alternative estimates of the public's total usage of cash | | | | |
CIT cash centre recycling rate [3]	Minimum estimate without recycling	Mininum estimate with public recycling	ATM distribution plus CIT deliveries and CI recycling	ATM distribution plus NCB distribution and CIT recycling	Best available estimate
(g)	(a+b)	(1+e)*(a+b)	(1+e)*a+(1+e+f)*c	(1+e)*a+(1+g)*d	
0.15				94.6	**94.6**
	600.7	690.8			**690.8**
0.25				115.0	**115.0**
	349.4	401.9			**401.9**
0.25				333.7	**333.7**
0.25				62.6	**62.6**
	268.2	308.4			**308.4**
0.25				12.8	**12.8**
	56.8	64.8			**64.8**
0.25				88.6	**88.6**
0.25	30.3			48.0	**48.0**
			21.8		**21.8**
					2243.0

3 Credit Institution (CI) recycling is applied only to OTC distribution (withdrawals) of banknotes
4 Recycling rates are here based on a rough assumption only. The sensitivity of these assumption on the calculations can be tested with the formulas in the alternative estimates row.

Cash usage estimates based on return frequencies and cash holdings in 2008, billion Euro

Table 6

Different measures of banknotes put into circulation				Frequency	Cash usage		
	Actual value of bank-notes	Capital key calcula-tion value	Mufa cash holding based value	Average return frequency	Actual circulation based estimate	Capital key based estimate	Cash holdings based estimate
Austria	6.7	20.7	28.6	3.92	26.11	81.04	112.11
Belgium	2.1	24.8	24.7	2.52	5.23	62.55	62.34
Finland	8.4	12.4	5.8	2.13	17.90	26.33	12.35
France	69.9	141.5	77.9	3.04	212.50	430.17	23682
Germany	328.4	208.2	182.1	4.26	1397.31	885.73	774.87
Greece	20.8	20.2	6.9	3.18	212.50	430.17	236.82
Ireland	23.2	9.5	13.1	.99	22.92	9.45	12.97
Italy	139.5	129.9	168.0	.98	136.68	127.33	164.44
Luxembourg	52.6	2.0	1.6	2.96	155.76	6.02	4.74
Netherlands	23.9	39.0	39.4	1.40	33.44	54.63	55.16
Portugal	1.6	17.3	10.7	2.68	4.22	46.47	26.68
Spain	83.1	76.01	117.2	2.15	176.76	163.45	251.98
EU12	**760.1**	**765.4**	**676.0**	**2.79**	**2120.75**	**2135.50**	**1886.04**

ECB's Monetary Union Financial Accounts (MUFA) is available only for 2002-2008.

6. Comparison of distribution cash usage estimates to other studies and methods

The recycling parameters can be calibrated from additional national data sources such as questionnaires forwarded to CIT companies.[20] Cash questionnaires can be therefore used to calculate the proper size of the public and/or CIT recycling rates.

6.1 The case of Germany

The Deutsche Bundesbank's (DBB) study (2009) on payment behaviour did not give any exact value for cash payments, but 21 percent of the German respondents paid exclusively with cash, even though they had payment cards. Consumers had on average 118 Euro in their wallets, with median holdings of 90 Euro, while the average ATM withdrawal was around 215 Euro. In the 2010 published study about the withdrawal behaviour in Germany we can find an estimation of the total cash holdings for people above 18 years. According to this people in Germany hold about 14.5 billion Euro for transactional purposes. The share of cash in retail transaction volume in Germany was as high as 82.5 % and the euro value of cash payments from the turnover was 58 percent.[21]

Estimates of cash holdings of national residents are found in the ECB's Monetary Union Financial Accounts. These ECB's MUFA statistics provided quarterly estimates of total cash holdings of German residents only up to 2008, but at the end 2008 these were 182.1 billion Euro.[22]

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20 Also ECB statistics on CIT recycling of banknotes could be used as reference. Return frequencies can be used as reference even though they are based on the capital key calculations on the banknotes put into circulation.
21 If this turnover portion of cash is applied to the consumer debit card spending statistics for Germany, we arrive at the following estimate of total cash spending of consumers in 2009: 2.27 * 115.81 billion Euro = 262.6 billion Euro.
22 Here we have compared the calculations for 2008 only, since this was the last year for which the Mufa statistics were compiled.

A DBB study (2011a) on the other hand shows the German banknote cycle and estimates the consumer cash consumption in 2009 at 702 billion Euro and retail turnover in cash at around 542 billion Euro in Germany. Migration and hoarding are not estimated in this study, but the banknote cycle shows many useful aspects of the German cash cycle.

The increase in German banknote issuance after Euro changeover clearly cannot be explained by the domestic transaction demand growth. Rather, as is concluded in Bartzsch et al. (2011a) and Bartzsch et al. (2011b), a major part of DBB issued banknotes are related to banknote migration either by Germans exporting them via travelling to euro countries and outside euro area or by shipments abroad from Germany. The active circulation of banknotes issued from DBB in Germany was estimated to be only around 30 percent at the end of 2009. It was also estimated that the active circulation of banknotes in Germany has been around 130 billion Euro since 2005 up to 2009, which accounts for only one-third of banknotes issued by the DBB. However, observing the difference between flows and stocks and taking into account that DBB return frequency was 4.3 on average, banknotes worth 130 billion Euro roughly equates to 558 billion Euro worth of cash transactions.

This estimate of active banknote circulation seems to be somewhat low, if we take into account that ATM withdrawals of cash in Germany were 317 billion Euro and OTC withdrawals 369 billion Euro in 2009 (together 686 billion Euro), even taking into account that Germans exported 8.4 billion Euro net worth of banknotes during 2009. Net shipments of cash outside the euro area have annually amounted to between 5 and 15 billion Euro. The net shipments of cash are ordered through commercial banks, but they are not included in OTC distribution of cash. Migration of euro cash may also partly explain the difference in the estimates. Even if the cash usage had been around 900 billion Euro, this could have been done with rather limited amount of banknotes in circulation, as the banknotes circulate and return

to the central bank a few times a year. To sum up, there are plenty of estimates around, but the trouble is that it is not easy to assess or order these various estimates into a uniform framework.

We can also compare cash usage estimates from the distribution approach to other rough methods of calculating cash usage like the cumulative net issuance of banknotes times the average return frequency of banknotes to NCBs. The actual circulation of banknotes does give us a reliable estimate of the cash usage in Germany due to net shipments and banknote migration by the German populace. The capital key approach is artificial also, but it could be used as a reference for what the cash usage could have been in a normal situation. The cash holdings of German residents multiplied by DBB average return frequency could yield us at least another comparative estimate of the German cash spending. In the German case, the cash holdings applied to average return frequency yield an estimate of 775 billion Euro in 2008. Thus this estimate is also much in the same range as the others (see Table 6).

6.2 The case of the Netherlands

No official or other recent published estimates of cash usage exist for the Netherlands either. However, a projection of a recent study has been used to obtain a figure for cash usage. The Dutch retail association performed a comprehensive study of retail payments in 2009 (Pleijster and Ruis, 2011). Based on extrapolations from this study, the value of cash payments in point-of-sales terminals was estimated at around 57.1 billion Euro.[23] However, this estimate was also limited to POS terminals. Adding recycling to the distribution model, we end up with

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23 This estimate for 2009 57.1 billion Euro was done by Nicole Jonker, and it is quite close to the sum of ATM and OTC withdrawals, 63 billion Euro in 2009. In a more recent study Jonker, Kosse and Hernandez (2012) POS cash payments were estimated to be 53 billion Euro in 2010. In addition person-to-person cash payments were 8.6 billion Euro worth, so in total cash usage is 61 around billion Euro, which is quite close to the distribution model calculation yielding 65 billion Euro. Based on this public recycling rate of cash in Netherlands could be around 14 percent.

81.5 billion Euro (without small change banknotes 72.5 billion Euro), of which ATM and OTC distributions alone total 63 billion Euro. In addition the distribution approach does not separate the hoarding motive from the transactions.

It might be the case that the Dutch use euro banknotes quite heavily also outside of the Netherlands, and the distribution model somewhat exaggerates cash usage, since the alternative estimates of the cash usage based on cash holdings times the average return frequency yield around 55 billion Euro of cash usage in 2008 (Table 6).

The coverage of the Dutch retail study done in association with the retail association was exceptionally high as it represents around 85 % of POS transactions. The average cash payment in the Netherlands was estimated to be relatively low, namely 12.5 Euro, while the total number of cash payments was very high, 2.35 times as high as debit card payments, even though the value of debit payments was 76.1 billion Euro.[24]

6.3 The case of Finland

In Finland, no official or even unofficial estimate for the usage of cash is available. Statistics Finland does estimate the cash holdings of the different sectors in their financial accounts. The actual cumulative net issuance of euro banknotes put into circulation by the Bank of Finland is around twice of the estimated cash holdings of Finnish sectors, as the major part of Euro cash is assumed to have migrated outside Finland (Figure 2).

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24 Earlier comparative results can be found in Jonker and Kettenis (2007).

Growth of cash demand in Finland

Figure 2

million Euro

Source: Bank of Finland and Statistics Finland.
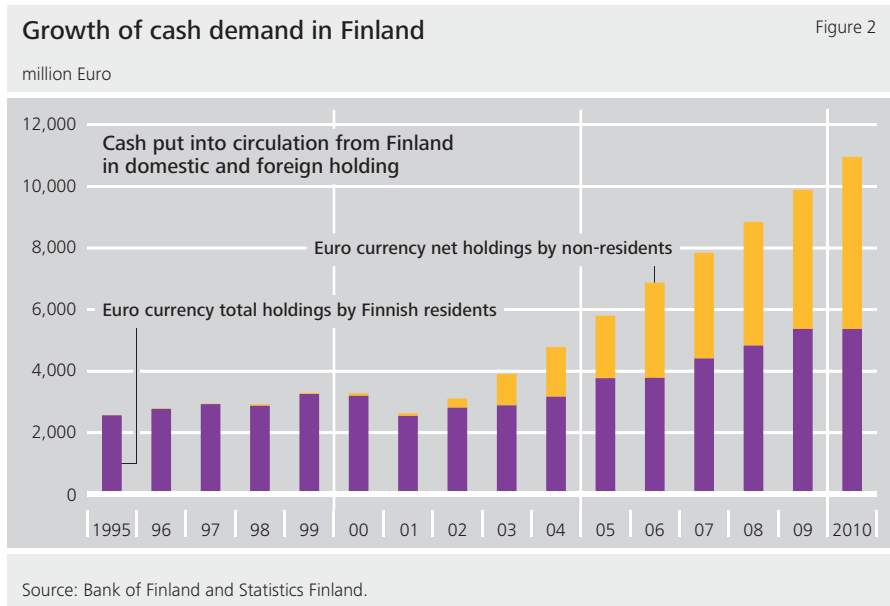
The Federation of Finnish Financial Services (FFFS) provides aggregate card payment statistics and also handles annual questionnaires about the most common retail payment shares of consumers. Figure 3 shows the consumers' assessment of their most commonly used daily payment media, which clearly shows the decline in cash payments and increase in card payments in retail payments. Card payments have dominated the major retail payment media since mid-2000, and currently less than 30 percent of consumers regard cash as their main payment medium. Similar results have been obtained from Bank of Finland consumer questionnaires. The FFFS questionnaire can be combined with official consumption statistics to get an estimate of cash and card usage. This cash usage estimate can be compared with the cash distribution estimate, and questionnaires can be used to calibrate the recycling parameters to get more consistent cash usage estimates with the distribution method.

Cash payment motives in Finland

Figure 3

% of respondents

Most common means of payment in daily goods purchases

Legend: 1999, 2001, 2003 Jan, 2003 Oct, 2004 Apr, 2004 Oct, 2005 Apr, 2006 Feb, 2007 May, 2008 May, 2009 May, 2010 May, 2011 May

Categories: Cash, Bank cards (Debit function), Visa Electron card, Credit cards, Retail shop card, Account
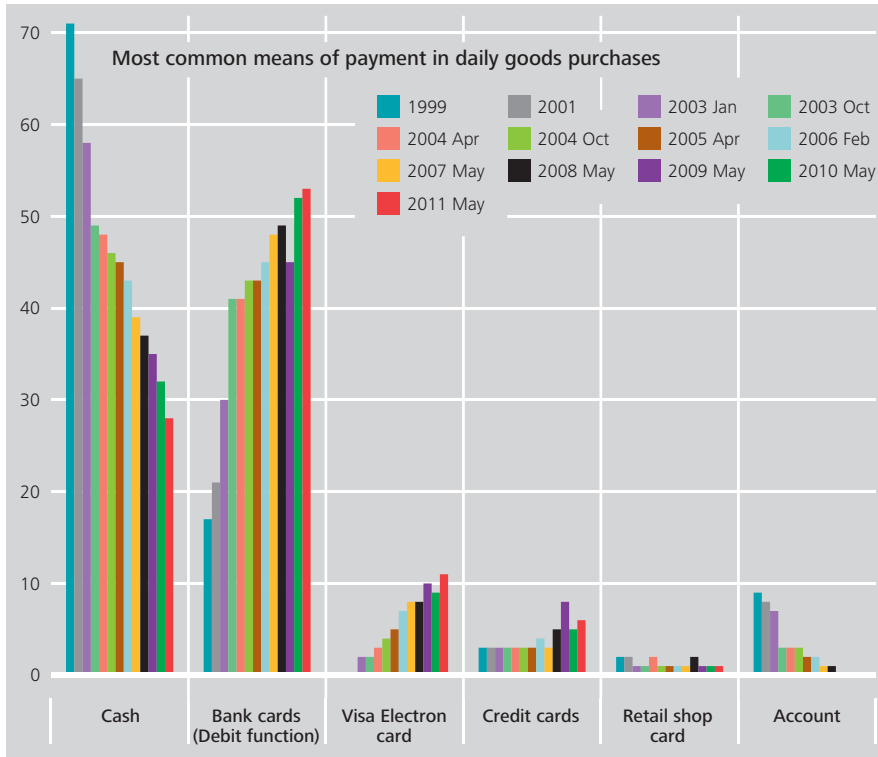
Source: Federation of Finnish Financial Services, Saving and use of credit, May 2011.

If household consumption expenditure is used to measure ordinary daily retail payments, then housing expenditure (rents) and out-patient health services can be deducted directly from this figure, as they are paid overwhelmingly as credit transfers. The questionnaire percentage shares can be multiplied directly by the household consumption statistics to get the payment expenditure value. This card usage estimate can also be compared with the FFFS statistics collected from banks' card payments (Figure 4). This card payments estimate slightly exceeds the actual

40 billion Euro. These calculations lead to cash usage of 22-23 billion Euro in Finland, whereas the ATM and OTC distribution of cash has been about 18-19 billion Euro in recent years. In some respects, the domestic use of cash seems rather limited, currently only about half of the euro value of card payments. Based on banknotes put into circulation from BoF and migration estimates, cash is still very popular in travelling and on holidays in the euro area.

Estimates of card payments in Finland   Figure 4

billion Euro

Source: Statistics Finland and Federation of Finnish Financial Services.
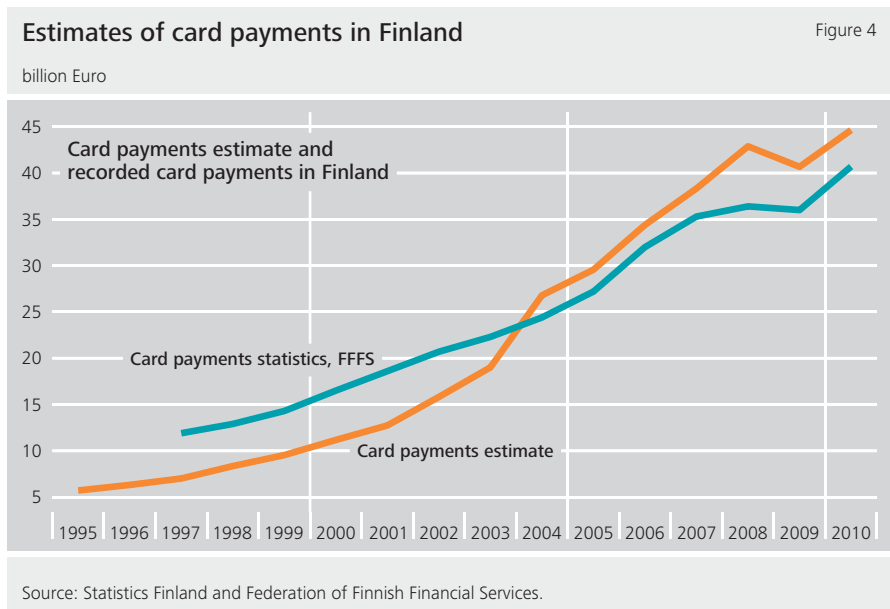
The cash holdings of Finnish residents combined with the average return frequency of the banknotes yields on 12 billion Euro estimate of cash usage in Finland (see Table 6). For Finland this estimate seems rather low, since for instance the ATM distribution also has been quite steadily around 16 billion Euro for the last decade. Most likely the cash holdings of Finns are slightly larger than the MUFA estimate and the financial accounts estimate.

6.4 Cash holdings and cash usage

Cash usage can also be approached by combining the estimate of cash holdings combined with the NCB return frequency of banknotes. These calculations are presented below for three different concepts of cash holdings. The first is the actual cumulative net issuance of banknotes, the second is the capital key calculation and the last one is the ECB's MUFA statistics estimate of cash holdings of residents living in each of the EU12 countries.

The actual cumulative net issuance of banknotes is heavily affected by migration between Euro countries and by bulk transfers of high denomination banknotes outside the euro area for Germany and Austria. For this reason the stock of banknotes put into circulation is a meaningful measure only for some Euro countries. [25]

In the capital key calculations, the total cumulative net issuance of Euro banknotes is (artificially) divided among euro area countries using the cash capita key, which is based on GDP and population. The financial accounts (MUFA) estimates are based on an economic model-fitted value, where explanatory variables for each country included GDP, interest rates, deposits etc. In most of the Euro countries, financial accounts figures give realistic figures for actual cash holdings within a country, as these figures are not affected by migration or outflow of banknotes outside the euro area. When the average return frequency is applied to these figures, we also get quite reasonable estimates of the cash usage (Table 6). These figures are also relatively close to the cash distribution model calculations.

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25 The true stock of banknotes put into circulation is not even available in the IMF monetary statistics for every Euro country, but instead the capital key based net issuance is published. Quite recently Eurostat has also suggested that capital key figures should be used for cash holdings estimates in the financial accounts.

Estimates of cash payments   Figure 5

billion Euro

Source: Statistics Finland and Federation of Finnish Financial Services.
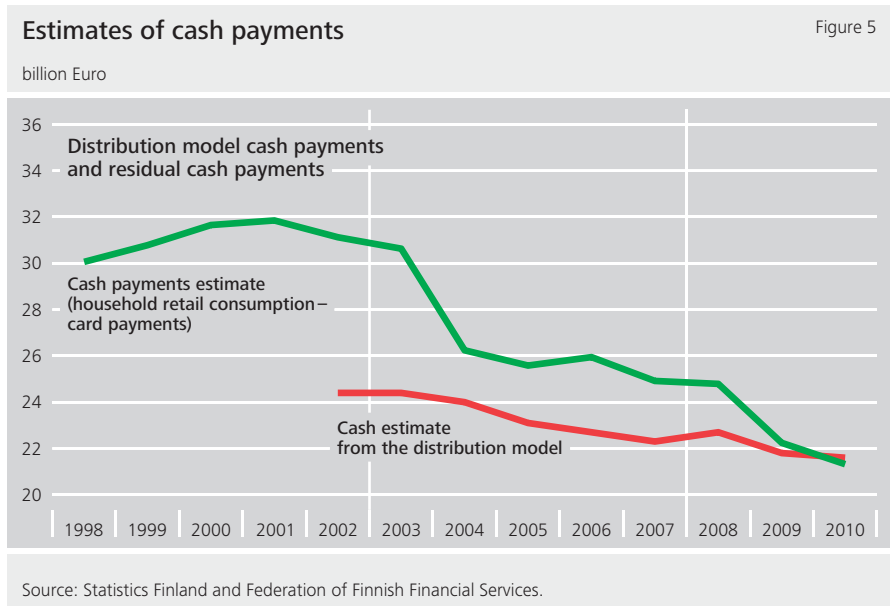
7. Evidence from Finnish micro studies

The Bank of Finland has in recent years conducted several micro studies on the use of cash. These have focused on cash holdings, withdrawal behavior and attitudes of consumers and firms towards the use of cash and the quality of cash.

Next we summarize some of these studies from the point of view of the distribution of cash holdings. The reason for this perspective is that average values may grossly understate true cash holdings. This is especially true if cash holdings are estimated on the basis of withdrawals from ATMs. Many people who visit an ATM almost daily inflate the number of withdrawals and deflate the average value of sums withdrawn. In principle, the people who withdraw just 10 or 20 Euro have so little cash that their aggregate cash holdings could be approximated by zero. By contrast, people who withdraw more than 200 Euro are of more interest from the point of view of large cash holdings.

The problem is that the use of ATMs represents only a part of cash supply, and it appears that withdrawal practices are quite different in bank offices. The difference becomes even more pronounced when we take into account that firms probably use bank offices as the main venue for cash supply.

Here we report results from three consumer surveys (Tables 7, 8 and 9) that address mainly the everyday transaction behaviour of households. In addition we report results concerning surveys on bank customers: consumers, firms and, also banks' cash operators (Tables 10 and 11). These surveys were conducted among the customers of banks (the data were collected from those who visited banks during the survey period/day). Therefore, there is an obvious sample selection bias in the results, and it is not at all clear to what extent the results can be generalized to all households and firms. With firms, the sample selection problem is much more serious, and we can do very little to correct it (cf. however, the earlier studies of Hirvonen and Viren (1996) and Viren (1996).[26]

Next, we shortly summarize the main findings in the order of the subsequent tables:

Consider the mean values. For the 2007 consumer survey, the mean value of money balances held by all consumers was 70.68 Euro. In the same survey, the mean value of cash used during one week turned out to be almost the same number (73.75 Euro). On average, people used cash 3 times a week. In the 2008 survey, the mean value of cash balances was 72.69, which corresponds well with the 2007 survey values. In the most recent 2012 survey, the average monthly withdrawal was estimated at about 400 Euro, which implies a weekly rate of 100 Euro.

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26 In this study, 1.5 billion in Finnish markka cash holdings could be located at business firms. If this number is indexed by GDP and converted to Euro, the sum would be about 500 million Euro, which is equal to about 0.25 per cent of GDP.

As for individual surveys, we add the following comments. In Table 7, for the 2007 consumer survey we observe some not so surprising findings: *ceteris paribus*, old people hold more cash than the young, and entrepreneurs and farmers have particularly large sums of money. But notice that old people do not seem to **use** more money than the rest of population. In terms of use of money, these groups are not distinguishable. By contrast, students seem to hold more money. As for the money balance – frequency of use nexus, we see that the relationship is very weak indeed. By contrast, there is quite a strong relationship between the amount of money used in transactions and the frequency of cash transactions.

Table 8, for the 2008 survey, provides more or less the same evidence as Table 7. The novel feature is that this survey is a question of the distance between home and the nearest ATM. As one might expect, the distance seems to have a positive impact on the size of cash balances, although the relationship cannot be estimated very precisely.

The 2012 survey shows that the use of ATMs and Bank office (OTC) facilities differ greatly: ATMs are used on average almost once a week while bank offices are visited only roughly twice a year. The withdrawn sums also differ widely: the estimated annual sum is 3,800 Euro from ATMs and about 1,000 Euro from bank offices. Hence the total withdrawn amount of money is about 400 Euro per month. This number is roughly consistent with the 2007 survey result (see above) that the average weekly use of cash in transactions is 73 Euro. The problem with these numbers is that the OTC channel is used so rarely that there could be a very large sampling error in our estimates due to the relatively small sample size of our survey (less than 500). The problem is especially severe for OTC withdrawn sums of cash. As revealed in the 2006 bank office questionnaires (Table 10), there may be just one or two very large withdrawals, which may completely change the estimates of mean values of withdrawn sums. In the 2012 survey, we also have the problem that exact sums are not available, so we make a subjective assessment of that

mean value for the category "withdrawn sum of money is above 2,000 Euro". Our estimate is 3,000, but equally well it could be 30,000.

As for the estimation result for the 2012 data, we refer to Table 9, which includes models for the "cash user" dummy (the respondent mainly uses cash), the average withdrawn sum of money from an ATM (wa), the corresponding annual withdrawn sum of money (way), and the average monthly withdrawn sum of money from bank offices (bank).

It seems that ATM and ORC withdrawals are not substitutes. As seen in Table 9, OTC withdrawals "depend" positively on ATM withdrawals (and, in fact, vice versa). Thus, we may say that those people who use cash more than the average generally use both channels of withdrawal. The link is not statistically significant, but at least at the qualitative level it appears to be quite persistent and robust over different estimating specifications.

Otherwise, the results follow the same pattern as in the 2007 and 2008 surveys. There is a relatively clear gender difference in the withdrawn sums of money (both ATM and OTC). The age pattern is quite clear for ATM withdrawals but – presumably due to the small sample size – not so clear for OTC withdrawals. Basically, the withdrawn sums increase with the age.

As for occupations, two heavy users can be detected: farmers and entrepreneurs; whereas students and the unemployed show the opposite pattern. Basically, the same occupational pattern applies to ATM and OTC withdrawals, but there apparently are some exceptions. Students seem to use bank offices relatively often, obviously representing the withdrawal patterns of student loans.

All in all, the results seem to follow the same patterns as for the ECB surveys for 2008 and 2009 (see ECB 2011). In our case, the main problem is the relatively small

number of observations, which in the first place shows up in the accuracy of estimates. Unfortunately, this lack of accuracy also affects the estimates of money holdings. The problem is that the distribution of money holdings (as well as withdrawals of money) is skewed and the importance of extreme observations is exceptionally large.

The questionnaires to bank customers (Tables 9 and 10) provide results quite different from those of the consumer surveys. This reflects at least two things. Withdrawals consist not only of withdrawals for everyday transaction purposes but also for exceptional (large) transactions. On the other hand, there is an obvious sample section bias in the data; the questionnaire was given only to those who visit a bank office (and who withdraw a nontrivial sum of money). It is no surprise that the withdrawn sums are large. Obviously this is true for firms, but the values for ordinary customers are also relatively high, the mean value of withdrawals being 1,133 Euro. Obviously this is due to very large outliers, but even if we eliminate all withdrawals that exceed 10,000 Euro, the average size of a withdrawal is 849 Euro (this covers to 98.5 per cent of the sample). The size distribution of OTC withdrawals is illustrated in Figure 6 (the graphs refer not only to households but also firms and bank operators' assessments of withdrawal patterns).

A somewhat striking result of the survey is that even though old people seem to take out larger sums of money pensioners are not distinguishable from other groups. Another interesting feature of the data is the withdrawal frequency does not have a very strong impact on withdrawn money amounts. There reason becomes obvious from the estimates of coefficients of the frequency dummies. Money balances seem to increase with the frequency of withdrawals, but the relationship is not monotonous. Only when we have people who take out money every day or several times within a week are (withdrawn) money balances clearly larger than normally.

For firms (Table 11) the findings are not so striking. Big firms use more cash than small firms, but industry differences seem to be relatively small, and the frequency and cash balances nexus appears quite weak (firms that take out money only once a year obviously take very small sums, but the sums do not increase monotonically with frequency. The maximum is obtained at a frequency corresponding roughly to one visit to a bank office a week.

Finally, consider the results from questionnaires for banks cash operators (notice that the sample size is only 54). The useful feature of bank officers' questions/ answers is that they basically cover all banks' customers, frequent and not-so-frequent visitors and both households and firms. According to cash officers of banks, households account for about 80 per cent of withdrawn cash and 88 per cent of visits to bank offices.

There are some interesting aspects of these results. For households, we find that according to cash operators' estimates, there is a hardly any relationship between average withdrawal size and withdrawal frequency (Figure 7). It is also interesting that when operators are asked to estimate the average size of a withdrawal the result is much larger than that derived directly by dividing the sum of withdrawn money by the number of withdrawals. In the case of households, the direct estimate for the basis of total sum of withdrawals and the total number of visits is 289 Euro. If, however, we compute the average withdrawn sum from the frequency distribution, we obtain a number as high as 2,400 Euro.[27] Their estimate of the average annual frequency of withdrawals is 34.5, which means that we obtain an estimate of 1,560 Euro for the amount of weekly withdrawals. The estimated frequency is obviously much larger than the number from the 2012 customer

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27 The number is based on the assumption that the try-values are located in the middle of the interval (i.e., 750 for the class is 501-999). Obviously this produces an upward bias to the numbers, but even if we take the lowest value for each class (i.e. 502 for class 501-999) we end up with an estimate of 633 Euro, still well above 279 Euro.

survey for households that visit a bank office at least one a year (the corresponding number is 6.3). Obviously, banks' cash officers' interpretation of their customers is quite different than their true customer population.

Cash officers were also asked for the maximum single household withdrawal from their bank office. The average value that 53 officers reported was 71,888 Euro and the median was 50,000 Euro (the maximum was 350,000 Euro and the minimum 6,000 Euro). It is clear see that survey results (with a small sample size) may change greatly even if just one such big withdrawal is included.

Firms' cash officers estimate that the average withdrawal size is 8,322 Euro and the average frequency is just over twice a month.[28] The average value of the maximum withdrawal they had experienced was 90,744 Euro (the median was 50,000 Euro, the biggest withdrawal was 535,000 Euro and the smallest 9,000 Euro). For firms, the relationship between withdrawal size and withdrawal frequency appears to be quite clearly positive, as it was in bank office survey results conducted among the firm (non-household) customers (Table 11). Thus, heavy users of cash visit banks often and withdraw large sums of money. This shows up in the distribution of withdrawal sizes and withdrawal frequencies (Figure 8). For firms, the distributions are much more skewed than for households, indicating that there is really no typical firm. The difference is especially striking in frequencies, which may simply reflect different sales/market behavior. Looking at the characterization of non-household customers (by cash officers of the banks), the most typical are tax companies, car dealers, second-hand shop owners, and so on. Thus, it is not entirely surprising that large amounts of cash are still used among certain types of companies.

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28 Again, this number is much higher than the value obtained by dividing the weekly withdrawals by the number of visits by non-households customers, 771 Euro.

According to banks' cash officers only about 14 per cent of cash withdrawn from banks non-household customers goes abroad. By contrast, about 30 per cent is simply exchange money in the form of smaller denomination notes and coin. About one half of the visits to banks are motivated by this exchange money motive, but in value terms the share is obviously smaller.

If we look at the relationship between withdrawal size and weekly number of visits to a specific bank office, we find the relationship clearly negative for both households and firms (see the lower panel in Figure 7). This probably reflects the different levels of income and perhaps age differences in terms of households. In poor locations, the withdrawn sums are smaller and frequencies greater.

Results from 2007 consumer survey							Table 7
	m	m	m	log(m)	log(m)	log(m)	use	cash user
constant	54.66 (1.94)	14.067		2.876 (8,48)	2.446 (1.73)			
use	.175 (2.36)	.201 (2.06)	.172 (2.37)	.224 (3.97)	.232 (3.41)	.230 (4.10)		
m								.193 (2.80)
frequency	-.346 (0.65)	-.143 (0.23)		-.018 (0.52)	-.033 (0.94)		.234 (6.51)	
less than once a m.			35.266 (1.25)			2.730 (7.75)		
twice a month			53.866 (1.87)			2.910 (8.27)		
twice a week			57.247 (1.95)			2.889 (7.89)		
every day			43.700 (1.31)			2.732 (6.88)		
female	-13.952 (1.52)	-12.916 (1.21)	-14.520 (1.56)	-.170 (2.92)	-.153 (1.73)	-.186 (2.49)	-4.68 (0.59)	-.275 (2.08)
age: 20-34	-2.818 (0.27)	7.594 (0.58)	-3.187 (0.30)	-.085 (0.55)	.035 (0.20)	-.111 (0.71)	.47.44 (3.21)	-.783 (2.95)
age: 35-49	-2.662 (0.17)	17.788 (1.08)	-4.399 (0.27)	.004 (0.02)	.309 (1.62)	-.028 (0.16)	52.67 (3.92)	-.495 (1.81)
age: 50-64	.35.19 (2.13)	58.061 (2.60)	32.951 (1.98)	.407 (2.24)	.686 (3.12)	.366 (2.02)	.52.85 (3.08)	-.183 (0.65)
age: >64	60.06 (2.39)	83.234 (2.42)	57.277 (2.28)	.756 (3.03)	1.000 (3.12)	.706 (2.85)	51.23 (2.58)	.111 (0.30)
student	-18.834 (0.67)	11.443 (0.69)	-20.686 (0.739	-.115 (0.41)	.180 (0.81)	-.139 (0.49)	28.25 (2.25)	.165 (0.75)
worker	-10.83 (0.41)	9.325 (0.79)	-9.431 (0.36)	-.096 (0.39)	.112 (0.70)	-.096 (0.37)	-6.72 (0.40)	.075 (0.28)

Results from 2007 consumer survey (Continued) Table 7

	m	m	m	log(m)	log(m)	log(m)	use	cash user
white-collar	-15.809 (0.63)	9.306 (0.68)	-15.434 (0.36)	-.109 (0.45)	.108 (0.64)	-.117 (0.46)	-13.87 (0.83)	-5.81 (2.01)
farmer	34.445 (1.07)	49.045 (1.66)	35.292 (1.08)	.738 (2.31)	.862 (2.91)	.691 (2.11)	-10.86 (0.36)	-.685 (0.96)
entrepreneur	104.083 (2.13)	154.152 (3.15)	104.482 (2.14)	.622 (1.97)	.972 (3.07)	.617 (1.89)	-12.40 (0.45)	-.121 (0.33)
pensioner	-22.515 (0.79)	-19.490 (0.80)	-21.409 (0.76)	-.331 (1.22)	-.347 (1.36)	-.329 (1.18)	-19.85 (1.06)	-.153 (0.47)
house-wife	-33.775 (1.27)	-19.705 (0.98)	-34.717 (1.23)	-.214 (0.69)	-171 (0.57)	-.247 (9.78)	-25.05 (0.61)	.127 (2.16)
unemployed	-33.775 (1.27)	-1.700 (0.12)	-35.763 (1.26)	-.374 (1.37)	-.061 (0.32)	-.388 (1.39)	-0.45 (0.02)	.173 (0.51)
cash user	23.311 (1.73)	17.698 (1.01)	23.179 (1.71)	.218 (2.18)	.255 (2.11)	.266 (2.47)		
R^2	0.193	0.176	0.195	0.261	0.236	0.266	0.181	
SEE	91.87	92.79	91.90	0.737	0.749	0.736	80.56	0.447
n	478	478	478	478	478	478	487	
weighted	no	yes	no	no	yes	no	no	probit

Dependent variable: m = amount of cash held at moment of interview, use = amount of cash used within a week and cash user = respondent uses mainly cash (dummy variable)

Results from 2008 consumer survey

Table 8

	m	m	m	log(m)	log(m)	n	cash user
constant	49.55 (1.82)	87.92 (2.51)	89.04 (2.51)	3.527 (10.14)	4.116 (8.64)		
distance to ATM	1.04 (1.17)	1.18 (1.26)	1.09 (1.24)	.020 (0.88)	.026 (0.96)	1.06 (2.12)	-.007 (0.57)
female	-22.23 (3.26)	-9.53 (1.55)	-17.85 (1.98)	-.135 (2.59)	-.022 (0.39)	-22.05 (3.22)	-.221 (1.46)
age: 20-34	-8.57 (0.80)	2.91 (0.53)	-4.68 (0.43)	-.096 (0.87)	.054 (0.60)	2.69 (0.27)	-2.408 (2.19)
age: 35-49	7.98 (0.60)	14.39 (1.83)	8.58 (0.67)	.123 (0.98)	.228 (1.99)	14.80 (1.17)	-1.396 (1.29)
age: 50-64	18.04 (1.25)	32.55 (3.51)	18.39 (1.28)	.223 (1.70)	.387 (3.18)	24.69 (1.79)	-1.365 (1.26)
age: >64	19.73 (0.81)	33.27 (1.40)	18.77 (0.78)	.346 (1.96)	.462 (2.56)	26.32 (1.10)	-1.004 (0.90)
pensioner	43.31 (1.41)	-17.90 (0.45)	31.00 (0.96)	.304 (0.88)	-.502 (1.04)	85.97 (3.83)	1.012 (0.92)
director	109.21 (2.02)	39.99 (0.60)	101.03 (1.84)	.879 (2.00)	-.093 (0.15)	151.97 (3.09)	-.980 (0.63)
housewife	8.20 (0.31)	-47.30 (1.31)	-4.68 (0.16)	.049 (0.13)	-.708 (1.41)	51.14 (3.34)	.704 (0.57)
farmer	105.96 (1.46)	-35.44 (0.89)	91.78 (1.29)	.641 (1.37)	-.411 (0.79)	168.47 (2.12)	1.344 (1.12)
student	-0.56 (0.02)	-54.51 (1.59)	-14.29 (0.51)	-.014 (0.04)	-.800 (1.70)	46.04 (5.69)	.776 (0.69)
white-collar	6.80 (0.27)	-60.80 (1.80)	-3.75 (014)	.036 (0.11)	-.881 (1.90)	49.64 (3.77)	.014
worker	11.05 (0.45)	-52.02 (1.54)	-0.17 (0.01)	.114 (0.34)	-713 (1.53)	54.12 (4.21)	.512 (0.47)
unemployed	7.23 (0.27)	-32.60 (0.89)	-7.21 (0.25)	.138 (0.40)	-.375 (0.74)	50.34 (3.39)	1.404 (1.25)
entrepreneur	76.52 (2.25)	-3.48 (0.09)	66.67 (1.86)	.510 (1.43)	-371 (0.76)	119.22 (4.45)	.576 (0.51)
cash user			-15.85 (1.98)				
R²	0.096	0.075	0.103	0.117	0.925	0.095	0.279
SEE	110.54	111.82	110.73	0.813	0.824	10.53	0.429
n	990	990	990	990	990	990	1009
weighted	no	yes	no	no	yes	no	probit

Dependent variable: m = amount of cash held at moment of interview. cash user = respondent uses mainly cash (dummy variable).

Results from 2012 consumer survey

Table 9

	cash user	wa	way	way	wb	wb	wb
frequency		-.310 (4.23)			.168 (2.67)	.189 (3.00)	.152 (2.71)
female	.010 (0.07)	-.266 (3.37)	-1.113 (2.57)	-1.725 (2.31)	-.572 (2.00)	-.506 (2.00)	-.340 (1.46)
age <20	-1.370 (1.90)	-.215 (1.58)	-2.307 (2.47)	-2.021 (1.40)	.086 (0.19)	-.279 (0.51)	.097 (0.20)
age: 20-34	-2.206 (3.71)	-.153 (1.25)	-1.910 (2.60)	-.807 (0.53)	-.21 (0.62)	-278 (0.76)	-.007 (0.02)
age: 35-49	-1.388 (2.47)	.205 (1.87)	-.503 (0.73)	-.784 (0.93)	.825 (1.72)	.777 (1.41)	1.118 (2.21)
age: 50-64	-1.215 (2.21)	.216 (5.83)	.010 (1.00)	.100 (6.61)	-.840 (2.67)	-.095 (3.00)	-.078 (2.81)
age: >64	-1.163 (1.98)	.296 (1.59)	.715 (0.83)	.953 (1.03)	.120 (0.27)	-.143 (0.36)	.062 (0.21)
pensioner	.678 (1.94)	.154 (8.50)	4.772 (8.06)	5.094 (7.20)	.835 (2.94)	.808 (2.69)	.388 (1.54)
director	..	.112 (5.12)	6.998 (2.41)	8,617 (1.83)	-.006 (0.01)	-.041 (0.11)	-.481 (1.10)
housewife	.800 (1.00)	.125 (4.79)	4.602 (4.98)	4.886 (4.15)	.569 (1.13)	-.508 (1.06)	.068 (0.15)
farmer	-.093 (0.12)	.197 (4.59)	6.545 (4.29)	5.916 (4.42)	1.582 (1.51)	1.327 (1.50)	1.148 (1.28)
student	.096 (0.14)	.084 (1.59)	4.236 (4.71)	3.713 (2.77)	.609 (1.37)	.666 (1.32)	.281 (0.63)
white-collar	.180 (0.32)	.113 (10.07)	4.763 (7.28)	5.831 (4.81)	.435 (1.04)	.315 (0.84)	-.073 (0.20)
worker	.681 (1.22)	.107 (9.35)	5.550 (7.60)	5.311 (6.27)	.619 (1.47)	.726 (0.84)	.430 (0.85)
unemployed	.801 (1.23)	.091 (5.02)	7.009 (2.85)	6.558 (2.89)	-.525 (1.60)	-.335 (0.95)	-.747 (1.76)
entrepreneur	.843 (1.40)	.118 (4.97)	4.614 (4.64)	4.586 (3.39)	2.377 (1.74)	-.041 (0.11)	1.671 (1.58)
wa*fa							.002 (0.94)
R^2		0.240	0.925	0.067	0.080	0.103	0.097
SEE	0.373	0.792	0.464	0.471	0.306	0.307	0.282
n	413	474	474	474	477	477	450
weighted	no	no	no	yes	no	yes	yes

Dependent variable: wa = usual amount of cash withdrawn from ATMs, way = wa*fa = amount of cash withdrawn from ATMs during one year and wb = amount of cash withdrawn from a bank office in one month.

Results from 2006 survey of bank office consumers (households)

Table 10

	wb	Wb	log(wb)	wb	nb
annual frequency = 2	.745 (5.08)	-1.980 (1.97)	4.743 (12.45)		
annual frequency = 4	1.439 (2.61)	-1.344 (1.34)	4.834 (13.68)		
annual frequency = 10	.549 (17.01)	-1.855 (1.89)	4.644 (13.46)		
annual frequency = 30	.740 (3.54)	-1.622 (1.69)	4.965 (14.61)		
annual frequency=45	1.677 (3.95)	-1.068 (1.349	5.102 (14.80)		
annual frequency = 120	1.766 (10.24)	-1.133 (1.34)	5.170 (14.92)		
annual frequency = 360	2.685 (6.29)	-1.122 (1.08)	5.203 (14.72)		
male		.334 (3.49)	.211 (5.02)		6.749 (1.68)
age: 20-34		.760 (1.13)	.155 (0.62)		67.3 (1.73)
age: 35-49		.761 (1.12)	.378 (1.51)		12.62 (0.31)
age: 50-64		.702 (1.04)	.259 (1.03)		-26.85 (0.68)
age: >64		1.119 (1.33)	.290 (1.12)		-30.67 (0.78)
worker		1.137 (2.14)	.832 (7.13)	104.9 (13.95)	86.9 (2.01)
pensioner		.831 (5.95)	.776 (10.71)	40.9 (21.95)	72.6 (1.67)
white-collar		1.466 (2.68)	.923 (8.41)	94.8 (11.52)	89.9 (2.04)
entrepreneur		2.861 (2.16)	1.198 (8.33)	90.8 (7.84)	85.1 (1.92)
unemployed		1.119 (1.94)	.631 (3.49)	41.7 (4.63)	48.2 (1.10)
farmer		.942 (2.09)	.734 (4.42)	43.7 (2.53)	63.9 (1.35)

Results from 2006 survey of bank office consumers (households) (Continued)   Table 10

	wb	Wb	log(wb)	wb	nb
house-wife		1.934 (1.51)	1.186 (3.16)	62.6 (2.59)	51.6 (9.93)
student		.767 (0.98)	.465 (2.42)	151.4 (5.83)	109.4 (2.86)
purchase of car		5.782 (6.09)	1.780 (6.61)		88.7 (3.03)
vacation		.357 (1.45)	.376 (1.67)		21.9 (0.86)
liquidity		.014 (0.07)	-.055 (0.25)		-13.0 (0.54)
other purchase		.395 (1.73)	.311 (1.40)		12.4 (0.51)
transport		1.252 (2.73)	.884 (3.03)		93.8 (2.63)
transfer		.430 (1.53)	.544 (2.08)		31.9 (1.08)
other		.468 (1.95)	.237 (1.07)		8.46 (0.35)
saving		.136 (0.52)	.150 (0.60)		-18.8 (0.76)
present		.351 (1.16)	.175 (0.67)		26.5 (0.91)
auction		2.165 (1.80)	1.084 (2.18)		.36.7 (0.64)
purchase of house		7.521 (1.55)	1.002 (1.22)		.34.1 (0.94)
import of goods		.492 (0.86)	.485 (0.63)		110.6 (2.34)
R²	0.040	0.215	0.306	0.104	0.345
SEE	3.269	2.987	0.831	87.99	81.34
N	1738	1738	1738	1744	1743

Dependent variable: wb = amount of cash withdrawn from bank account, nb = frequency of cash withdrawals in one year.

Results from 2006 survey of bank office consumers (firms)				Table 11
	Wb	**log(wb)**	**wb**	**nb**
small company	2.540 (1.45)	6.601 (14.00)		2.822 (17.28)
medium size company	3.598 (1.88)	6.826 (15.75)		2.915 (17.63)
large company	12.105 (1.12)	6.966 (11.81)		2.939 (9.71)
size not known	1.082 (0.54)	6.561 (11.34)		3.539 (4.74)
agriculture	-2.522 (1.57)	-.499 (1.62)		.404 (0.53)
industry	-2.710 (0.66)	.418 (1.09)		.448 (1.76)
construction	-.679 (0.33)	.745 (2.79)		.327 (1.65)
commerce	.115 (0.04)	.887 (3.05)		.524 (2.47)
transport	-1.144 (0.33)	.163 (0.33)		.336 (1.23)
frequency = 1	-1.813 (1.11)	-.211 (0.50)	.800 (4.35)	
frequency = 6	-.482 (0.32)	-.033 (0.09)	2.909 (5.01)	
frequency = 12	.942 (0.63)	.247 (0.56)	3.702 (4.56)	
frequency = 60	1.939 (0.83)	.153 (0.38)	5.528 (3.68)	
frequency=360			3.811 (3.67)	
global firm			-1.031 (0.81)	
R^2	0.055	0.099	0.011	0.044
SEE	12.259	1.368	12.163	1.052
n	197	197	197	197

wb = withdrawn sum of cash and nb = withdrawal frequency.

Distribution of OWC withdrawals

Figure 6
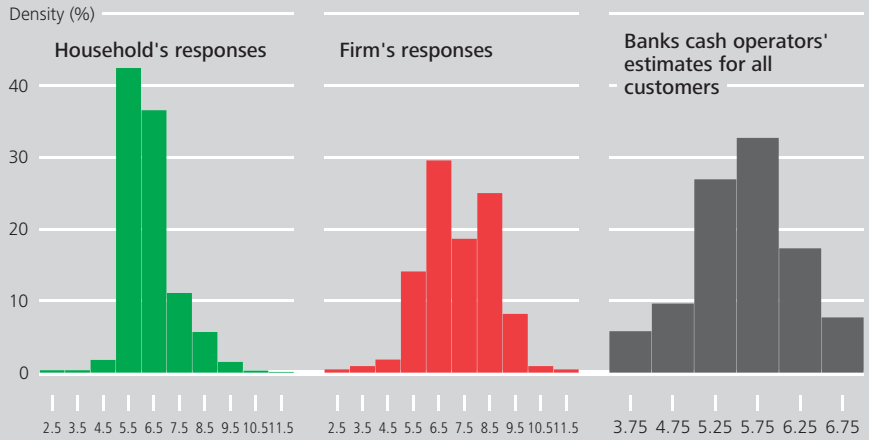
Graphs are based on log values, corresponding mean values are 1133, 3857 and 335, respectively.

Cash operators' estimates of the OTC withdrawal sizes and frequency

Figure 7

The first two graphs are based on banks' cash operators' estimates of average size of cash withdrawals (ws) and average cash withdrawal frequency of customers (n) in different bank offices. The upper panel represents house-holds and the lower firms. (for households ws = .515 − .045*n, R^2 = 0.119 and for firms ws = 7.357 + .409*n, R^2 = 0.202.) All values represent individual bank offices. The two latter graphs represent actual values of with-drawal size and volume (number) of withdrawals in individual bank offices based on household-non household distinction.

Banks' cash operators' estimates of average withdrawal frequencies and average withdrawal sizes

Figure 8
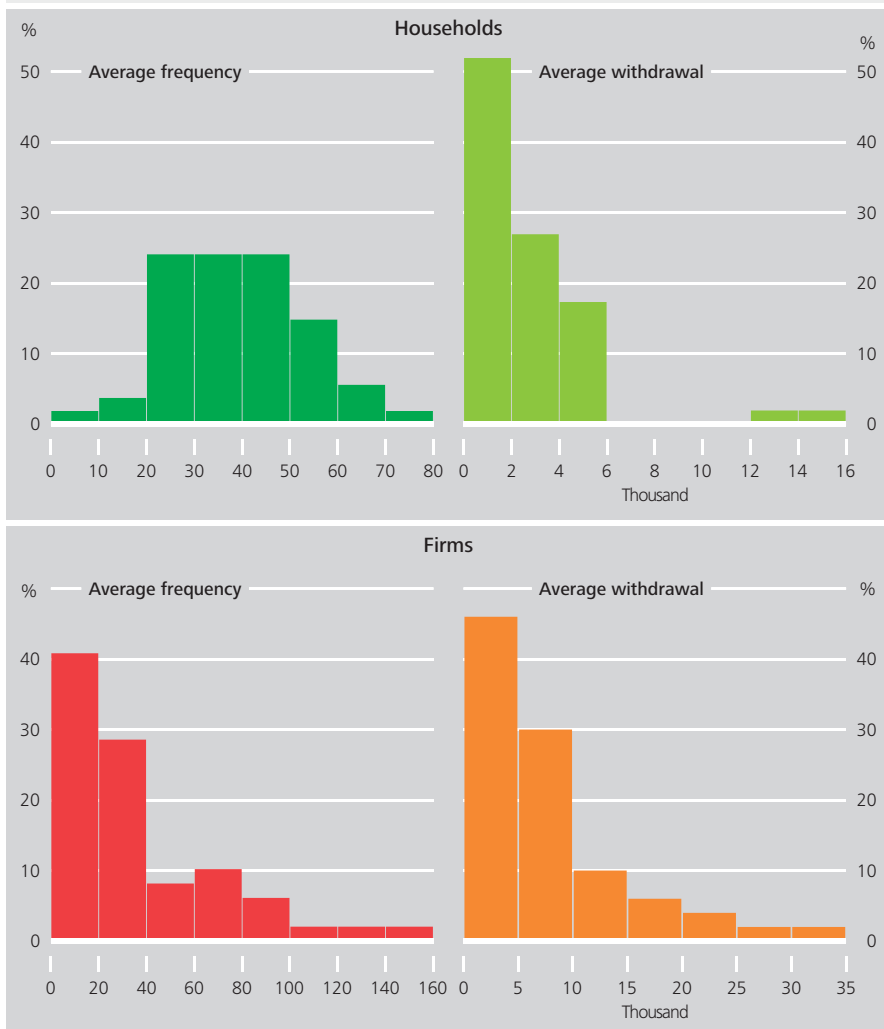
In the questionnaires, banks' cash operators were asked to provide data on household's and firms' withdrawals and withdrawal frequencies and on operator's subjective assessment of the distribution of withdrawals in terms of size of withdrawal and frequency of withdrawals of different customers (these later data are used in the figure) All values represent individual bank offices.

8. Conclusions

The aggregate use of cash is difficult to measure accurately. However, it is important or at least interesting to follow the development of cash payments in contrast to card payments. For most euro countries, there are no estimates of the volume or value of cash payments. In this paper, we have proposed a simple calculation scheme to estimate the public use of cash by tracking the primary sources of banknote distribution to the public. We suggest that we can approximate overall cash usage by summing up the ATM and OTC distribution of banknotes. In addition we must take into account that cash can be recycled by the public. Cash can be used and recycled between households (consumers) or between companies (B2B), as both of these sectors make cash transactions within the sector. Unfortunately, we do not have any reliable data about the extent of this recycling, so we have simply assumed recycling rates for them.

Consumers most often withdraw their cash from ATMs and in some euro countries also as OTC withdrawals from banks' branches. The total value of ATM distribution of banknotes is published in the ECB statistics, but the distribution of cash to the public over the bank counters is available only for some euro countries. This complicates our estimation. As for many euro countries, OTC withdrawals of banknotes were not available, we estimated the OTC distributions estimates based on either CIT deliveries of banknotes to bank branches or NCB withdrawals of banknotes, again assuming CI or CIT recycling rates to take into account the same physical banknotes taking part in the transactions.

For the EU12 countries, our cash usage estimates have been relatively stable at around 2400 billion Euro in 2007-2009. This is based naturally on the stability of ATM and OTC cash withdrawals, but it also depends on the reliability of OTC withdrawals data. For a couple of countries, the data may raise questions. For 2010, the euro area cash usage estimate shows a slight decrease. The cash usage calcula-

tions have been aggregated from country-specific data. In our calculations, we used rough assumptions of the recycling rates, as there is no current official statistics on the recirculation of banknotes. However, the ECB has already started to collect data on recycling of banknotes via NCBs from professional cash handlers in relation to the banknote recycling framework that could be used later in assessing cash recycling rates. Of course questionnaires can be used as well for calculating recycling rates.

The cash distribution estimates of cash usage were also briefly compared with the available estimates of the cash usage from Germany, the Netherlands and Finland. We also compared the estimates with other measures of cash usage, combining the return frequency of banknotes with different estimates of cash holdings and cumulative net circulation. Even if the range of estimates is rather large, this study used one method for tracking the use of cash over time, which is valuable for assessing trends in the cash cycle. So the cash distribution procedure at least gives us some ground for comparing the use of cash in retail payments over the euro area.

Analyses with the questionnaire data from Finland showed that the cash cycle estimates seem to be largely consistent with the available micro data. These data suggest that there are huge differences between different households and firms in terms of cash withdrawal behaviour. Thus average values do not necessarily give a solid basis for estimating the money balances in the economy. For firms, this problem is even more obvious, as the sampling errors can be much more important. The useful thing in the survey studies is that both ATM and bank office customers can be simultaneously compared and the total money balances can be estimated more precisely.

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Alessandro Calza and Andrea Zaghini
Welfare costs of inflation in the euro area

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1. Introduction

The statement that inflation is costly can hardly be questioned. The features of the costs of inflation have been systematically investigated by the literature and found to be of both economic and social nature. In particular, welfare costs linked to high and volatile inflation include high risk premia, the distorsive interaction between inflation and the tax code, the inefficient distraction of resources from production of goods to financial activities, lower capital accumulation and the arbitrary redistribution of wealth (see for instance Friedman 1969, Driffill et al. 1990 and Fischer 1995). However, few reasons have been put forward in favour of maintaining a positive inflation rate. Nowadays, central banks of major advanced economies are

pursuing an objective of price stability implying a low but still positive inflation rate over the reference horizon.[1]

A common way to measure the welfare cost of inflation is the approach proposed by Bailey (1956): the area under the (inverse) money demand function. This measure estimates the costs arising from a specific source of inflation-related costs (the so called "shoe-leather costs") which are associated to the inefficient management of agents' monetary holdings due to high inflation. Given that higher nominal interest rates increase the opportunity cost of holding money and assuming that monetary balances yield direct utility via liquidity services, the rationale underlying the shoe-leather costs is that higher expected inflation – via its impact on nominal interest rates – will lead agents to inefficiently economizing on their monetary balances.

The monetary aggregate most used in literature to compute the shoe-leather costs is M1 (the sum of currency in circulation and overnight deposits), which indeed represents a close empirical counterpart of the notional monetary balances featuring in the theoretical models of the demand for transaction balances. However, official M1 series provided by central banks are affected by measurement errors that are relevant for the computation of welfare costs. In fact, M1 series include all currency circulating outside banks regardless of the country of residence of the holder, thus mixing domestic and foreign holdings (see Prescott, 1996). Large currency holdings abroad may potentially lead to mis-specification of the money demand equation used for the computation of social welfare. In addition, not controlling for the foreign circulation of domestic currency may lead to overestimating the welfare costs accruing to domestic agents as a result of domestic inflation. When a substantial part of the domestic currency is held abroad the desirability of implementing the Friedman rule of zero inflation (or zero nominal rate) should be questioned (Schmitt-Grohé and Uribe, 2009).

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1 For a general survey about pros and cons of inflation see Issing et al. (2001).

The distortions implied by not disentangling domestic and foreign monetary holdings have started to be increasingly relevant in several countries. For instance, the FED's official estimates published in the Flow-of-funds accounts show that foreign hoardings of US dollar currently account for around 40% of total currency in circulation; Leung et al (2010) estimates that between 50% and 70% of the Hong Kong dollar in circulation in 2009 was held abroad; Bartzsch et al (2011) hint that in 2009 German euro banknotes outside the country (euro area) account for around 63% (46%) of all currency issued by the Deutsche Bundesbank.

The aim of this paper is twofold. First, we propose an estimate of the euro area money demand which is adjusted by currency held abroad. In particular, we use data after the introduction of the euro banknotes at the monthly frequency. Secondly, we compute the welfare costs of inflation by taking into account both domestic and foreign seigniorage.

2. Currency abroad and welfare

Our empirical exercise is based on estimates of the demand for the narrow monetary aggregate M1 adjusted for the circulation of the euro currency abroad over the 9 years from 2002 to 2010.

Official data of the notional stock of M1 are available at the monthly frequency and on a seasonally adjusted basis from the Statistical Data Warehouse of the ECB. However, as already mentioned, official data include all currency circulating outside MFIs, regardless of the country of residence of the holder. Therefore, they usually provide an upward-biased measure of the holdings of currency by domestic agents. In order to correct the data for this measurement error, we need an equally long time series of the estimated value of the euro currency circulating abroad.

A study by Porter and Judson (1996) reviews a number of methods that can be used to estimate the amount of currency circulating abroad. Most of these methods, unfortunately, are based on the seasonal technique and can be used to generate reliable estimates only at the annual frequency; others, instead, provide estimates at irregular points in time (e.g., the monetary demographic model). One exception is the shipments-proxy method proposed by Feige (1994, 1997), which has been implemented also by the ECB to generate monthly estimates of the amount of the euro currency held by non-euro area residents.[2]

The shipments-proxy method focuses on the net shipments abroad of domestic currency banknotes. For the euro area is the sum of individual country statistics with respect to non-euro area countries. In particular, considering only the net-exporter countries, the leader is Germany with a share of total net export of 76%, followed by France with 13.5% and Italy with 6.4%. The strongest net importer is Austria, with a negative share of around 30%. The ECB itself however warns that the use of euro banknotes outside the euro area cannot be estimated precisely. The estimate of the amount of euro banknotes circulating abroad that is published regularly on "The international role of the euro" is most likely downward biased. Indeed, the published data is considered to be a lower bound, given that the banking channel is only one of a number of channels for euro banknotes shipped outside the euro area: anecdotal evidence suggests that the outflows of euro banknotes via non-MFI channels as tourism or workers' remittances are often greater than the backflow via non-bank channels.

As Figure 1 shows, according to the shipments-proxy approach, the share of the euro currency circulating abroad has tended to rise over the past few years. In particular, it increased gradually after the cash change-over in 2002 and then

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2 The Federal Reserve Board in its Flow of Funds Accounts provides estimates of US dollar circulating abroad since 1996 using the same method.

stabilized over the period 2005-2006. After the collapse of Lehman Brothers it increased steeply to stabilized again at just below 110 billion when the financial crisis hit the sovereign bond market of some euro area countries. At the end of 2010 euro banknotes estimated to be in circulation outside the euro area amounted to 13% of the total euro area currency in circulation. However, taking into account ECB suggestions the share could actually be as high as 25%. As a comparison, in the US official estimates (based on the shipments proxy approach) suggest that dollars circulating abroad amount to around 40% of total circulation, but at the same time the FED warns that it might be as high as 60%.

ECB estimates of the euro currency held abroad   Figure 1

Cumulated Euro banknote shipments, seasonally adjusted

ECB estimates of the Euro currency held abroad
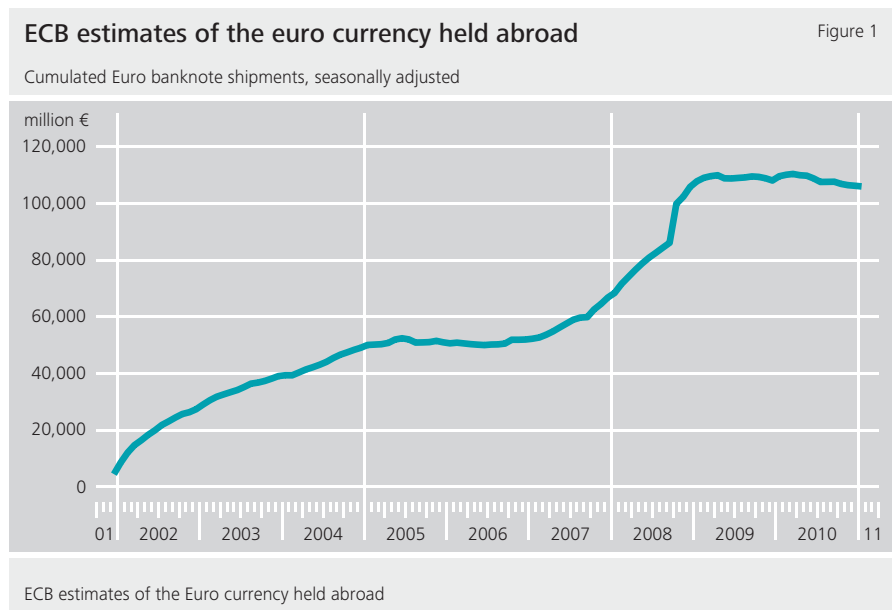
Regardless of whether including or excluding currency held abroad from the monetary aggregate, empirical works usually assume that the domestic demand for real balances is a function of a reference interest rate *(r)* and a measure of the volume of transactions *(y):* $M_t/P_t = L (r_t, y_t) = m (r) y$. However, not considering

money abroad may lead to inaccurate estimates of the money demand and, most likely, to upward biased estimates of the domestic welfare cost of inflation. This because Bailey's measure of shoe leather costs assumes that money is held entirely by residents. In particular, the Bailey's "welfare triangles" obtained as integrals of the inverse money demand function on the interval [m(r); m(0)], are corrected for the revenue accruing from seigniorage:

$$w(r) = \int_0^r m(x)dx - rm(r) \tag{1}$$

where m(x) denotes the money demand function. However, as noted by Calza and Zaghini (2011), in the presence of foreign holdings of the domestic currency, the correct specification of the welfare costs becomes:

$$w(r) = \int_0^r m^h(x)dx - rm(r) \tag{2}$$

where m^h is the demand function for domestic monetary holdings, while m refers to the total amount of money issued (i.e. also including currency holdings abroad). Indeed, while domestic residents only incur utility losses to the extent that their own demand for monetary services is distorted by inflation, the government obtains seigniorage revenues from the entire amount of money that is issued, regardless of the country of residence of its holders.

Euro area money demand (1996–2010)   Figure 2
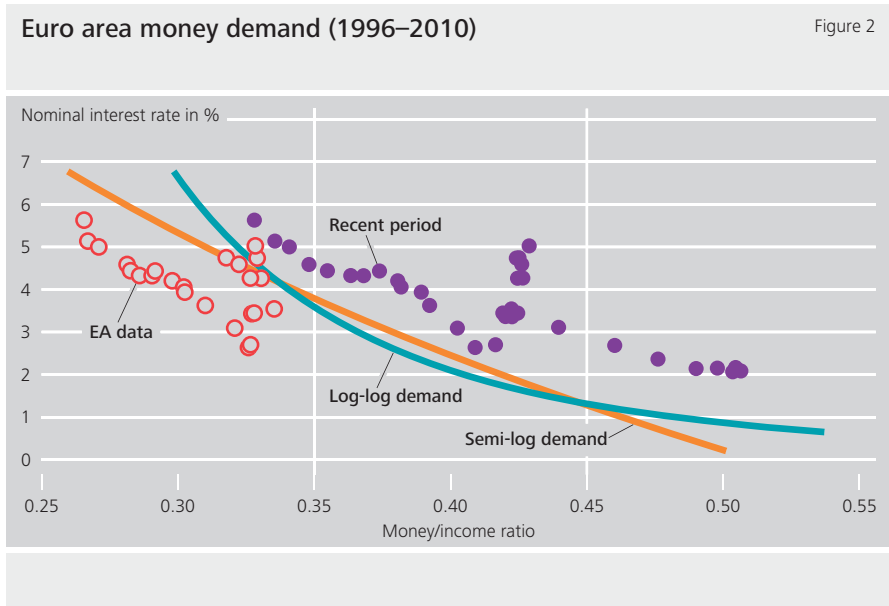
Figure 2 depicts the scatter plot of quarterly euro area money-income ratio with respect to interest rate from 1996 to 2010 and two estimated money demand functions. In particular, data from the decade 2001-2010 are depicted in bold. While it is diffcult to say anything about the elasticity of the money demand with respect to the nominal interest rate (the steepness of the curves), it is clear that data concerning the most recent period lay further away on the right hand side with respect to earlier quarters. Thus, even without any consideration of the currency held abroad, it seems it is worth investigating the most recent period: as suggested by the scatter plot, money demand might have well adjusted to the new economic framework of euro banknotes. In addition, the crisis years are clearly visible in Figure 2, since the increase in the short-run nominal interest rate (both EONIA and Euribor) happened in a context of relatively stable money/income ratio determining a sort of vertical clustering of data. In the rest of the paper we first propose an estimate of the money demand of euro area residents over the past

decade which does not include currency abroad, and then we compute the welfare cost of inflation reflecting both domestic demand and foreign seigniorage.

3. Empirical estimates

3.1 Adjusted money demand

Equilibrium money demand relationships are conventionally estimated in a cointegration analysis framework (see Sriram, 2001; Coenen and Vega 2001, Duca and van Hoose, 2004). As a preliminary step, the statistical properties of the variables (both in level and in log format) are examined using standard unit root tests (augmented Dickey-Fuller and Phillips-Perron) as well as the KPSS stationarity test. The results - not reported for the sake of brevity – suggest that over the sample period from January 2002 to December 2010 all the variables can be modelled as I(1) in levels.

Focusing on a semi-logarithmic specification of the money demand we run several cointegration tests, obtaining mixed evidence supporting the possibility of a long-run relationship between the money ratio and the nominal interest rate. Two tests are supportive of cointegration (Zivot and Johansen) at the conventional statistical levels, while the Philips-Ouliaris test does not rejects the null of no-cointegration.

Bearing in mind the possibly weak long-run statistical properties of the aggregate money demand, in Table 1 we report the estimated equilibrium relationship between the ratio of money to GDP (adjusted for currency abroad) and the nominal interest rate (3-month Euribor) using three alternative single-equation estimators: (1) standard OLS; (2) the Engle and Yoo's (1991) "three-step"approach to the Engle-Granger estimator; and (3) the dynamic OLS method by Saikkonen (1991).[3]

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3 The lags and leads of the estimates are selected using the Schwartz Information Criterion.

Estimated long-run interest rate coeffcients		Table 1
	$\ln(M=Y) = B - \xi r$	
	B	ξ
OLS	0.4457	3:9507*** (0:785)
EY(1)	0.4460	4:128** (1:860)
DOLS(1,1)	0.4473	4:078** (1:748)

Note: Standard errors in parentheses. *, **, *** denote statistical significance at the 10%, 5% and 1% critical levels, respectively. Number of lags (and leads for DOLS) in levels are reported next to the estimator. Newey and West robust standard errors.

Regardless of the estimation procedure employed, the estimated longrun interest rate semi-elasticity is statistically significant at the conventional levels. In addition, both sign and magnitude of the coeffcients are consistent with the interpretation of the cointegrating vectors as equilibrium money demand relationships.[4]

3.2 Domestic welfare costs of inflation

The coeffcients in Table 1 define the horizontal position and curvature of the money demand function adjusted for currency abroad $m^h(r)$ and must be substituted in (2) to estimate the consumer surplus lost by euro area agents because of a positive nominal interest rate.[5] Figure 3 shows the shoe-leather costs net of

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[4] The values for the intercept are calibrated as in Lucas (2000) so that they equal the average value over the sample of $me^{-\xi r}$.

[5] Note that in order to compute the seigniorage revenues, we also need to substitute in (2) the para-meters of m(r), the money demand estimated over the same time period for the whole M1 (i.e. including currency abroad).

total seigniorage revenues for different levels of the nominal interest rate obtained via the various estimates of $m^h(r)$ reported in Table 1.

As usual, the shoe-leather costs are convex in the nominal interest rate but, interestingly, for values below $r = 2\%$ the function lies below the X-axis. Thus, our estimates suggest that the welfare costs associated with very low nominal interest rates are not only small, but actually slightly negative. In particular, welfare costs are minimized at a value of the nominal interest rate around 1 per cent.

Welfare costs for different estimates of m^h Figure 3
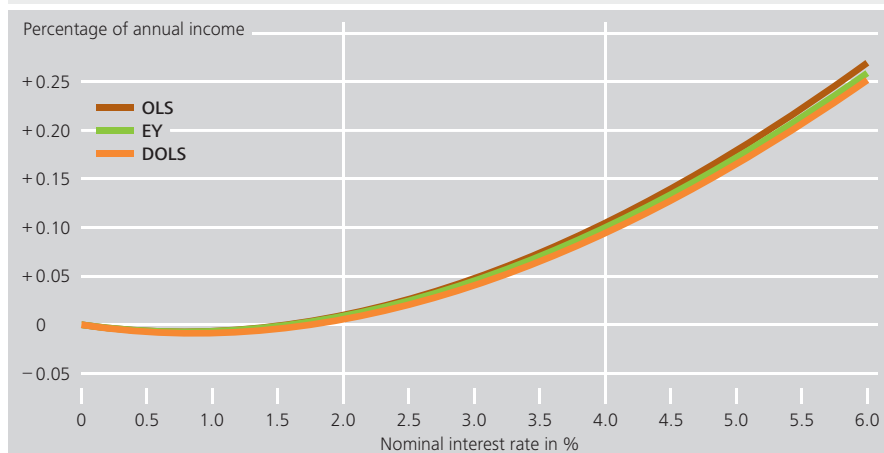
Welfare costs for different estimates of mh

Negative values of the shoe-leather costs are not intuitive, but can be explained by the existence of foreign demand for euro currency. In fact, in a closed economy, and assuming that money provides utility-enhancing liquidity services, the shoe-leather costs are non-negative and increase with the steady-state inflation rate.

However, in the presence of substantial foreign demand for domestic currency, the welfare costs can become negative if, for some levels of inflation, the disutility to domestic agents stemming from positive inflation is more than offset by the associated transfer of resources from abroad. In other words, the loss to domestic agents because of the money demand distortions is more than compensated by the seigniorage revenues from foreign holders of domestic currency.

This result is consistent with the model proposed by Schmitt-Grohé and Uribe's (2009) which suggests that, when the share of the domestic currency circulating abroad is very large, optimal policy may involve deviations from the Friedman rule. The targeting of positive inflation rates would be the choice of the domestically benevolent government which finds it optimal to impose an inflation tax as a way to extract resources from the rest of the world in the form of seigniorage revenue.

At the empirical level, a similar but stronger results is obtained for the US by Calza and Zaghini (2011). They find a broader range for the nominal interest rate for which the transfer from abroad allows negative shoe-leather costs. In particular, welfare cost of inflation are minimized at the 5% level of the nominal interest rate.

In order to illustrate more in details the effect of the inflation tax on foreign holders of euro currency, Figure 4 reproduces the baseline shoe-leather cost function based on the OLS estimates together with a function obtained under the counterfactual of no foreign demand for the euro currency. In practice, we estimate this shoe-leather cost function by substituting $m^h(r)$ for $m(r)$ in the second term of the formula of the welfare triangle (2): This is equivalent to treating the euro area as a closed economy and using the seigniorage revenues that the government extracts at home only (instead of total seigniorage revenues) to compute the welfare costs of inflation. For comparison purposes, we also include a shoe-leather costs function based on monetary data unadjusted for foreign holdings.

Welfare costs and seigniorage revenues

Figure 4

Percentage of annual income

Legend:
- Unadjusted for currency abroad
- Net of domestic seigniorage
- Net of total seigniorage

Nominal interest rate in %
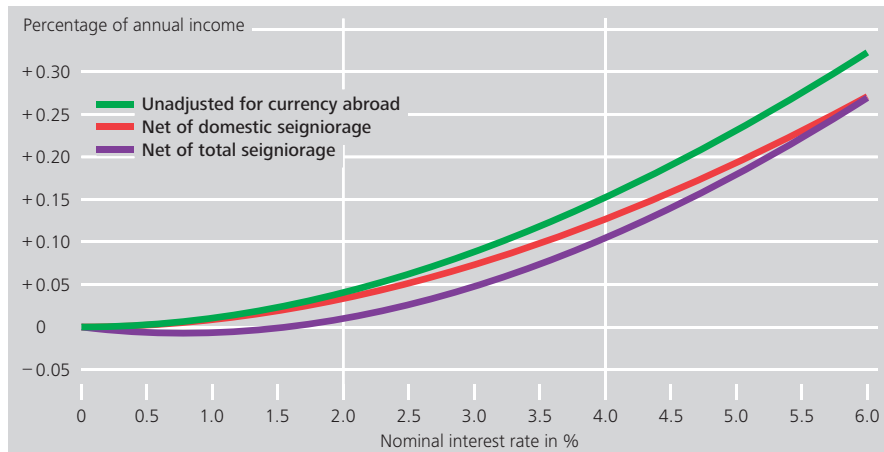
The difference between our baseline shoe-leather cost function (violet) and that obtained under the counterfactual of zero foreign demand for the euro currency (red) provides information on the magnitude of the inflation tax on foreign residents. As expected, under the counterfactual scenario, the shoe-leather costs are non-negative and, consistent with the Friedman rule, are minimized for $r = 0$. However, for relative high levels of the nominal interest rate, the functions under the baseline and counterfactual scenarios converge as the utility losses to domestic agents from rising inflation increasingly offset the transfer of real resources from abroad. The shoe-leather cost based on unadjusted data (green) are higher, suggesting that the failure to account for the circulation of euro banknotes abroad leads to a non-negligible overestimation of the welfare costs of inflation arising from money demand inaccurate estimation.

3.3 Robustness analysis

We run several robustness checks but results were not significantly affected. First we use the EONIA rate instead of the 3-month Euribor, maintaining the same semi-log specification. We then tried an unconstrained version of the money demand function of the type:

$$\log(m) = \log(B) + \beta \log(y) - \xi r \qquad (3)$$

The estimated values of the interest rate semi-elasticity are in line with those reported in Table 1 and consistent with a long-run money demand function. In addition, negative values of the shoe-leather costs appear again at low levels of the nominal interest rate.

4. Concluding remarks

Overall, our results suggest that the fact that a non-negligible share of the euro currency is held abroad has important implications for the computation of the welfare costs of inflation for domestic agents. After adjusting offcial M1 data for the estimated holdings of currency abroad, we obtain an estimate of the domestic shoe-leather costs which is significantly lower than when considering the whole M1 aggregate. In addition, it is likely that our calculations might err on the high side because of two factors: (1) we use estimates of the foreign hoardings of euro banknotes that are believed to underestimate the true amount of currency abroad, and (2) we assume that the deposits included in M1 are entirely not remunerated, which may lead to overestimating the distortions to money demand caused by inflation (Cysne and Turchick, 2010).

The fact that welfare costs may become negative implies a deviation from the Friedman rule of zero interest rate. Indeed, as noted by Schmitt-Grohé and Uribe (2009), in an economy with a significant share of its domestic currency circulating

abroad, the inflation tax is to a large extent borne by foreign residents, which implies a transfer of real resources from the rest of the world to the currency-issuing economy. Thus, when setting the optimal monetary policy, the government of the issuing country would need to carefully weight the welfare gains in terms of reduced opportunity costs for domestic agents against the losses stemming from reduced seigniorage revenues associated with the holdings of currency abroad.

Our estimates show that in the euro area welfare costs are equal to zero at the 2% level of the nominal interest rate and are minimized at a level of around 1%. This in turn implies that, given the possibly low level of the euro area natural interest rate (Mesonniere and Renne; 2007) and the fact that our estimates are most likely upward biased, the targeting of a small but positive inflation rate might be optimal even from the point of view of the minimization of the welfare costs of inflation.

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Kim P. Huynh, Ben S.C. Fung and Leonard Sabetti
Contactless-Credit Cards and the Cash Ratio[1]

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1. Introduction

The use of cash for everyday retail transactions both in Canada and in other countries is increasingly on the decline according to a number of sources, such as Amromin and Chakravorti (2009). In particular, the proliferation of debit and credit cards has led to large shifts on the part of consumers towards these payment cards away from cash. This trend leads many observers to predict a *cashless* society. A recent study by Arango, Huynh and Sabetti (2011) inter alia confirms this trend but also finds that cash remains the dominant method of payment for small value transactions under 25 dollars in Canada. The authors find that reliance on cash for *micro-payments*, those under 10 dollars, is associated with ease and speed of transacting, broad acceptance ofcash across merchants and low costs.

However, recent payment innovations mimic the desirable features of cash and are being marketed as easy and convenient payment methods especially for small vaue transactions. The introduction of the contactless-credit card in 2006 in Canada is a notable example. Consumers wave their card over the terminal reader and wait for an acceptance indicator. No PIN or signature is required under a certain dollar limit.

Central banks that are the sole issuers of cash, such as the Bank of Canada, study how changing technologies and consumer and merchant preferences can lead to changes in the payment landscape, such as substitution from cash to alternate payment methods. A recent study by Fung, Huynh and Sabetti (2012) assesses the impact of recent retail payment innovations, such as the contactless-credit card, on cash usage using a novel data set which surveys Canadian households' shopping behaviour. They shed light on the extent to which households are using payment innovations and offer an estimate of the causal substitution effect away from cash. To summarize, the study finds that the average individual with contactless credit feature spends roughly 32 dollars *less* cash over a three-day period relative to a non-user.

2. 2009 Method of Payment (MOP) Survey and stylized facts

The Bank of Canada Method of Payment (MOP) Survey was conducted in November of 2009 and provides a detailed view of the retail payment landscape from the Canadian household perspective. Respondents, a nationally representative sample of adult Canadians, completed a survey questionnaire (SQ) and a three-day shopping diary (DSI). The SQ collected information on household demographics, banking and payment card characteristics, perceptions on method of payment attributes such as benefits for record-keeping, ease of use and guarding against fraud, and finally cash management practices. The survey was made up of roughly 6,800 SQ respondents and participation in the DSI was optional. Roughly 3,200

respondents recorded their payment activity in the DSI for three days, including type of good purchased, value of transaction, payment method used and whether any cash was obtained during the transaction. The DSI in aggregate recorded over 17,000 transactions.

Who is using contactless-credit feature?		Table 1
	Non-Users	**Users**
Under 30K	0.104	0.041
30K-80K	0.433	0.369
Over 80K	0.462	0.590
High School	0.209	0.119
College	0.791	0.881
Credit Card Revolvers	0.367	0.147
Beginning cash ($)	79.32	76.68
Total spending ($)	221.18	260.92
Bank balance ($)	3328.79	3881.58

Note: Statistics are computed for respondents with three or more retail purchases in DSI. Income, education statistics are in proportions. Bank Balance and Total Spending DSI are in dollars. Non-users of contactless-credit exclude respondents without access to a credit card.

The data set provides insights as to how recent payment innovations may affect cash usage. For example, a question in the SQ asks respondents whether their main credit card was embedded with the new contactless-credit feature. Respondents also recorded whether they conducted a transaction using their contactless-credit card in the DSI. Table 1 presents descriptive statistics comparing users of contactless-credit to non-users. Contactless-credit users, roughly seven per cent of the sample participating in the shopping diary, have on average higher levels of income and education. They also spend more during the diary and carry on aveage higher bank account balances, suggesting a positive correlation

between wealth and use of payment innovation. Contactless-credit users are much less likely to be revolving on their credit cards (carrying unpaid balances month-to-month with a non-trivial interest rate).

The authors define cash usage as the proportion of the total value of cash purchases to total value of all purchases at the individual level, or cash value ratio. Table 2 shows the average contactless-credit user has a 13 per cent cash ratio while the average non-user 32 per cent. The difference across groups suggests a reduction in the cash ratio of 19 per cent attributed to the contactless-credit card. This finding is consistent across demographic groups, such as income levels.

Cash ratios for contactless-credit users vs. non-users		Table 2
	Non-Users	Users
Overall	**0.317**	**0.127**
Under 30K	0.466	0.178
30-80K	0.323	0.124
Over 80K	0.279	0.126
Age below 25 years	0.372	0.084
Age 25 to 45 years	0.281	0.119
Age over 45 years	0.336	0.144
Credit Card Revolvers	0.335	0.125
Non-Revolvers	0.307	0.128

Note: Statistics are computed for respondents with three or more retail purchases in DSI.
The numbers displayed in percent.

The diary also reveals interesting empirical facts characterizing the use of contactless-credit cards compared to traditional payment methods. Table 3 shows contactless-credit card purchases are overwhelmingly used for groceries,

56 per cent, and at gasoline stations, 24 per cent. Notably, only three per cent of contactless-credit purchases were for retail goods compared to 22 per cent in the case of credit cards. The lower use of the contactless-credit feature relative to the traditional swipe-method for this class of spending, which tend to be purchases of higher value and more time-intensive, suggests both reduced availability from merchants and less demand for facilitating the speed of the transaction on the part of consumers. The majority of cash purchases are for Groceries and Entertainment/Meals, these categories are where consumers favour convenience.

Transaction Type Across Payment Methods				Table 3
	Cash	Debit	Credit	CTC
Groceries	0.327	0.426	0.327	0.562
Gasoline	0.043	0.088	0.124	0.235
Retail Goods	0.066	0.134	0.218	0.031
Services	0.028	0.031	0.049	0.019
Hobby/Sports	0.036	0.045	0.056	0.012
Entertainment/Meals	0.338	0.176	0.133	0.086
Other	0.162	0.100	0.093	0.056
Number of Transactions	5676	3391	2832	162

Note: Numbers are in proportions and are based on 12,271 transactions in DSI.
CTC: contactless-credit.

3. Empirical methodology and results

Using the MOP survey, Fung, Huynh and Sabetti (2012) estimate the difference in cash usage, measured in terms of value and volume of purchases, between users of payment innovations, for example contactless-credit, and non-users. However,

this estimated difference may not be causal due to the *chicken or egg problem*. Does payment innovation cause households to shift away from cash or is it that households use payment innovation to meet their preference for using less cash ex ante? To the extent that the latter interpretation is correct for some individuals, it may lead to a *selection bias*, or a possible over-estimate of the true causal impact. Ideally a controlled experiment would remove the selection bias by randomly assigning contactless-credit cards to a sub-sample of the population. Subsequent changes in payment behaviour measured relative to the remaining population would provide an appropriate estimate of the causal impact on cash usage.

To ameliorate selection bias, Fung, Huynh and Sabetti (2012) utilize an econometric technique known as propensity-score matching (PSM). PSM is a statistical method that enables the users to construct a quasi-random experiment by weighting the observations based on observable characteristics. In particular, they compare the spending of a user of payment innovation with a seemingly identical non-user based on observable characteristics such as demographics, perceptions of payment attributes and payment behaviour during the shopping diary. In the first step, a logit model with extensive characteristics of each individual is estimated to generate a propensity score or a predicted probability of using contactless credit cards. Based on the propensity score, similar individuals' cash ratios are compared. Users of contactless-credit make up the treatment group and non-users belong to the control group. The resulting calculation is known as the average treatment effect (ATE).

The ATE implies a causal statement of the mean effect of contactless credit on the cash ratio. The propensity-score matching approach finds that the ATE of using contactless-credit is roughly 14 per cent. As a back-of-the-envelope calculation, for an average non-user who spends 221 dollars over a three-day period, the ATE estimate would imply that cash spending would drop by roughly 32 dollars if they had used contactless-credit. This estimate is slightly lower than the estimate

obtained using the ordinary least squares regression approach and the sign of the estimate is highly robust.

4. Conclusion

Anticipating changes to the demand for cash is important for central banks, such as the Bank of Canada, as they are the sole issuers of cash. Canadians rely on cash for a host of reasons besides retail transaction purposes, including as a store of value and for precautionary motives. However, understanding future changes in the retail payment landscape and how they may affect household demand for cash remains an important question. The increasing popularity of credit cards and debit cards over the past 20 years has resulted in a shrinking share of banknotes used for retail transactions. The advent of new payment innovations such as contactless-credit cards, which are designed to be more convenient and less costly, may lead to further reductions in cash usage. The contactless-credit card was in its initial stages of deployment in Canada in 2009 so the results in Fung, Huynh and Sabetti (2012) may not reflect the extent to which households are currently shifting their payment habits in light of these new payment technologies.

The literature on two-sided markets such as Rysman (2009) suggest that for any new payment technology to have a significant impact on the use of cash it would have to be widely used both by merchants and consumers. To understand the evolution in household payment behaviour, longitudinal data will be required. For example, the Canadian Financial Monitor which surveys households semi-annually, may be an important source of data for future research.

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Point of sale transactions, costs calculation

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1. Introduction

Costs of payments have been measured in the Netherlands for over 15 years. The most recent measurements concern the years 2006 and 2009. These measurements were initiated by the Dutch Association to promote Efficient Payment Systems (abbreviation: SBEB[1]) and the Central Bank of the Netherlands. In the SBEB the central organisations in the sectors retail, petrol and hospitality (hotel, restaurants, bars, and leisure-industry) and the Dutch Banking Association participate. Since 1992 All measurements have been performed by EIM, a Dutch company for economic policy research on business matters. This paper will deal with the measurement that has been performed in 2010 and 2011 and that concerned

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1 The abbreviation will be used in this paper.

the year 2009[2]. Nearly 1,000 merchants participated in this measurement. Furthermore 29 of the largest retail companies participated and 4 large commercial banks contributed to this research by giving all the necessary information.

In this paper we will discuss the aim and the organisation of the research, in particular the methodology (chapter 2). The Dutch payment market will be discussed (shortly) in chapter 3. Chapter 4 presents the main results of the research for the Netherlands in total and per payment method. The cost efficiency will be examined in chapter 5. Chapter 6 addresses the cost development since 2006. Also a cost forecast for 2012 based on a growth target of 40% for debit card payments in 2012 compared to 2009 is presented. Finally, chapter 7 presents the conclusions.

2.   Aim, method and cost model

2.1 Aim

The aim of the study was to provide actual and accurate information on the level and structure of all costs for the merchants to make payments by different methods possible. Thus the scope of the research concerns the external costs (fees to be paid to third parties) as well as internal costs, in particular the economic (cost) value of the time used for payment related activities and the depreciation of equipment to be used for cash or electronic payments.

The research should result in:
– Knowledge about the level and structure of costs of payments in 2009 for each distinguished payment method at national level (Netherlands). In this paper we will focus on *cash payments, debit card payments* and *payments by credit card*.

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2 This research resulted in the report Point-of-sale Transactions in 2009 (in Dutch: Toonbankbetalingsverkeer in 2009). The English version of this report can be asked for at the SBEB, see www.efficient-betalen.nl.

– Knowledge about the level and structure of costs of payments in 2009 per payment method for each of the distinguished (retail) industries. In the study the following industries were distinguished:
  • retail industry: i.e. food and non-food retail taken together;
  • hospitality industry: i.e. hotels, restaurants and bars;
  • petrol stations: i.e. petrol stations with personnel.
  In this paper these sectors will not be distinguished.
– Knowledge about the changes in costs per payment method and industry for the period 2006–2009.
– Knowledge about the changes in total costs to be expected if the level of debit card transactions would increase with approximately 40% and the number of cash payments would decline by 15% resulting in an unchanged total for all cash and debit card payments.

2.2 Method

The methodological fundaments for the research are:

– *A telephonic survey* among of small and medium sized merchants in the retail and hospitality industries and the petrol stations. 979 merchants (net response) participated in the survey. The questionnaire focussed on:
  • the number of payments;
  • a breakdown of these payments by payment method;
  • the division of the turnover by payment method;
  • the use of payment equipment;
  • the costs of activities related to payments;
  • other payment related internal and external costs.
– *A written questionnaire* sent to the 70 largest retailers in the Netherlands of which 29 provided the necessary information for all business divisions in the company

– *A written questionnaire* sent to the 6 largest commercial banks in the Nether-
   lands of which 4 replied. The questionnaire was focussed on the tariffs these
   banks apply for payment related services.
– *Desk research* regarding the number of establishments and total turnover for
   the distinguished industries and regarding tariffs applied by banks, telecom ser-
   vice providers and professional money transporters, etc.
– *Use of external data:* data from Currence were used regarding registered debit
   card 'pin' transactions[3] and from DNB[4] regarding cash transactions.
– *In situ measurements* of the time needed per payment method to perform the
   payment transactions in order to calculate the front office cost. The measure-
   ments covered over 2,200 payment transactions in 21 shops, restaurants and
   petrol stations in January 2010.

In order to obtain results at national level the single measurements were reweight-
ed with factors depending on sector and enterprise size, the number of enterprises
in a sector in 2009 and the sector turnover in 2009.

The method used was in line with the method used in 2007 that calculated the
payment costs for the year 2006, to make sure that the results could be compared
without any further methodological constraints.

2.3 Cost model

To calculate the costs of payment and to perform further analyses we developed a
special cost model. In this model we distinguish 18 cost components, split up by
payment method, into internal and external cost and into fixed and variable costs.
In case of the variable costs we distinguish transaction related costs and turnover

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3 The domestic brand of debit cards in the Netherlands is PIN. Currence is the institute that registers
the debit card transactions.
4 DNB stands for De Nederlandsche Bank, the Central Bank of the Netherlands.

related costs. Table 1 shows the division of payment costs by cost component, payment method and type of costs (fixed or variable). In case a cost component showed to be partly fixed and partly variable we are presenting - as a result of the performed analyses - in table 1 also the share of the fixed part and the variable part in these cost components.

The division in these 18 cost components by type of costs makes it possible to asses:
– the contribution of each component to the total costs of payment;
– the costs of components that may be reduced by transaction related actions;
– the costs of components that may be reduced by investment related actions;
– the costs of components that may be reduced by increasing internal efficiency;
– the costs of components that may be reduced by calculating lower tariffs.

The cost model: fixed and variable costs, internal and external costs

Table 1

Cost component	Payment method		Type of costs		
	Cash	Debit/ credit card	Fixed	Variable transaction related	Variable turnover related
Internal costs					
Front office costs	✓	✓		✓	
Back office costs cash	✓		✓ (15%)	✓ (13%)	✓ (72%)
Back office costs debit/credit card		✓		✓	
Costs of own money transport	✓			✓	
Loss of money (theft, fraud)	✓				✓
Loss of money (interest on cash stored)	✓				✓
Costs of payment equipment for cash payments	✓		✓		
Costs of payment equipment for electronic payments		✓	✓ (93%)	✓ (7%)	
External costs					
Costs of cash insurance	✓				✓
Bank deposits costs	✓				✓
Loss of money (interest on deposits)	✓				✓
Bank costs of acquiring cash	✓				✓
Professional money transport	✓		✓		
Processing costs electronic payments		✓		✓	
Bank fee for handling electronic payments		✓	✓		
Costs of credit card companies		✓		✓	
Monthly costs telecommunication companies		✓	✓		
Costs for telecommunication per transaction		✓		✓	

Source: EIM, 2012

3. The Dutch payment market

In the Netherlands cash payments count for 5.2 billion transactions (year 2010) of which approximately 4.4 billion concern transactions by consumers in shops, on markets (street trading), in the hospitably sector, in petrol stations, museums, cantinas, clubs and institutions where consumers can pay directly (consumer-to-merchant)[5] by cash or card.[6] Debit card transactions account for approximately 2.1 billion transactions in 2010 of which approximately 1.7 billion concern consumer-to-merchant payments (CTM payments).[7]

In 2010 there were approximately 6.4 billion CTM payments in total, of which 66% were handled by cash, 27% by debit card and 1% by the use of credit cards. The remaining 6% concern payments performed with petrol cards, gift cards and bank transfers.

The average size per payment differs by method. The average size of a cash payment (as CTM payment) is approximately 12 EUR; of a debit card payment 33 EUR and of a credit card payment 49 EUR. In the last few years debit card payments tend also to be used more for low value purchases. The campaign 'Klein bedrag, Pinnen[8] mag' (Small purchase, use debit card please) was a great success. Nowadays, younger people in particular, do not have much cash anymore in their wallets and use their debit card for most of their purchases.

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5 We will use the expression consumer-to-merchant payment (CTM) to indicate all transactions where consumers can pay the merchant directly and on site for their purchases. Payments for trips by bus or train or for the use of vending machines and parking meters or person-to-person payments are not included in this number.
6 Source: DNB, Contante betalingen geteld, October 2011. In the EIM research report a lower number of cash and debit card transactions is presented, due to the fact that in the research not all sectors with CTM transactions were covered. The sectors covered were retail industry, hospitality industry, petrol stations and street trade. See also 4.1.
7 Source: Currence 2009, 2010 (see www.currence.nl).
8 PIN is the Dutch domestic debit card brand. Since 2012 this brand is no longer active and has been replaced by debit cards that use the EMV technology (Maestro e.g).

Looking at the value of the payments, about 51 billion EUR was paid by cash, 55 billion EUR by debit cards and 2 billion EUR by credit cards. It is to be expected that the number of payment by debit cards will increase in the coming years since a growing number of merchants accept debit cards for all kind of payments without any charge, thus lowering the constraints for the use of debit cards. Also the policy of merchants to diminish all kinds of risks and costs related to cash payments (e.g. by the use of *pin only checkouts*[9]), will stimulate the debit card payments.

4. The results at macro level

4.1 Total costs of payment
In this chapter we will present and discuss the costs of payment (for CTM transactions) at a macro level (the Netherlands, in total, and per payment method in total). EIM measured the costs related to CTM payments covering 80% of all merchants accepting direct payments on site. The measurements covered about 85% of all CTM payments. For the calculation of the costs we used the cost model as presented in table 1.

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9 Pin only checkouts are checkouts in supermarkets where the consumer cannot pay anymore by using cash. The cashiers at these checkouts will only accept debit cards (in the Netherlands normally indicated by the domestic brand PIN).

Fixed and variable costs, internal and external costs (x 1,000)					Table 2
Cost component	Type of costs				
	Fixed	Variable turnover related	Variable transaction related	Total costs	
Internal costs					
Front office costs			€ 363,600	€ 363,600	29%
Back office costs	€ 37,400	€ 182,400	€ 62,900	€ 282,700	23%
Costs of own money transport	€ 95,200			€ 95,200	8%
Loss of money (theft, fraud)		€ 26,500		€ 26,500	2%
Loss of money (interest on cash stored)		€ 1,500		€ 1,500	0%
Costs of payment equipment	€ 69,500		€ 3,400	€ 72,900	6%
Total internal costs	**€ 202,100**	**€ 210,400**	**€ 429,900**	**€ 842,400**	**68%**
	24%	**25%**	**51%**	**100%**	
External costs					
Costs of cash insurance		€ 9,400		€ 9,400	1%
Bank deposits costs		€ 92,700		€ 92,700	7%
Loss of money (interest on deposits)		€ 300		€ 300	0%
Bank costs of acquiring cash			€ 7,200	€ 7,200	1%
Professional money transport		€ 51,500		€ 51,500	4%
Processing costs electronic payment	€ 7,300		€ 74,500	€ 81,800	7%
Costs of credit card companies		€ 88,300		€ 88,300	7%
Costs of telecommunication companies	€ 17,700		€ 30,900	€ 48,600	4%
Other external costs		€ 9,700	€ 10,500	€ 20,200	2%
Total external costs	€ 25,000	€ 251,900	€ 123,100	€ 400,000	32%
	6%	63%	31%	100%	
Total costs	**€ 227,100**	**€ 462,300**	**€ 553,000**	**€ 1,242,400**	**100%**
	18%	**37%**	**45%**	**100%**	

Source: EIM, 2012

In table 2 the costs of payment are displayed in total with a division of the costs by cost component and type of costs (fixed, variable transaction related and variable turnover related). Table 2 shows that two third of the total costs of payment is set by internal cost. One third is covered by the external costs. Only 8% of all costs concern contributions to the banks (for deposits and cash withdrawals) and 7% concern contributions to credit card companies (including interchange fee, processing costs and fee for the scheme). However, this also implies that payments with credits cards result in 23% of all external cost, counting for only 1 percent of all payments. The use of credit cards should have much compensation in other cost components to result in an equal total cost level compared to cash and debit cards. We will discuss this item in chapter 5.

Finally, figure 1, gives an overview of the share of each payment method in total transactions and total costs in 2009.

Total transactions and costs with a breakdown by payment method, 2009

Figure 1
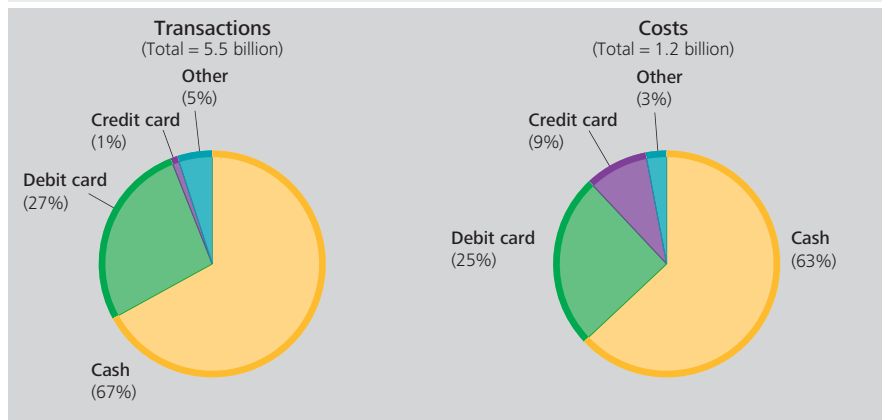
Source: EIM, 2012.

4.2 The total costs of payment by method

In the tables 3, 4, and 5 the costs are presented per payment method (cash, debit card and credit card).

Looking at the different methods (tables 3, 4, and 5), we see a clear difference in the cost structure between cash payments, debit card payments and credit card payments.

– The costs for cash payments are dominated by internal costs (80%, in particular back *and* front office costs).
– For debit card payments internal costs count for 59% of all payment costs (in particular front office costs) and external costs count for 41%.
– 83% of the credit card costs are external costs.
– For cash payments, the external costs depend strongly on the costs related to bank deposits.
– For debit card payments the external costs are set for the largest part by processing costs.
– For credit card payments the external costs are almost completely set by the contributions to the credit card companies. This contribution consists of processing costs, interchange fee and scheme fee[10].

Compared to cash payments and debit card payments, the use of credit cards shows indeed a significant lower share of internal costs in the total costs. Still, the question is whether this lower share will compensate enough the relatively high share of credit cards in the external costs for all payments (see comments earlier under table 2). We will discuss this further in chapter 5.

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10 We asked the merchant only to indicate the total contribution to be paid for the use of credit cards; we did not split the contribution into the various components.

Costs of cash payments (x 1,000) Table 3

Cost component	Type of costs				
	Fixed	Variable turnover related	Variable transaction related	Total costs	
Internal costs					
Front office costs			€ 229,300	€ 229,300	29%
Back office costs	€ 37,400	€ 182,400	€ 32,300	€ 252,100	32%
Costs of own money transport	€ 95,200			€ 95,200	12%
Loss of money (theft, fraud)		€ 26,500		€ 26,500	3%
Loss of money (interest on cash stored)		€ 1,500		€ 1,500	0%
Costs of payment equipment	€ 26,500			€ 26,500	3%
Total internal costs	€ 159,100	€ 210,400	€ 261,600	€ 631,100	80%
	25%	33%	41%	100%	
External costs					
Costs of cash insurance		€ 9,400		€ 9,400	1%
Bank deposits costs		€ 92,700		€ 92,700	12%
Loss of money (interest on deposits)		€ 300		€ 300	0%
Bank costs of acquiring cash			€ 7,200	€ 7,200	1%
Professional money transport		€ 51,500		€ 51,500	7%
Total external costs	-	€ 153,900	€ 7,200	€ 161,100	20%
	-	96%	4%	100%	
Total costs	€ 159,100	€ 364,300	€ 268,800	€ 792,200	100%
	20%	46%	34%	100%	

Source: EIM, 2012

Costs of debit cards (x 1,000)					Table 4
Cost component	Type of costs				
	Fixed	Variable turnover related	Variable transaction related	Total costs	
Internal costs					
Front office costs			€ 116,900	€ 116,900	38%
Back office costs			€ 22,200	€ 22,200	7%
Costs of payment equipment	€ 40,000		€ 3,200	€ 43,200	14%
Total internal costs	€ 40,000	–	€ 142,300	€ 182,300	59%
	22%	–	78%	100%	
External costs					
Costs of telecommunication companies	€ 16,300		€ 28,400	€ 44,700	15%
Processing costs electronic payment	€ 6,600		€ 73,900	€ 80,500	26%
Total external costs	€ 22,900	–	€ 102,300	€ 125,200	41%
	18%	–	82%	100%	
Total costs	**€ 62,900**	**€ 0**	**€ 244,600**	**€ 307,500**	**100%**
	20%	**0%**	**80%**	**100%**	

Source: EIM, 2012

Costs of credit cards (x 1,000)   Table 5

Cost component	Type of costs			
	Fixed	Variable turnover related	Variable transaction related	Total costs
Internal costs				
Front office costs			€ 8,900	€ 8,900	8%
Back office costs			€ 8,000	€ 8,000	7%
Costs of payment equipment	€ 1,700		€ 100	€ 1,800	2%
Total internal costs	€ 1,700	–	€ 17,000	€ 18,700	17%
	9%	–	91%	100%	
External costs				
Costs of credit card companies		€ 88,300		€ 88,300	81%
Costs of telecommunication companies	€ 1,000		€ 1,100	€ 2,100	2%
Total external costs	€ 1,000	€ 88,300	€ 1,100	€ 90,400	83%
Total costs	**€ 2,700**	**€ 88,300**	**€ 18,100**	**€ 109,100**	**100%**
	2%	**81%**	**17%**	**100%**	

Source: EIM, 2012

5. The cost efficiency of payments

To asses which payment method is handled most efficiently we can look at the costs in different ways:

– The costs per single transaction. This is reflected by dividing the total costs per payment method by the total number of transactions for each distinguished method. This method of comparing costs gives a fair benchmark assuming that costs are not related to the value of the payment, but only to individual handling and processing costs.

– The cost in percentages of the average transaction value. This is reflected by dividing total costs per payment method by the total sales value for all transactions for each distinguished method. This method gives a good indication of the cost pressure of each payment method and is a fairly good benchmark for the efficiency of payment methods assuming that payment costs are in particular related to the transaction value.

– The marginal cost per transaction (i.e. the variable costs for the last added transaction of an average transaction value).

As explained in chapters 2 and 4, costs depend on various factors and will result in fixed or variable costs (transaction related or turnover related). This implies that neither of the first two ways of comparing costs will express differences in efficiencies in a fully clear way covering all relevant scopes. However, by combining these two ways of comparing costs levels, clear conclusions can be drawn for the cost efficiency of each payment method. We will first focus on the costs per single transactions (paragraph 5.1) and then on the costs related to the turnover value (paragraph 5.2). The third paragraph of this chapter presents the marginal costs for each payment method.

5.1 The costs per single transaction

In table 6 the costs per transaction are presented for each payment method in Euro cents. Based on the results presented in table 6 the following conclusions can be drawn:

– The costs of a single debit card transaction are comparable with the costs of a single cash transaction[11];
– The costs of a single credit card transaction are almost 9 times higher than the costs per transactions of cash and (domestic) debit card;
– In particular the external costs – and that is the component which will interest merchants (in particular in micro or small companies) the most – seem to be fully out of order for credit card costs;
– The external costs of handling cash are still lower than the external costs for handling debit card payments, although in the Netherlands banks already do not charge any interchange fee for handling debit card payments;
– The front office costs per transaction are still the lowest for cash payments, due to a slightly more efficient process in handling cash payments at the counter. It is to be expected that this advantage of handling cash will disappear in the next few years as a result of improved technical procedures and the introduction of pin only checkouts;
– The internal back office costs of credit card payments are also relatively high. The reason for this that in the Netherlands the number of credit card payments per shop is very low. Thus, no real economies of scale will be possible for handling credit card payments;
– Also the front office costs of credit card payments showed to be relatively high. This can be a result of more time consuming handling because consumers and merchants are not very used to pay with and handle credit cards. Also the fact

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11 Only when low value payments (below approximately 8 EUR) strongly dominate the structure of payments for a single merchant, the costs per payment show to be lower for cash payments than for debit card payments. This situation however hardly occurs in Dutch retail. We will disregard this situation in the analyses and further considerations in this paper.

that in most cases the credit card is not used for shop purchases, but for paying for services in the hospitality sector might have influence on front office costs of credit card payments.

Costs per transaction for cash, debit cards and credit cards			Table 6

Cost component	Costs per transaction		
	Cash EUR (cents)	Debit card EUR (cents)	Credit card EUR (cents)
Internal costs			
Front office costs	6.2	7.9	15.4
Back office costs	6.8	1.5	13.8
Costs of own money transport	2.6	–	–
Loss of money (theft, fraud)	0.7	–	–
Loss of money (interest on cash stored)	0.0	–	–
Costs of payment equipment	0.7	2.9	3.1
Total internal costs per transaction	**17.1**	**12.3**	**32.3**
External costs			
Costs of cash insurance	0.3	–	–
Bank deposits costs	2.5	–	–
Loss of money (interest on deposits)	0.0	–	–
Bank costs of acquiring cash	0.2	–	–
Professional money transport	1.4	–	–
Processing costs electronic payment	–	5.4	–
Costs of credit card companies	–	-	152.0
Costs of telecommunication companies	–	3.0	3.6
Total external costs per transaction	**4.4**	**8.4**	**155.6**
Total costs per transaction	**21.5**	**20.7**	**187.9**
Total # transactions (x 1,000)	**3,680,400**	**1,486,200**	**58,100**

Source: EIM, 2012

5.2 The costs in percentages of the total turnover

For the single entrepreneur the most important question is at the end: What is the pressure of the payment costs on my turnover and how can I reduce this? To answer the first part of this question we calculated the costs of payment as a percentage of the turnover realised per payment method. The results are illustrated in table 7.

The payment costs in % of the turnover by payment method			Table 7
	Cash	Debit cards	Credit cards
Internal costs	1.37%	0.37%	0.66%
External costs	0.35%	0.26%	3.17%
Total costs	1.73%	0.63%	3.83%
Source: EIM, 2012			

The results show that, related to their relevant average turnover, payments by debit cards have the lowest cost pressure on turnover. Also from this point of view payment by credit card is the most expensive method, in spite of the fact that higher amounts are paid by credit card. There are a fewer number of payments by credit card involved per (e.g.) 100 EUR turnover value (2 payments) than that there will be by cash (8 payments) or by debit card (3 payments).

5.3 The marginal costs

A third possibility to assess efficiency differences is to look at the marginal costs only. The marginal costs equal the variable costs of a last added transaction of an average transaction value, assuming that for each payment method the fixed costs will only change in case of a substantial change of the number of transactions. In table 8 these marginal costs are presented assuming that for every payment method the last added transaction has a value of 19.50 EUR (this is the average

transaction value for all CTM payments in the Netherlands in 2009). Also by this approach, debit card payments showed to be the most efficient payment method.

Marginal costs by payment method (for transaction with a value of 19.50 EUR)	Table 8
Payment method	**Marginal costs**
Cash	€ 0.23
Debit card	€ 0.16
Credit card	€ 0.75
Source: EIM, 2012	

Looking at all different approaches for comparing the cost of payment by payment method, we can conclude that payments by debit card have to be preferred over cash and credit card payments.

6. Development of costs

In this chapter we will discuss the development of costs during the period 2006-2009. As mentioned before, EIM also measured the payment costs in 2007 (concerning the year 2006), using the same cost model as used in the 2009 measurement. This makes it possible to make a comparison between the level and composition of the costs of payment in 2006 and 2009. At the end of this chapter we will also look forward, considering a scenario of 15% less cash transactions (in favour of debit card transactions) in 2012 compared to 2009.

6.1 2006–2009

Table 9 shows the total number of transactions and costs per payment method for the years 2006 and 2009. During this period, the total number of transactions has

declined by 3%. Looking at the different payment methods, we see a decrease of cash transactions and an increase of debit and credit card transactions.

Total costs of cash, debit and credit card transactions are 3% lower in 2009 compared to 2006. The payment costs of cash have decreased by 22%. This is partly caused by a substantial lower number of cash transactions (decline of 10 %). Furthermore, the front office costs are lowered, because of a small reduction in the average time of a cash transaction. Also the back office costs are lower in 2009 compared to 2006.

The increase in the costs of debit card payments (+ 20%) can be explained for the larger part by the increase in the number of debit card transactions (+ 22%). Total costs do not rise in the same proportion as the number of transactions, because some of the costs are fixed.

Finally, the costs of credit card payments have decreased by 9%. This is particularly the result of a lower average amount per transaction and a reduction in the tariffs for the use of credit cards, resulting in a lower contribution per transaction. The costs of credit card transactions depend to a great deal on the amount of the transaction, since the fee merchants have to pay to the credit card companies, often is a percentage of the transaction value.

It is important to note that not only a lower or higher amount of transactions has resulted in differences in costs between 2006 and 2009. Also changes within the cost components are responsible for lower/higher costs. For example the hourly wage (opportunity costs of time), the bank costs of acquiring cash and the bank deposits cost have increased during the period 2006–2009. On the other hand, processing costs of electronic payments and the costs of payment equipment have decreased.

Total transactions and costs per payment method (cash, debit card and credit card), 2006–2009			Table 9
Transactions	2006 (x 1,000)	2009 (x 1,000)	2006-2009 (%)
Cash	4,104	3,680	-10%
Debit card	1,221	1,486	22%
Credit card	38	58	53%
Total these methods	5,363	5,224	−3%
Costs	2006 (x 1,000)	2009 (x 1,000)	2006-2009 (%)
Cash	€ 1,010	€ 792	−22%
Debit card	€ 257	€ 308	20%
Credit card	€ 120	€ 109	−9%
Total these methods	€ 1,387	€ 1,209	−13%

Source: EIM, 2012

6.2 2012

A major goal for the SBEB is to raise the share of debit card payments each year substantially. The SBEB formulated a target level for 2012 of 2.7 billion debit cards transactions. This implies that the number of debit card transactions should increase with 40% in the period 2009–2012. In order to realize this growth SBEB started or intensified various campaigns towards merchants and consumers.

The question is of course how the cost of payments will change if:
– the number of debit cards payments will increase with 40%;
– the total number of payments will not change;
– each new debit card payment will replace a (former) cash payment;
– as a result the number of cash payments will decline by 15%;
– the fixed costs of debit card payments and credit card payments will not change;
– there will be no further change in the number and costs of credit card payments.

We calculated the payment costs in 2012 for the sectors in the research for the research domain over 2009 (see 2.1). The results of this calculation are shown in tables 10 and 11, only for the use of cash and debit card[12] . The results show that the total costs of payment will decline by approximately 3%. Looking at these results the revenues for the merchants of the increase of debit card payments are not substantial in a financial way, but there are of course also revenues in terms of safety.

Payment costs in 2012 compared to 2009, assuming a 15% decline in cash payments, resulting in a 40% increase in debit card payments					Table 10
	Transactions 2009 (x 1 million)	Transactions 2012 (x 1 million)	Payment costs 2009 (x 1 million)	Payment costs 2012 (x 1 million)	change in costs (x 1 million)
Cash	3,707	3,093	€ 792	€ 638	-/- € 154
Debit card	1,486	2,100	€ 308	€ 427	+ € 119
Total	5,193	5,193	€ 1,100	€ 1,065	€ 35

Source: EIM, 2012

7. Conclusions

Contracted by the SBEB, EIM measured the costs of payments for consumer-to-merchant transactions (CTM transactions) in the Netherlands for the year 2009 based on a cost model that has also been used for the measurement of these costs for 2006. EIM also predicted the cost for 2012 assuming that the number of debitcard payments will increase with 40% and the number of cash payments will decline by 15%.

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12 We do not present the number and costs of credit cards payments since we assumed that these items will not change over the period 2009–2012.

In 2009 the total number of payments (cash, debit card, credit card and other payment methods) was 6.4 million of which 66% were cash transactions, 27% debit card transactions, 1% credit card transactions and 6% other transactions Referring to the total value of the payments, 51 billon EUR was paid by cash, 55 billion EUR by debit card and 2 billion EUR by credit card. Payments by debit and credit card have on average a significantly higher value than cash payments.

The total costs of payment (for 85% percent of all CTM transactions) were in 2009 1,242 million EUR (excluding other methods) of which 64% concerned cash payments, 25% debit card payments and 9% credit card payment. The costs of cash transactions are dominated by internal costs (80%), while the costs for credit card payments are dominated by external costs (83%). For debit cards, internal costs set 59% percent of the payment costs.

Payment by debit card, shows to be the most efficient payment method compared to cash and credit card when looking at the costs per transaction, the costs in percentages of the transaction value and the marginal costs.

During the period 2006–2009, total payment costs declined by 3%, in particular caused by a significant lower number of cash payments in 2009 compared to 2006. This illustrates a clear trend: cash payments are declining in favour of debit card payments. A further growth of the share and number of debit cards payments is foreseen for the coming years. The SBEB aims to increase the number of debit card payments in 2012 with 40% compared to 2009. If this will be realised, a further decline of the costs of payments with 3% is foreseen.

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Poland as compared to other countries – the usage of cash and non-cash payment instruments

Poland: macro cash statistics

The global volume of non-cash transactions amounted to 260 billion in 2009, after sustained annual gains of 6.8% since 2001 (Capgemini 2011: 8). Globally, non-cash transaction volumes have proved resilient to the effects of the financial crisis, however the pace of the annual growth in 2009 was slightly lower (5.2%) than the compounded annual growth in the years before the beginning of the crisis (7.2% in the period 2001-2007).

Despite their continuous growth, non-cash transactions are still not the dominant retail payment media. There are countries in which more than 95% consumer payments take place in cash (McKinsey 2009).

Share of cash in retail payments by countries or regions (2008) — Figure 1

As a percentage
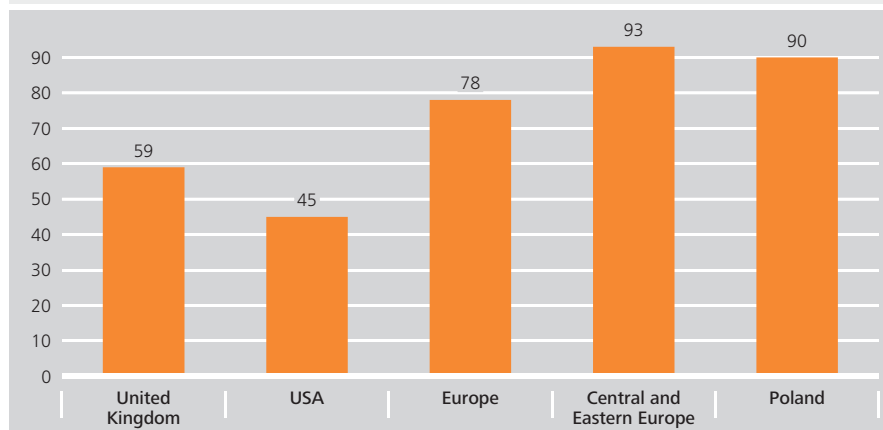
Source: Based on Delnevo R. (Bank Machine), *The challenge of ATM operators. Can cash remain on its throne?*, a presentation shown at the meeting of ATM operators in Poland held under the auspices of the ATM Industry Association Europe, 10 September 2010 (Retail Banking Research data).

In general, in more developed countries the number of cash payments is lower (see figure 1 – United Kingdom, USA), while in less developed countries – higher (see figure 1 – Poland). Cashless payments are particularly popular in Scandinavian countries. In 2008 in Finland, Norway and Sweden, the share of cash payments was below 50% (Liikanen 2008). In the value of retail transactions the share of cash is relatively smaller than in the number of transactions. In the country which probably has the most cashless society in the world, Iceland, banknotes and coins accounted for only 9% of the purchased value at Points-Of-Sale, other transactions were mainly conducted using debit and credit cards (Liikanen 2008).

Over the last years, the share of cash payments has steadily been decreasing. According to the data from the British UK Cards Association (formerly APACS) in the UK in 2000, consumers paid in cash for 73% purchases, whereas in 2010 for 53% (20 percentage points less) (Delnevo 2010). This trend also occurs in other countries, although the process it is not always as rapid as in the UK.

In spite of the decline in the share of cash in the total number of transactions, the amount of cash in many countries is growing – not only in nominal, but often in real terms. Between 2002 and 2008 the value of euro cash in circulation was increasing in nominal terms at a rate of approximately 19% per annum (11%, excluding € 200 and € 500 banknotes), while the value of non-cash transactions – by about 14% annually and the number of non-cash transactions per capita – by

Cash value as a percentage of narrow money (M1) over the years 2001–2010

Figure 2

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Poland	32,3	30,9	30,3	28,9	25,9	24,9	23,0	26,0	23,1	20,6
EU	17,1	19,5	19,4	19,3	17,5	17,1	18,0	19,7	18,5	18,1
Euro area	10,5	12,5	14,6	15,9	15,3	15,8	16,4	17,9	16,9	17,0
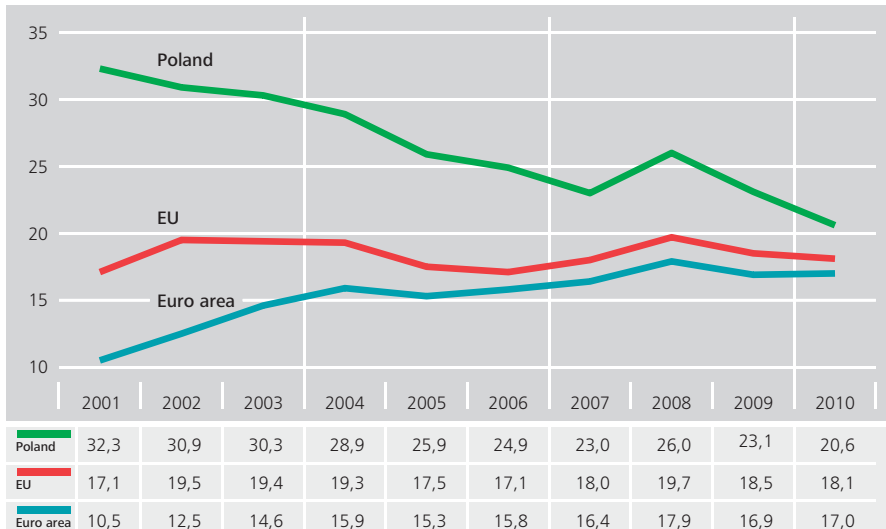
Note: EU estimations, 2010 weighted average across 28 EU countries, 2001–2009 NBP estimations. Source: NBP and ECB data (Statistical Data Warehouse).

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4% (compare Capgemini 2010: 14 and EPC 2007b: 3). The two figures below show the share of cash in the money aggregate M1, the first chart (figure 2) – in the period 2001-2010, while the second chart (figure 3) – in 2010, but for a wider range of countries.

In Poland the share of cash in the monetary aggregate M1 has been gradually decreasing (figure 2). On average, in the European Union it fluctuates from one year to another and in the eurozone it is even going up. In the latter case, the increase in the share of cash in M1 relates to the role of the euro as an international currency (compare below). The sudden rise of the cash value as a percentage of narrow money in 2008 was due to the failure of the Lehman Brothers bank and the outbreak of the global financial crisis. A part of society relies on cash more than on deposit money and in hard times withdraws money from banks. This anomaly of the demand for banknotes and coins shows that some events may easily lead to a banking panic.

Share of cash in M1 in 2010–cross-country comparison

Figure 3

As a percentage
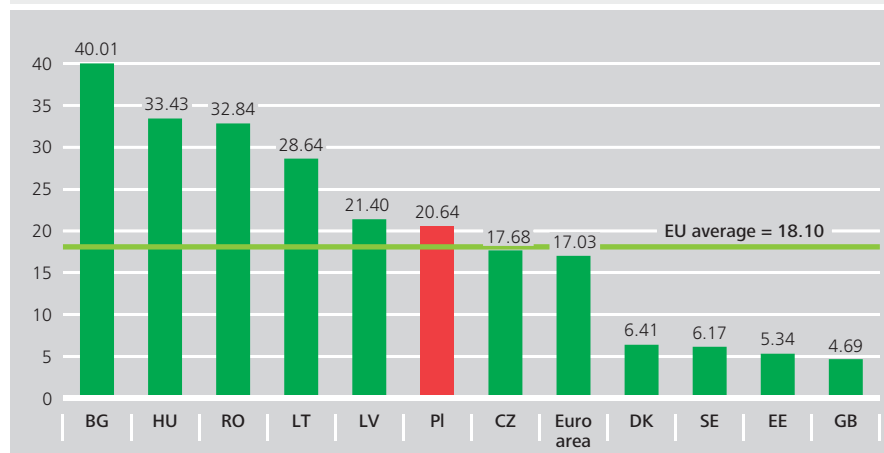
Note: EU average – estimations. Source: ECB data (Statistical Data Warehouse).

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The cross-country comparison of chosen countries indicates, that at the end of 2010 in Poland, the share of cash in M1 was 3.61 percentage points higher than in the eurozone and 2.54 higher than the estimated average level for the whole Community (figure 3). One country from the Central and Eastern Europe region – the Czech Republic was characterised by a slightly lower share of cash in M1 as compared to Poland. In other CEE countries not belonging to the euro area there were relatively more banknotes and coins. In some developed countries of Western Europe and in one Baltic country the cash value as a percentage of narrow money stood at less than 6.5% (Denmark, Sweden, Estonia, United Kingdom).

The phenomenon of the increase in currency in circulation with a simultaneous decrease in the share of the notes and coins in the total number of transactions can be explained by the growing role of cash as a store of value. Cash does not bring interest income, and its real value decreases due to inflation, so it should not be used for hoarding purposes. However, empirical studies show that individuals often save in cash1. This can easily be noticed especially in the case of currencies which act as international ones (euro, pound sterling, U.S. dollar). In accordance with the estimates of the European Payments Council (EPC) only between 40% and 60% of issued cash circulates and is used in transactions, while the rest is hoarded (EPC 2007b: 8).

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1 The omnibus survey conducted by the PBS DGA between 18 and 20 February 2011 on a nationwide representative sample of 1.048 adult Poles showed that 47.6% Poles who admitted to having savings (29.6% of the total population) declared that they kept them either in cash or on a transactional account, usually non-interest bearing or very low-interest-bearing (Kowalczyk 2011).

Also, the results of foreign studies show that cash is often used as a store of value or as a medium of exchange in the gray and black markets. According to the research of Humphrey *et al.* (2004: 231) conducted in Norway, 67% of the whole stock of cash in circulation acted as a savings asset or means of payment in the shadow economy. It can be assumed that this cash was used not only by individuals but also companies.

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It does not change the fact that in the European Union about 8 in 10 retail trans-
actions are made in cash (EPC 2007a: 2). In 2008, according to RBR (2010), 388
billion payments were made in the EU, including 301 billion in cash (78%).

Number of non-cash transactions *per capita* and share
of payment instruments, Poland–comparison 2000 and 2010
Figure 4
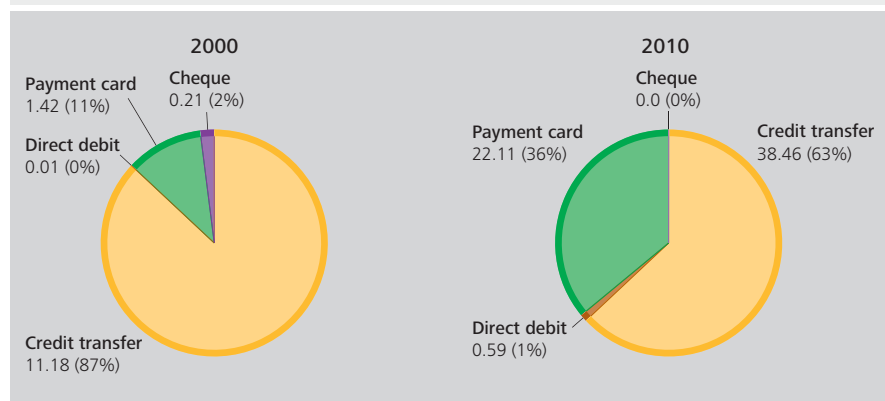
Note: The first figure on pie charts indicates the number of transactions performed by non-MFIs (non-banks)
with a given non-cash payment instrument annually and the second indicates the share of a payment instrument
in the total number of non-cash transactions. Source: NBP data.

In the period from 2000 to 2010 there was a sudden increase in the number of
non-cash transactions per capita (figure 4). In 2000 one Pole performed on average
12.85 non-cash transactions, while 10 years later as many as 61.16. In this period
definitely the proportion of the use of various payment methods changed. Cheques
practically disappeared from circulation, whereas the significance of payment cards
increased. During this decade, the share of payment cards in the number of non-
cash transactions increased by 25 percentage points, to 36%. Payment cards are
now mainly used to pay at physical Points-Of-Sale and to withdraw cash at ATMs.
The increase in the number of transactions using cards at Points-Of-Sale is
connected with the replacement of cash transactions by card transactions. All over

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the world, cards, especially credit cards, are commonly used in remote transactions (MOTOIO,). However, in Poland the credit transfer and cash on delivery are the most common ways of remote payments for long-distance shopping (compare the chapter "Payment habits of Polish consumers"). The credit transfer may be initiated in either paper or electronic form. The latter is becoming more and more common, and thus the costs of credit transfers are decreasing. Between 2000 and 2010 the number of credit transfers increased by over 27%, however their share in the number of non-cash transactions decreased from 87% to 63%. It was caused by the above mentioned rapid increase in the number of transactions made with payment cards. The direct debit is an instrument preferred for settlements by mass creditors because it gives them the control over the repayment of the debt. Poles, however, do not trust this form of payment, which is confirmed by statistics (in 2010 there were 0.59 direct debits). Poles prefer to pay their bills with different payment instruments – by credit transfer or in cash. Credit transfers can be executed using the electronic banking service or they can be initiated in some other ways, for example by telephone or in a bank branch. Cash payments in Poland are made at the creditor's cash desk, at a bank cash counter, through a bank agent, at a post-office or using the terminals of such agents as Via Moje Rachunki, Unikasa, TransKasa and Żabka. Terminals accepting cash payments have been installed in Polish stores and petrol stations.

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Poland as compared to other EU countries in non-cash statistics (2010).

Table 1

Statistics	EU average (per capita)	Poland (per capita)	Poland's position as compared to other EU countries
Number of overnight deposits	1.29	0.99	22 out of 25
Number of payment cards issued	1.45	0.84	26 out of 27
Number of card payments	68.05	22.11	22 out of 27
Number of credit transfers	47.89	38.46	17 out of 27
Number of direct debits	43.90	0.59	25 out of 27
Number of transactions with non-cash payment instruments	172.84	61.17	24 out of 27

Source: ECB data (Statistical Data Warehouse).

Poland does not rank the highest in the non-cash circulation development as compared to other EU countries. According to the ECB statistics (table 1) Poland's highest position in the EU ranking was 17 (out of 27 countries) in the number of credit transfers per capita. The statistics, that is the number of overnight deposits per capita and payment cards issued per capita, do not reflect the real situation and may hide the phenomenon of financial exclusion. Both the numbers are close to one, while in fact the number of unbanked Poles is much higher than these statistics suggest. On the other hand, Poles are open to innovations. Contactless technology in Poland develops rapidly. It can be estimated that already 1/3 of cards in circulation are equipped with RFID (Radio-Frequency Identification) tags. Polish consumers willingly execute proximity payments. The number and value of such payments is growing quickly. Regarding contactless card technology Poland is one of the three most dynamically growing markets in Europe. The others are the UK's and Turkey's markets.

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A general problem of payment markets worldwide is the low cost transparency of payment instruments, which impedes the transformation of payment habits towards a social optimum (Górka 2009b). Currently, payment service providers, that is mostly banks, apply mainly opaque charging conventions (compare Bergman *et al.* 2007, Leinonen 2008). Cost-based pricing would steer consumers from dear to low-cost payment methods (compare Humphrey *et al.* 2005 and 2008, Enge and Øwre 2006,). In the end, all costs/charges are paid by consumers. However, when charges are not transparent, consumers face biased costs. Therefore, introducing transaction fees and cost-based pricing would bring serious changes to the payments market (compare De Grauwe *et al.* 2006, Van Hove 2008). Cost savings for society would arise as a consequence of a better allocation of resources. Nevertheless, there are serious barriers to the enforcement of the cost-based pricing. Inter alia banks and international payment organisations resist any changes in pricing conventions for many reasons (Górka 2009a and 2009b). Payment markets are two-sided. The successful strategy to increase the number of card payments is to apply the skewed pricing strategy through hiding the cost of cards from consumers under the merchant service charge and forbidding surcharging. On the other hand, the cost of cash is also not communicated to consumers. Traditionally, banks do not charge cash withdrawals or deposits in bank branches and often at ATMs. As a result, clients using cash may not be aware of banking costs related to cash management.

In Poland the situation on the payments market has become quite hard. Cash circulation is prevalent and at the same time the costs of cards are very high.

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Interchange fees in card payments in Europe (2011)

Figure 5

As a percentage

Visa

Poland	1.60
Germany	1.58
Cyprus	1.50
Spain	1.42
Slovenia	1.10
Greece	1.05
Austria	1.00
Czech Republic	1.00
Estonia	1.00
Romania	1.00
Lithuania	0.90
Portugal	0.90
EU average	0.72
Slovakia	0.70
Italy	0.66
France	0.63
Latvia	0.55
Ireland	0.41
Bulgary	0.40
United Kingdom	0.37
Denmark	0.30
Luxembourg	0.25
Netherlands	0.25
Belgium	0.21
Hungary	0.21
Malta	0.21
Sweden	0.21
Finland	0.19

MasterCard

Poland	1.64
Hungary	1.16
Czech Republic	1.10
Estonia	1.05
Lithuania	0.85
Countries average	0.77
Greece	0.75
Latvia	0.60
Ireland	0.41
United Kingdom	0.37
Sweden	0.36
Finland	0.23

Note: Fee tiers as of September 2011, *Visa debit, full EMV, consumer* percentages fees; the percentage fee after the inclusion of a flat fee element *Debit MasterCard, full EMV, consumer, general*. The Debit MasterCard is not issued in all countries. In some countries MasterCard fee tiers are set by local banks. In some countries the information on MasterCard fee tiers in not disclosed. Source: Visa and MasterCard websites and the NBP data.

Interchange fees on card non-cash transactions in Poland are generally the highest in Europe (figure 5), with the exceptions of some types of cards. One can ask the question of why there are such great differences in interchange fee tiers among countries and whether real resource costs of cards in Poland justify these differences?

High merchant service charges discourage merchants from accepting card payments. In effect, the expansion of the POS terminal network in Poland is hindered and even a new Visa project called "Big Idea" does not help it. According to the NBP and ECB data, in December 2010 Poland had 6 595 POS terminals per one million inhabitants, and only Romania had less (4 995). In the EU there were 17 561 POS terminals per one million inhabitants and in the euro area 19 873.

Poland is also characterised by a low density of the ATM network. At the end of 2010 there were 431 cash dispensers per one million inhabitants (the fourth last place in the European Community). In the EU at the same time twice as many ATMs per one million inhabitants (866) were installed. ATMs are the main distribution channel of cash to Polish consumers (compare next chapter) but the growth of the network was seriously slowed down after the reductions in ATM interchange fees in the Visa and MasterCard systems in 2010. The reductions of 63-66% were introduced quite abruptly by MasterCard without consulting major ATM operators in Poland. Visa with their member banks followed the MasterCard's decision shortly. The interchange fee is the main source of income for ATM owners. Consequently, the profitability of the ATM business fell considerably in 2010 and 2011 (compare Górka 2011b and Górka 2012).

Payment habits of Polish consumers

In this chapter payment habits of Poles are described according to the findings of the research conducted in the fourth quarter of 2010 and in the first quarter of 2011 by the author (project supported by the Economic Research Committee of the National Bank of Poland; Polasik, Marzec, Fiszeder, Górka 2012). Only the main findings which have relevance to the costs and benefits of cash, cards and other non-cash payment instruments are presented below.

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Payments at physical Points-Of-Sale

Share of payment instruments in purchase transactions conducted over a month at physical Points-Of-Sale in Poland (2010/2011)

Figure 6
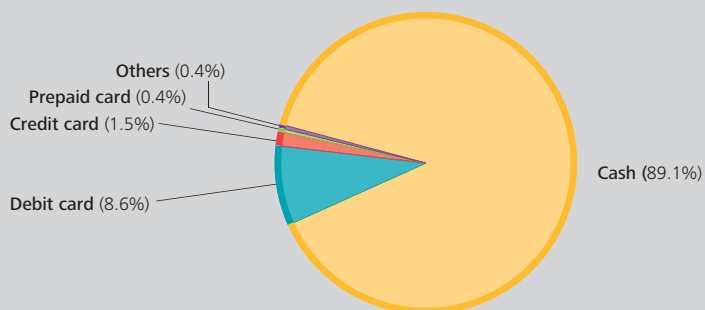
Source: Polasik M., Marzec J., Fiszeder P., Górka J., *Modelling the Usage of Retail Payment Methods on the Polish Market*, National Bank of Poland Working Papers 1/2012 (265), research conducted in the project supported by the Economic Research Committee of the National Bank of Poland, sample: n=2974. The project financed from the resources of the National Bank of Poland.

The survey revealed that in purchase transactions at physical Points-Of-Sale (POS) the share of cash was at the level of 89.1% (figure 6). According to the McKinsey consulting agency, in 2007 in Poland cash accounted for 94% of payments (McKinsey 2009: 10) and in 2002 for 98% (McKinsey 2005: 5). In terms of the number of transactions in Poland, cash is thus gradually being replaced by other payment instruments, particularly by payment cards, with which Polish consumers made 10.5% purchases. The remaining part (0.4%) comprised payments with vouchers, installment purchases, etc. Among payment cards the most popular were debit cards (8.6%) followed by credit card (1.5%) and prepaid cards (0.4%).

The perception of cash and debit cards

Perception of cash by Polish consumers (2010/2011)   Figure 7

As a percentage

	Strongly agree	Agree	Difficult to say	Disagree / Strongly disagree
Convenient	54.6	37.0	6.1	2.2
Cheap	56.0	36.7	6.1	1.2
Quick in use	56.2	37.5	4.9	1.3
Safe	47.0	38.9	9.6	4.4

0   10   20   30   40   50   60   70   80   90   100

Note: The numbers may not add due to rounding. The disagree and strongly disagree answers summed up.
Source: Polasik M., Marzec J., Fiszeder P., Górka J., *Modelling the Usage of Retail Payment Methods on the Polish Market*, National Bank of Poland Working Papers 1/2012 (265), research conducted in the project supported by the Economic Research Committee of the National Bank of Poland, sample: n=2974.

More than 90% of Poles think that payment in cash is convenient (91.6%), cheap (92.7%) and quick (93.7%). Cash safety rates lower. 85.9% of the respondents agree that this payment method is secure (see figure 7). As for debit cards, 50.2% of Poles consider this payment method as convenient, 40.2% as cheap, 47% as quick in use, and 43.7% as safe. However, each of the four criteria evaluated by Poles regarding debit cards obtained from 36.8% to 41.2% of the "difficult to say" answers (see figure 8).

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Perception of debit card by Polish consumers (2010/2011)   Figure 8
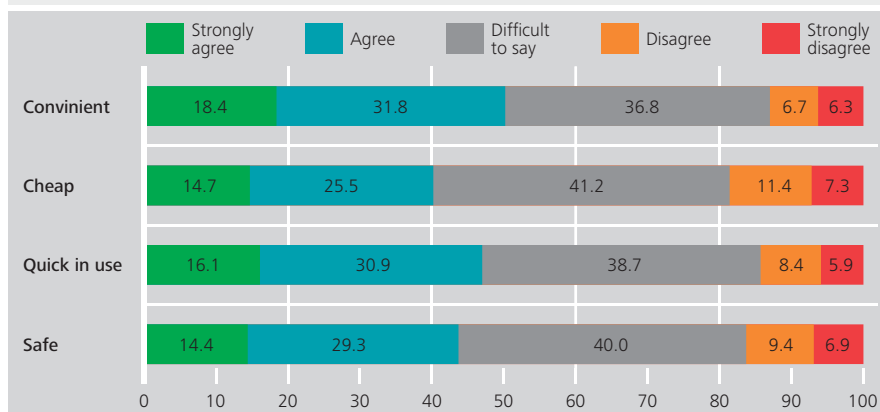
Note: The numbers may not add due to rounding. Source: Polasik M., Marzec J., Fiszeder P., Górka J., *Modelling the Usage of Retail Payment Methods on the Polish Market*, National Bank of Poland Working Papers 1/2012 (265), research conducted in the project supported by the Economic Research Committee of the National Bank of Poland, sample: n=2974.

The attachment of Poles to cash is also confirmed by other studies. In the years 2009-2010 Maison made a qualitative and quantitative analysis. It revealed that part of the Polish society, especially those people who do not have a bank account or use it very rarely, are characterised by a strong, emotional attitude to physical currency. Describing this phenomenon in Poland Maison coined the term: "cult of cash" (2010).

The development of non-cash payments in Poland is also affected by the opinion of merchants. A study conducted in Poland between 2007 and 2008 on a sample of 30 large stores and 111 additionally selected smaller shops showed that under various criteria, cash was always seen as the best method of payment (Polasik and Maciejewski 2009: 119-124). Banknotes and coins were compared with the credit card, debit card, contactless and mobile payments. All payment methods were evaluated by merchants under such criteria as: the cost, the security of payment,

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the popularity among current and potential clients, the ease of transaction servicing by salespersons, the perceived duration of a transaction at a counter and the time of clearing and settlement of funds.

The overall positive perception of cash by consumers and merchants does not speed up the development of non-cash payments in Poland. However, the fraction of the "difficult to say" answers in the case of debit cards indicates that an intense promotion of payment cards, which is taking place currently, may with time change the perception of payment cards by Polish consumers.

How Poles obtain cash

How Poles withdraw and/or obtain cash (2010/2011)   Figure 9

Cash back (0.2%)
Different way (1.0%)
At post office (0.9%)
From postman (e.g. pension) (5.5%)
At bank or credit union counter (6.1%)
Business payment (6.4%)
Salary at work place (6.8%)
From spouse, partner, family member (11.1%)
ATM (62.0%)

Note: The numbers may not add due to rounding. Source: Polasik M., Marzec J., Fiszeder P., Górka J., *Modelling the Usage of Retail Payment Methods on the Polish Market,* National Bank of Poland Working Papers 1/2012 (265), research conducted in the project supported by the Economic Research Committee of the National Bank of Poland, sample: n=2974

Poles obtain cash in different ways. Cash withdrawal at a bank, a credit union counter or via an automated teller machine is of primary character, because cash is directly transferred to a consumer by a bank or an independent ATM deployer

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and there is no other intermediary. Other ways of obtaining cash are of secondary character. Banknotes and coins are at first distributed directly by banks or through automated teller machines, however, later they are passed between consumers and businesses.

Based on the survey data (figure 9) one can state that 62% of all the situations of acquiring cash are connected with withdrawing cash at ATMs and only 6.1% are withdrawals of cash at bank or credit union counters. The rest, nearly 32% of all the operations are of secondary character. Over 13% of the operations are salary transfers at a workplace (6.8%) and business payments (6.4%), where a person runs its own small business and gets paid for a service rendered. 11.1% of cash is transferred directly to a consumer by his/her spouse, partner or a family member and these operations have usually much to do with running a household. Money transfers between family members play a big role in the whole economy. Still, 5.5% of all the operations of getting cash are pensions or social benefits delivered in cash by a postman. 0.9% are withdrawals at a post office. These traditional ways of obtaining cash are popular amid the least banked society groups such as pensioners. Changes in this area occur slowly.

How Poles pay on the Internet

The survey results revealed that almost half of the Polish society use the world wide web several times a week or more often. However, only some Poles surfing on the Internet (38%) buy goods or services in e-shops and online auctions. On average, one Internet user pays for merchandise online 0.65 times a month. On the other hand, the most active e-shoppers make even a dozen or more Internet purchases a month.

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**Share of payment methods in total number
of purchase payments on the Internet (2010/2011)**

Figure 10
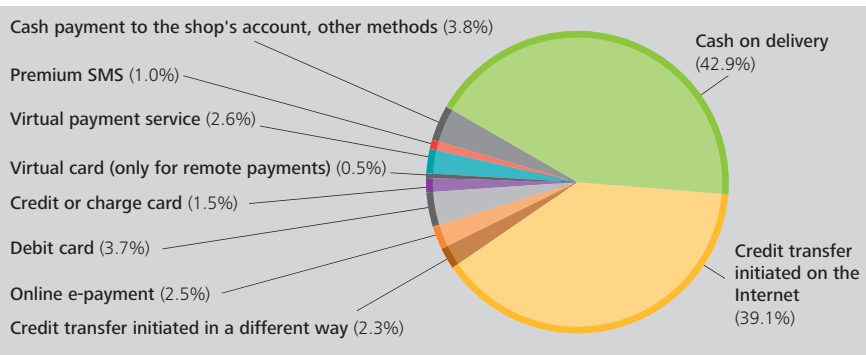
Cash payment to the shop's account, other methods (3.8%)

Premium SMS (1.0%)

Virtual payment service (2.6%)

Virtual card (only for remote payments) (0.5%)

Credit or charge card (1.5%)

Debit card (3.7%)

Online e-payment (2.5%)

Credit transfer initiated in a different way (2.3%)

Cash on delivery
(42.9%)

Credit transfer
initiated on the
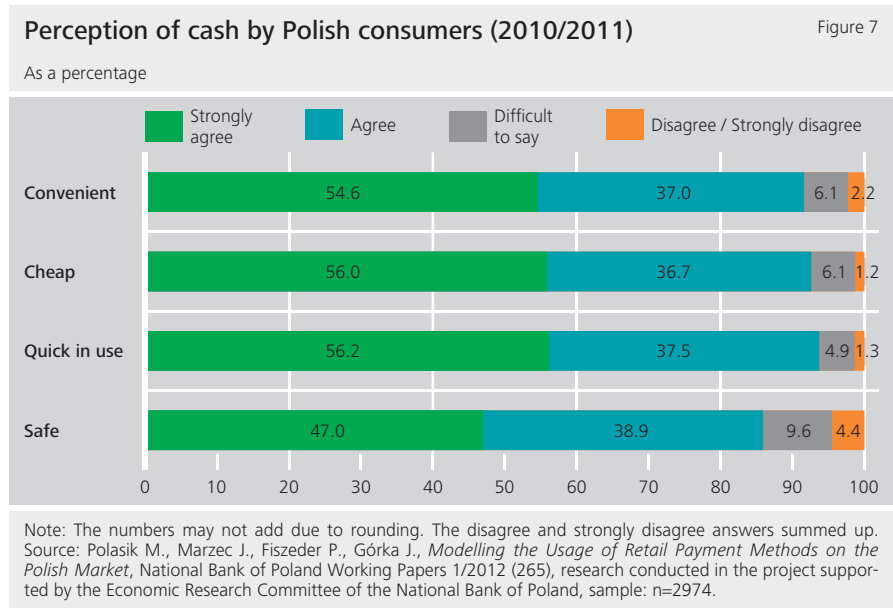Internet
(39.1%)

Note: The numbers may not add due to rounding. Source: Polasik M., Marzec J., Fiszeder P., Górka J., *Modelling the Usage of Retail Payment Methods on the Polish Market*, National Bank of Poland Working Papers 1/2012 (265), research conducted in the project supported by the Economic Research Committee of the National Bank of Poland, sample: clients of Internet shops n=390, clients of Internet auctions n=294 and clients buying Internet services n=106, number of payments N=1153.

A wide range of payment methods is available in Polish e-commerce. Two of them, however, are the dominant forms of payments, they are: cash on delivery (42.9%) and a credit transfer initiated on the Internet through a bank customer electronic banking service (39.1%). Together, these two payment methods account for 82% of all online purchases in Poland (figure 10). When an online e-payment (2.5%) and a credit transfer initiated in a different way, mainly at a bank counter or at a post office (2.3%), are added to credit transfers initiated via the Internet (39.1%), they already account for more online purchases than cash on delivery (43.9% against 42.9%). The online e-payment service is provided in Poland by the so-called Internet payment integrators (e.g. DotPay, Płatności.pl, Przelewy24). The online e-payment is a more convenient method of payment for a client, based on a credit transfer. After choosing the e-payment option, the client is redirected from a store webpage to his bank website, where, after a successful login, he can see a prefilled form of a credit transfer, which he only has to confirm and authenticate

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(second level authentication). He does not need to fill in the details of the credit transfer. For an Internet seller this option has this advantage that he is instantly informed about the incoming transfer of money which is guaranteed by the service provider. Neither payment cards nor virtual payment services (e.g. the domestic PayU system, the international PayPal system) have gained popularity among Polish Internet consumers. 5.7% of online purchases are executed with payment cards and 2.3% via virtual payment services. The latter number is the same as the number of cash payments to the store's account (at a post office or elsewhere). The remaining methods of online payments account for 1.5% of the total number of purchases on the Internet in Poland.

Poles' attitude to the anonymity of payments

Payment instruments feature different degrees of anonymity from the consumer's viewpoint. This issue also concerns merchants. At physical Points-Of-Sale debit and credit card transactions can be quite easily traceable, whereas cash still remains highly anonymous.

It turns out that almost 2/3 of Poles want to be anonymous at Points-Of-Sale. 16.6% of Polish consumers do not have a definite opinion about this matter and 18.1% have nothing against the fact that their transactions are recorded and possibly can be traced (figure 11). This is an important piece of information for companies that want to introduce new payment solutions. If such solutions provided the users with a certain degree of anonymity and exhibited other features desirable for consumers they could become successful on the Polish market. People want to be anonymous for different reasons. For some of them anonymity means more freedom and independence they are not ready to give up for loyalty points and a record keeping benefit accompanying card payments. For others anonymity is important because they work in a shadow economy. According to Schneider

Do Poles want to be anonymous when paying for goods and services?

Figure 11

Difficult to say
(16.6%)

Strongly agree
(20.5%)

Strongly disagree
(3.9%)

Disagree
(14.2%)
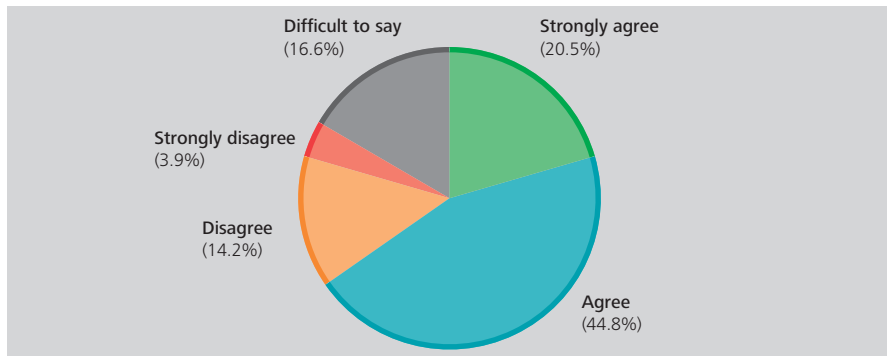
Agree
(44.8%)

Note: The numbers may not add due to rounding. Respondents were asked to either agree or disagree with the following statement: "I prefer when my payment in a shop is anonymous so as nobody could check, what I bought and when". Source: Polasik M., Marzec J., Fiszeder P., Górka J., *Modelling the Usage of Retail Payment Methods on the Polish Market*, National Bank of Poland Working Papers 1/2012 (265), research conducted in the project supported by the Economic Research Committee of the National Bank of Poland, sample: n=2974.

(2010) the size of an unofficial economy in 2009 in Poland was considerable (25.9% of the annual GDP) and much higher than in countries characterised by a bigger share of electronic payments (e.g. United Kingdom, Netherlands, Finland). Poles value their privacy and fear that either state employees or bank employees could have access to sensitive information.

The concepts of private and social costs

The costs of payments can be considered and calculated from the perspective of various payment actors/stakeholders/participants. The main parties in the payment chain are (compare Gresvik and Haare 2009: 7):
– the central bank,
– commercial banks,

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– subcontractors, that is institutions supporting banks and intermediating payment
  transactions (clearing houses, acquirers, payment organisations, cash handling
  companies including Cash-In-Transit)
– merchants,
– consumers.

The costs may be estimated all together or separately for different payment instru-
ments. The basic payment instruments are: banknotes and coins, credit cards,
debit cards, electronic money (hardware/software), credit transfers and direct
debits. However, it is sometimes necessary to divide payment instruments more
narrowly – e.g. Visa or MasterCard payment cards, cards verified with a PIN or
signature, the Proton electronic purse, PayPal electronic money, etc.).

Each party has its own private costs and benefits (including revenues) which can be
attributed to a given payment instrument. The costs and benefits may be of
pecuniary or non-pecuniary character (pecuniary items: fees, charges, material
costs, wages, etc., non-pecuniary items: time costs – e.g. consumers' shoe leather
costs or merchants' tender time costs, externalities, etc.). The costs and benefits
can be aggregated and consolidated using social or net social cost concepts.
The latter relies more explicitly on benefits (possibly both: pecuniary and non-
pecuniary), while in the case of the social cost concept these benefits are in the
background of the analysis – the revenues of one party net out against the
costs of another party in a payment chain and the non-pecuniary benefits are not
included (like the range of an acceptance base, anonymity/privacy, the perceived
ease and convenience of use, immediate settlement, record keeping, credit option,
card rewards, etc.). Non-pecuniary costs and benefits are not expressed in mone-
tary units. In order to quantify them one must use an appropriate converter (e.g.
an average hourly wage). The conversion often requires making some arbitrary
assumptions.

Social (societal) costs are the costs of the resources, in terms of the capital and
labour, that are put into the production of payment services. Social costs are calcu-
lated by extracting payment participants' payment revenues (from fees, tariffs)
from their total private costs. Alternatively, the social cost is the sum of all internal
costs made by the relevant parties in the payment chain in order to carry out
transactions. Private costs include all costs, including the fees paid, borne by
payment participants (compare Brits and Winder 2005: 13–18, Bergman et al.
2007: 4–6, Górka 2009b: 132, Turjan et al. 2011: 10).

Net social costs are social costs corrected for social benefits. They are derived
from private costs and benefits which exclude transfer payments, that is double
counting of some items (compare Garcia-Swartz et al. 2006a and 2006b, Simes
et al. 2006).

Payment cost studies in the world

Over the past decade eleven extensive studies of the costs of payment instruments
have been carried out in the world – Netherlands (Bank of Netherlands 2004, Brits
and Winder 2005), Belgium (Bank of Belgium 2005, Quaden 2005), Sweden (Guibourg
and Segendorf 2004, Bergman et al. 2007), Australia (Reserve Bank of Australia
2007), Finland (Takala and Viren 2008), Norway (Gresvik and Haare 2009), Hungary
(Turjan et al. 2011), USA (Garcia-Swartz et al. 2006a and 2006b), Australia (Simes et
al. 2006), Norway (Gresvik and Øwre 2003), Portugal (Bank of Portugal 2007).

The above mentioned studies on payment costs can be divided into three groups
according to the cost methodology used:
1. The social cost methodology: studies in the Netherlands, Belgium, Sweden,
   Australia 2007, Finland, Norway 2009, Hungary (group I).
2. The net social (marginal) cost methodology: studies of Garcia-Swartz et al. USA
   and Simes et al. Australia (group II).

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3. The private and social cost methodology with the use of the Activity Based
   Costing (ABC) method for evaluating banks' costs: studies in Portugal and
   Norway 2003 (group III).

The studies of groups I and III were either conducted entirely or supported by
central banks. The surveys differ between each other significantly although they
use similar cost concepts. Therefore, the comparison between all the results ought
to be made cautiously. Each country has its own unique payment structure and
payment culture, different institutional solutions, governing business and legal
rules. The surveys do not have the same scope. They do not necessarily cover all
payment stakeholders and the same payment instruments. Most of them focus
only on physical Points-Of-Sale and do not comprise remote payments. The surveys
are based either on the primary or secondary data. In addition, the data in the cost
studies comes from different years.

The author has quite thoroughly analysed all the studies (Górka 2008, 2009a,
2009b, 2011, 2012). Below only a short description and conclusions are given.

The study of group I shows that in the light of social costs from among payment
instruments used in POS payments (Górka 2009b: 35-36):
– the electronic purse is the cheapest one (it is however not available in all coun-
   tries; its costs were measured in Belgium and the Netherlands),
– cash is cheaper than debit cards in low value payments: up to EUR 11.63 in
   Netherlands, EUR 10.24 in Belgium, EUR 7.55 in Sweden, EUR 30.67 in Australia,
   about EUR 15 un Finland, about EUR 8 in Portugal; above these thresholds a
   debit card is cheaper.
– the debit card is always cheaper than the credit card,
– the credit card and cheque are the most expensive payment instruments.
– Moreover, among payment instruments available on the Internet the cheapest
   ones are: the credit transfer, direct debit and network money.

The studies of group II have revealed that in principle from the payment methods available at Points-Of-Sale, the electronic ones (debit and credit cards) are cheaper and the paper ones (cash and cheques) more expensive. According to Garcia-Swartz et al. and Simes et al. the cheapest payment method is using a PIN-authorised debit card. Cash is a relatively cheap means of payment in low value transactions. The shift from cash and cheques to electronic payments is beneficial, however the distribution of costs and benefits is not balanced. Certain groups, notably con-sumers, would likely gain from the shift. In contrast, some merchants might lose. Nevertheless, in general, the shift toward a cashless society appears to improve the economic welfare.

The main findings of the study of group III are briefly summarised below. For banks paper payment instruments (including cheques and cash) have considerably high social/resource costs. Credit cards are characterised by high resource costs, but these cards also generate high profits for banks. This is the reason why they are promoted by credit institutions. Direct debits, (electronically initiated) credit trans-fers and debit cards have the lowest social costs. The ABC analysis is particularly well-suited to the cost distribution where support functions generate a large share of the total costs and where there is a considerable variation in products, services, customers and production processes.

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Calculating costs and benefits in practice

The study of the costs of payment instruments proves that using a single methodology of cost estimation is extremely difficult. The central bank, commercial banks and non-bank payment service providers do not run a cost accounting system separating costs on payment instruments, but they compare their costs in the format required by the law. Therefore, only at the research stage, an appropriate division of costs can be made, often distinguishing the costs of payment instruments from other more general costs, e.g. from the cost of wages, third party services, depreciation, etc.

In some studies (e.g. in the Dutch, Belgium and Swedish studies), a conventional division of costs into variable and fixed is used and in other studies the Activity Based Costing (ABC) is used (in the Norwegian and Portuguese studies).

The division of the total costs into fixed and variable is connected with defining how in a given period (e.g. over a year) the different costs change. There are two types of variable costs: transaction-linked and sales-linked. A fixed cost is any cost that is not affected by changes in transaction numbers or sales, generated in a given period (Brits and Winder 2005, Quaden 2005). Therefore, depreciation, overhead costs, rents and annual fees are fixed costs in a one year period, whereas variable costs include all the transaction fees (merchant service charges, credit and money transfer fees, etc.), the time required to execute a transaction with a given payment instrument, the time spent travelling to ATMs, etc. Variable sales-linked costs are insurance costs, the costs of robberies, theft and fraud. Some cost items may contain all types of costs (fixed and variable dependent on the transaction number and on sales) – e.g. cash production costs, transportation costs with armoured car services. Defining the proportion of the costs is only possible at the stage of data compilation. The respondent (e.g. a bank) itself defines the proportions, using the directions of the author of the study (Górka 2011a: 48–49).

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The problem of the division of costs into variable and fixed can be eliminated when the Activity Based Costing is used. In this method, the division into direct and indirect costs is of paramount importance. In commercial banks many costs are of indirect character. For example, the following departments are involved in the creation of a particular payment service: the IT Department, Sales Department, Marketing Department, Customer Service Department, Security Department, etc. The problem arises of which costs (and in what proportions) incurred by the above departments should be allocated to particular services/payment instruments. In the ABC method, the functional organisational structure can in a way be cut across, basing the analysis on the sequences of the business process. Activities performed by people and machines which are important for producing the payment service are distinguished. Then, cost drivers (measurement units which are the basis for assigning activities to particular payment services) are identified. After that, cost pool of the activities is established, which contains the cost of resources taken from the costs of company departments. Finally, the costs of activities are allocated to payment services on the basis of their requirement for a particular type of activity. The ABC method is different from the conventional one in the approach to indirect costs. Direct costs are allocated in a similar way in both methods, namely in relation to the number (possibly value) of transactions. In the case of indirect costs, in the ABC method, the allocation key is the activities which are required for creating a particular payment service, and not the cost centres, that is organisational structure departments, as in the conventional method (Górka 2008: 46).

The period adopted for the analysis and the approach to initial or replacement investments may have influence on the cost measurement of payment instruments. When the costs of the infrastructure set-up are treated as sunk costs, they are not revealed in the costs of payment instruments. However, if we consider the initial or replacement investments in terms of depreciation, it may turn out that in the costs of payment instruments there will be more or less costs, depending on the year of the analysis. For example, if machines used for the physical processing of bank-

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notes and coins or servers switching card transactions and card acceptance terminals become totally depreciated in a particular year of the analysis, their cost will be lower than in the period of depreciation. It may turn out that adopting a particular year for the analysis will result in increasing the costs of one and reducing the costs of another payment instrument.

Limiting the scope of analysis to social costs of four groups from the payment chain and including payment services providers in the group of commercial banks (Brits and Winder 2005, Quaden 2005), the relations shaping the payment system in a particular country may not be fully exposed. In Poland the role of acquirers facilitating Points-Of-Sale in the acceptance of card payments and the role of independent ATM operators, developing the ATM network, is very important. The increase or decrease in the interchange fee or other fees may heavily impact the economic situation of these institutions (Górka 2010a, 2010b and 2011b).

Trying to use the proper method of measurement of non-pecuniary costs and benefits some problems are encountered. First of all, the time spent on payment transactions with different instruments must be quantified in money terms (Polasik, Górka et al. 2011), as well as the time devoted to cash withdrawals (Górka 2011b) and possibly other time costs. Secondly, accepting a particular quantifier may significantly change the level of cost consumption of a particular payment instrument. This was the case in the American study (Garcia-Swartz et al. 2006), the Australian study (Simes et al. 2006), the Swedish study (Bergman et al. 2007) and the Bank of Australia study (2007). In these analyses, to calculate time costs different kinds of wage rates were used, such as the average full national wage rate, the net wage rate, the half of the average wage rate, etc. Moreover, in all the studies enumerated above, different duration times of the same activities were defined (e.g. the time of travelling to an ATM and withdrawing money). As a consequence, after the conversion to pecuniary units, different time costs of the same activities were obtained (compare Górka 2009b: 165 and 168). Thirdly, a method of assign-

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ing money value to some benefits connected with the perception of a particular payment instrument (safety, convenience, anonymity) is on the one hand difficult on account of using a particular pecuniary quantifier, and on the other hand the benefit connected with perception changes with time, can be manipulated by promotion and articulated in a poll may not be true.

As it was aforementioned, costs, revenues and benefits of every payment participant can be split into private and social. Then, one attributes these costs to a given payment instrument. A cost can be social or private, revenue is always private and a benefit may be either private or social. Revenue can be treated as a private benefit and it is treated as such in the American study of Garcia-Swartz et al. (2006) and the Australian study of Simes et al. (2006). A benefit is social when it causes externalities. A social benefit in not explicitly included when calculating the pecuniary costs of payment instruments. It exists not only for individuals but for a group. Therefore, we can talk about social benefits mostly as far as consumers are concerned. The broadness of merchant acceptance of a particular payment instrument (positive externality, network effect) is a typical social benefit of consumers. Other benefits of consumers are for example: the anonymity of payment, the ease of use of a particular payment instrument, the immediate settlement, the credibility of the issuer, etc. It is a moot question as to which of these benefits can be classified as social, but they certainly are of private and non-pecuniary character.

The author's method for the cost analysis of payment instruments

The author has already made attempts to undertake an extensive study of payment instruments in Poland but has so far failed to convince the Polish central bank and representative groups of Polish banks and merchants. All institutions felt apprehensive about disclosing sensitive data. Moreover the costs of undertaking such a study seemed considerable. Especially commercial banks would have to put much effort into reporting the costs of payment instruments in a required configuration.

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An alternative way of conducting the research would be to use secondary data and certain approximations but this way would not guarantee the same degree of precision as in the studies based on primary data. The author successfully completed research on a more narrow scale in which he estimated unit costs of cash withdrawals at ATMs and at bank branches as well as cost savings for the Polish economy, banks and consumers arising from the use of ATMs instead of bank branches (Górka 2011b).

A purely social cost analysis is quite neutral, because it does not affect any stakeholder, especially commercial banks which earn profits on payment instruments. However, market reality involves balancing reciprocal costs and revenues/benefits. Therefore the cost-benefit approach seems more justified in analysing the choice and profitability of payment instruments.

The efficiency of payment instruments is a complex issue. The lack of convergence between private and social costs resulting from the subsidisation of cash and paper-based payments instruments, bundling and tying payment instruments with other bank products, hiding the true costs of payment instruments and lack of transparent cost-based pricing in banks make the issue even more complex (compare Bergman et al. 2007, Van Hove 2008, Leinonen 2008).

The approach to the extensive measurement of costs put forward by the author takes into account four stakeholders – the central bank, commercial banks, merchants and consumers (Górka 2011c). The author's concept is summarised below.

The central bank

Under article 227 of the Constitution of the Republic of Poland, the National Bank of Poland shall have the exclusive right to issue money as well as to formulate and implement monetary policy. The major social benefit of money circulation partici-

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pants (consumers, companies) ensured by the central bank is the certainty of cash acceptance and its appropriate quantity.

The National Bank of Poland, like most other central banks, makes profits on cash, not on other retail payments instruments.

By issuing cash the central bank earns revenues called seigniorage. Cash is the direct source of finance and non-interest bearing liability of the central bank. At the end of November 2011 the cash item accounted for more than 31% of NBP's total liabilities. The central bank can invest and make a return on the cash value in circulation, which in fact is an interest-free loan. The National Bank of Poland holds a long position in foreign exchange reserves. At the of November 2011 they accounted for 99% of NBP's total assets. Therefore, a significant share of earnings on forex reserves is strictly linked to cash. From the perspective of all entities other than the central bank, seigniorage can be perceived as a quasi tax. Cash loses its value due to inflation and does not produce any interest income to its holders. They bear the alternative cost of cash.

The NBP must reduce seigniorage revenues by deducting own private costs of cash issuance, including: currency production, delivering currency to banks, exchanging worn and damaged notes and coins, conducting authenticity and quality controls of currency, carrying out periodic analyses and evaluations of currency stocks, forecasting the circulation of notes and coins of particular denominations, bearing storage and security (vault) costs, etc.

In order to measure the central bank's costs of cash, alternative methods can be used: the conventional method based on the division of costs into fixed and variable, the ABC method or the mixed method. So as to be consistent with the analysis of commercial bank costs, the same method of cash measurement should be adopted.

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Commercial banks

For commercial banks and other payment service providers payment instruments are products or business lines, which generate both costs and revenues and may be profitable or not. Payment instruments are often tied to other banking products (like accounts) and used to cross-sell more profitable banking products (like credits). According to McKinsey (2005: 1-2) and Capgemini (2007: 50) payments account for 1/4 of revenues and 1/3 of costs in banks.

Payment cost surveys conducted in the world showed that undertaking payment cost study requires from banks financial input and a lot of effort to report costs in a demanded manner. The author has built a framework which is based on tables

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of bank rates and charges, so that banks would have ready data to report without the need to reconfigure them (Górka 2011c). However, the framework also contains elements of the ABC analysis in order to include properly direct and indirect costs (all overheads) pertaining to payment activities. Financial statements made public by commercial banks do not suffice. The collaboration of banks is necessary to extract these data from cost centers and departments to allocate costs to payment instruments.

Profitability of payment products/instruments in banks.				Figure 12
Profit on payment product	=	Revenues (mainly direct)	–	Costst (direct and indirect)
Source: Author's concept.				
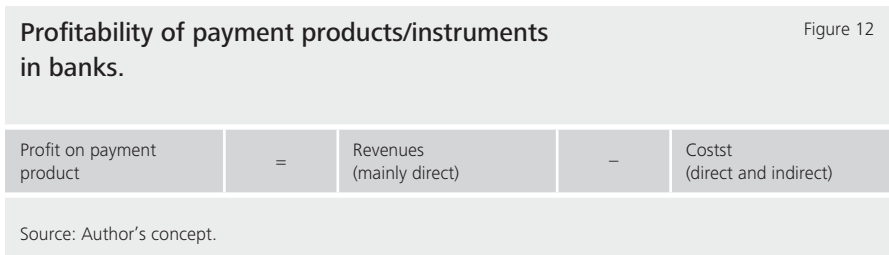
In banks payment products generate mainly direct income from fees and charges received, whereas the costs of payment are not only direct (e.g. fees and charges paid for processing transactions to clearing houses) but also indirect (e.g. IT, staff, marketing, security costs, foregone interest on cash stocks, etc.).

Method for estimating bank costs and revenues on payment products/instruments.			Figure 13
Costs (direct and indirect)	→	Allocation key based on cost drivers (preferably two types of costs drivers: transactional data and time data)	→	Cost of payment instruments
Revenues (mainly direct)	→		→	Revenues from payment instruments
Source: Author's concept.			

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Direct costs and revenues are allocated using transactional cost drivers (the number and value of payment transactions and data about overnight deposits). It is more difficult to distribute indirect costs between particular payment instruments, first identifying bank activities and services performed in producing payment products and then allocating them to each payment instrument with the help of cost drivers (transactional, time and if necessary intensity drivers).

Originally, the author distinguished quite many direct and indirect costs split into general categories and specifically into particular payment products (Górka 2011c). In the case of cash, for example, the costs comprise such items as: cash counter services, back-office counting and other cash handling activities, foregone interest on cash holdings, logistics (transport, CIT costs), ATM maintenance and interbank fees paid, security, frauds and robberies, book-account keeping costs and IT costs. Cash revenues include: client charges (corporations, small companies, individuals) for withdrawing and depositing cash at cash counters (in an open and closed form), ATM fees received (for withdrawals and deposits, interchange fees, other fees), transaction banking revenues and part of revenues from clients' current account charges.

Merchants

The costs of merchants, acceptors of payment instruments, constitute a significant fraction of the total payment costs. Merchants' costs can be divided into:
1. Pecuniary costs;
2. Time costs.

The first group of costs is clearly visible in the merchants' income statements. While the second group is harder to identify and requires a separate measurement. The merchants' costs differ depending on where the transactions occur. Remote Internet transactions are characterised by different costs than transactions at physical Points-Of-Sale (distinguished below). Polish consumers pay either in cash or with cards at shops.

Pecuniary costs of cash and cards for merchants (physical Points-Of-Sale).	Table 2

Payment cards	Cash
i. Costs of merchant service charge including interchange fee transferred by acquirers to banks issuing payment cards	i. Costs of cash open withdrawals/deposits
ii. Payment terminal rental costs	ii. Costs of cash closed withdrawals/deposits
iii. Telecommunication costs (depending on type of connection used – dial-up, ISDN, LAN, GPRS, etc.)	iii. Costs of safe envelopes and wallets
iv. Payment terminal service costs	iv. Costs of cash register (part of it)
v. Float costs	v. Costs of insurance against cash thefts and robberies
vi. Disputes and chargebacks	vi. Costs of counterfeited notes and coins
vii. Costs of frauds	vii. Costs of thefts, frauds and robberies
viii. Costs of adjustment to Payment Card Industry Data	viii. Costs of armoured car services (Cash-In-Transit, CIT costs)
viii. Security Standards (PCI-DSS)	ix. Costs of foregone interest on cash holdings.
ix. Other costs (for additional software, logo on slips, enhanced payment terminal interface, etc.)	x. Other costs

Source: Author's concept.

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Time costs of cash and cards for merchants (physical Points-Of-Sale).

Table 3

Payment cards	Cash
i. Payment tender time (card payments).	i. Payment tender time (cash payments)
ii. Time of payment terminal operations, (preparing, switching on and off, changing terminal paper rolls, etc.)	ii. Time of preparing cash registers
iii. Time of contacts with the acquirer service, telephones due to malfunctioning of terminals (e.g. problems with authorisations)	iii. Time of changing cash in other stores when there is lack of particular denominations of notes and coins at cash registers, possibly time of supplying needed denominations to cash registers in other ways
iv. Time of sending payment orders packages to an acquirer at the end of a day, possibly at other times of a day	iv. Time of travelling to banks
v. Time of disputes with clients who want to execute chargeback	v. Time of reconciling payments at the end of a day (or possibly at other times of a day) and preparing for cash (open or closed) deposits
vi. Other time	vi. Other time

Source: Author's concept.

In order to calculate the total and unit costs of payment instruments the following transactional data is needed:

1. The number and value of cash transactions.
2. The number and value of card transactions (division into types of cards).
3. Possibly other transactional data (e.g. the number of cash open and closed deposits).

Tables 2 and 3 include merchants' cost items which, depending on the payment instrument acceptor, can be more or less important. Smaller merchants have their employees deliver cash to their banks, whereas bigger merchants pay for the services of CIT companies which deliver cash to banks on behalf of merchants. In Poland small merchants often do not necessarily deposit cash in banks or withdraw it every day. They may use earned cash to pay back their current obligations. Some time costs of cash, like preparing for cash deposits at bigger merchants (e.g. super-markets), may involve work of more than one employee. The time costs of payment

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cards can also be considerable, especially in the cases when terminals do not respond to authorisation orders, which additionally may cause negative externalities for clients, who willing to pay with a card, cannot execute a payment and do not have cash at hand.

The major benefit for merchants resulting from card payments is bigger sales. Consumers may spend more with a card. They may prefer card payments and be additionally induced to spend more by loyalty programmes. Often however in such programmes at Polish Points-Of-Sale customers get reward points whatever payment instrument they use. Possibly another benefit for merchants resulting from the use of credit cards issued by banks is that they can avoid investing in in-house credit departments.

Consumers

Consumers are payers who decide what payment instrument to choose in a given payment situation. They, just like merchants, do not earn on payment instruments but bear specific costs. Consumers can also benefit from using a particular payment instrument. The benefits and costs of two basic payment instruments are shown in tables below.

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Consumers' costs and benefits of cash.	Table 4
Type of cash cost or benefit	**Benefit / cost**
Anonymity, privacy	benefit
Popularity of cash and certainty of acceptance	benefit
Means of storing wealth (financial asset)	benefit
Ease of controlling expenditures	benefit
Convenience and ease of use	benefit
Immediate settlement	benefit
Possibility to settle debts without additional infrastructure necessary to execute an electronic transaction	benefit
Credibility of the issuer	benefit
Possibility to execute consumer-to-consumer transfers	benefit
Time spent on a cash payment transaction at a Point-Of-Sale	cost
Time spent for a trip to an ATM or a bank and the time spent on a cash transaction alone (withdrawal/deposit)	cost
Theft/robbery	cost
Seigniorage	cost
Fees paid for cash deposits/withdrawals at a bank counter	cost
Fees paid for cash deposits/withdrawals at an ATM	cost
Fees paid for cash withdrawals at a Point-Of-Sale (cash back)	cost
Part of fees paid for current accounts, bundled services (e.g. free of charge ATM withdrawals)	cost

Source: Author's concept.

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Consumers' costs and benefits of payment cards.	Table 5
Type of card cost or benefit	**Benefit / cost**
Float (delay between purchase and settlement of accounts)	benefit
Credit option (credit card)	benefit
Card rewards (credit card), possibly money back (the bank shares the interchange fee with the card user)	benefit
Record keeping (possibility to track purchases executed with a card)	benefit
Possibility to withdraw cash at a Point-Of-Sale (cash back)	benefit
Time spent executing a card payment transaction at a Point-Of-Sale	cost
Time spent checking card statements and reconciling credit card and debit card account statements and the time spent paying credit card bills and speaking with bank employees about card issues	cost
Fees paid for cards (annual/monthly fees, charges for issuing cards, for a change of PIN, for altering card payment limits, for bank statements, for transfers of money from cards, for card insurance, for late repayment of a credit on cards, for exceeding credit limits on cards, etc.)	cost
Source: Author's concept.	

After careful consideration of consumers' costs and benefits, the conclusion can be drawn that some items may be relative or not equally important for all consumers. The cash benefit – the ease of controlling expenditures means that a consumer pays more attention to the amounts spent using cash than when making purchases with a card. However, in the case of cash transactions he deprives himself of the record keeping benefit accompanying card payments, by which all trans-actions are automatically saved and can be later verified and controlled via the bank statement. On the other hand, the record keeping benefit on a card is a disadvantage in some situations for consumers who value anonymity. In effect consumers face a trade-off. Moreover, the record keeping benefit may entail bearing time costs (compare table 5).

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The float as a benefit attributed to cards may in fact be negligible in the case of debit cards. Its importance grows with credit cards, when a consumer pays off the balance by the end of a grace period. When he does not pay the balance off, the loan is not interest free. Conversely, the loan may be quite expensive in terms of interest and a consumer may have to pay additional costly charges to his bank. It should be remembered that according to various cost studies (compare above) credit cards are a very profitable product for banks in all countries. Therefore, what may be a benefit for a single consumer who uses his credit card responsibly, brings losses to all credit card users and produces significant gains to banks. These gains may be of such magnitude that banks are willing to diminish them by offering credit card reward programmes, which however induce consumers to pay with their credit cards more often.

Recently in Poland several banks offered consumers additional card benefits. Consumers who pay with their cards frequently may benefit from a money back programme. A bank shares an interchange fee with them. By each payment a consumer gets a percentage of the amount credited back to his account at the end of a month. Obviously, the bank limits money back sums, so that they could not exceed some thresholds. This phenomenon clearly shows that interchange fees pertaining to card payments are too high in Poland.

The discussion of cost-benefit studies of payment instruments

Undoubtedly in conceptual terms the cost-benefit approach to payment instruments is advantageous compared to the purely social cost analysis or social and private cost analysis that include only pecuniary items. The cost-benefit approach seems closer to the real economic situations in which parties take decisions.

However, objective quantifying non-pecuniary costs and benefits of payment instruments pose difficulties. The problem is shortly discussed on the example of

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two studies: the American study of Garcia-Swartz et al. (2006) and the Australian
study of Simes et al. (2006). The Simes study replicated the Garcia-Swartz method-
ology, hence both studies are almost directly comparable.

List of costs and benefits calculated in Garcia-Swartz et al. and Simes et al. studies.			Table 6
Demand side of the payments market			
Merchants		**Consumers**	
Costs	**Benefits**	**Costs**	**Benefits**
– Tender time (cash, cards) – Deposit preparation (cash) – Bank charges (cash, cards) – Float (cards) – Other direct costs* (cash, cards)	– No benefits calculated	– Processing time (cash, cards) – Queue time (cash, cards) – Explicit price/bank charges (cash, cards) – Implicit price (cash) – Seigniorage (cash)	– Float (cards) – Credit option (cards) – Record keeping (cards) – Cash back option (cards) – Reward cards (cards) – Privacy (cash)
Supply side of the payments market			
The central bank		**Commercial banks**	
Costs	**Benefits**	**Costs**	**Benefits**
– Processing cost (cash) – Production (cash)	– Seigniorage (cash) – Processing revenue (cash).	– ATM maintenance (cash) – Production (cards) – Processing (cash, cards.) – Reward cards (cards)	– Processing revenue (cash, cards) – Float (cards)

* This includes the cost of fraudulent use of payment instruments incurred by the merchant (e.g., dishonoured cheques, collection fees, credit card chargebacks where the merchant cannot verify transaction authorisation, value of cash theft and counterfeiting and associated loss prevention measures) and the cost of armoured car transport for cash (Simes et al. 2006:14).

Source: Garcia-Swartz et al. (2006) and Simes et al. (2006).

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Comparing the list of costs and benefits in the studies of Garcia-Swartz *et al.* and Simes *et al.* with the author's list of costs and benefits it is clearly visible that the discussed studies did not include all items. Especially the list of consumers' cash benefits was short, only privacy (anonymity) was taken into account by Americans and Australians, whereas the list of consumers' cash benefits is much longer (e.g. broad acceptance base, immediate settlement, no infrastructure required, possibility to perform easy consumer-to-consumer transfers).

Moreover, analysing Garcia-Swartz *et al.* and Simes *et al.* estimates, one has to admit that costs of cash were overstated. The author agrees with the Shampine's critique (2007: 496) who wrote: "For example, ATM maintenance costs and ATM fees are included in Garcia-Swartz *et al.* analysis (costs incurred prior to the customer arriving at the cash register) but credit card reader and electronic network maintenance costs and credit card annual fees are not. If one were to include ATM maintenance, then one should also include the maintenance of electronic card readers, including data line costs and servicing costs".

In Garcia-Swartz *et al.* and Simes *et al.* studies privacy was also rated too low as a benefit equal to the discount provided by loyalty cards (compare Poles' attitude to anonymity at physical Points-Of-Sale – survey results and Shampine 2007: 503).

On the other hand, the implicit price of cash (the value of time spent travelling to an ATM and conducting an ATM withdrawal) was calculated too high. In both studies it was assumed that on average, 5 minutes were required to travel to the nearest ATM (4 minutes) and complete a transaction (1 minute). In other studies – e.g. Bergman *et al.* (2007) and Reserve Bank of Australia (RBA 2007) – shoe leather costs of obtaining cash were estimated much lower (simplifying, travelling to an ATM should take on average 1 minute and withdrawing cash – 50 seconds). Also multiplying the time of obtaining cash by the average U.S. (or Australian) full

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wage seemed to be too high. In the study of RBA (2007) this time was calculated on the basis of a half of the average wage rate in Australia.

Garcia-Swartz *et al.* and Simes *et al.* did not consider any time costs of cards, which certainly exist. The RBA enumerated these costs and partly included them in its calculations. Time costs of cards comprise such items as: the time associated with checking credit card statements for fraudulent or mistaken activity, the time involved in reconciling credit card and debit card account statements and the time spent paying credit card bills and speaking with customer service representatives about account-related queries (RBA 2007: 19).

There are many consumers' costs associated with cards (different fees and charges) which were disregarded by Garcia-Swartz *et al.* and Simes *et al.* (compare the author's list in the previous chapter and Górka 2011c). Although card fees paid to banks have nothing to do with the choice of a payment method at the Point-Of-Sale, they are important from the perspective of consumers' private costs. ATM charges and the time spent travelling to cash dispensers and withdrawing money also have nothing to do with the choice of a payment method at the Point-Of-Sale but they were included by Garcia-Swartz *et al.* and Simes *et al.* in cost calculations. Seigniorage is another cost which a consumer bears before payment transactions occur at the cash register. Even ignoring the fact that Garcia-Swartz *et al.* and Simes *et al.* estimated costs of seigniorage for cash and did not take into account similar costs of foregone interest on banking current accounts (which gave no interest or negligible interest) attributable to cards and other non-cash payment instruments, the way of calculating seigniorage in analysed studies was disputable. Garcia-Swartz *et al.* and Simes *et al.* obtained the seigniorage cost figure by counting the difference between what it cost the government to produce currency and the face value of the currency which was then at the government's disposal (Garcia-Swartz *et al.* 2006: 190, Simes *et al.* 2006: 34). The author believes that the method of calculating seigniorage proposed by him (the section "the central bank")

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is more adequate. The government does not spend the currency on goods consumption, in fact the central bank issuing cash invests these funds in different types of assets, in Poland – in foreign highly-rated assets (forex reserves). Therefore, the return upon these assets, multiplied by the share of cash in the central bank's liabilities, minus the costs of cash for the central bank, produces an outcome which can be treated as the central bank's seigniorage income. However, in any case one should claim that the obtained figure is the seigniorage cost for consumers or other entities holding banknotes and coins. From their perspective the foregone interest on cash holdings should be counted as an opportunity cost of, let say, risk free Treasury securities (or other risk-free financial instruments). Unfortunately, when one calculates seigniorage differently for the central bank and consumers (possibly other cash holders) this cost item will not net out in the social cost calculations consolidated for all payment stakeholders.

Finally, Garcia-Swartz *et al.* and Simes *et al.* did not find a way to include merchants' card benefits, such as increased sales as an effect of using cards and savings resulting from avoiding running in-house credit departments in the case of sales produced by credit cards.

Garcia-Swartz *et al.* and Simes *et al.* underline that their calculations ought to be interpreted as suggestive and illustrative but not definite, and further refinements may be possible. The author is of the opinion that both studies deserve a good appraisal although in his view their outcomes must be treated with great caution since many underlying assumptions and methods of calculation were arguable (compare above).

The survey results presented in the chapter "Payment habits of Polish consumers", show that currently Poles still perceive cash as far more convenient, cheaper, quicker in use and safer than cards. Merchants are of a similar opinion. Polish consumers consciously and unconsciously weigh their pecuniary and non-pecuniary costs and

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benefits when deciding about the choice of a payment instrument. It turns out that Polish consumers still think that cash is less costly and more beneficial for them, since they use it more often than cards at physical Points-Of-Sale. On the Internet, the benefits of cash are of smaller magnitude, in effect on the Internet cash in Poland is more quickly driven out by other payment instruments (mainly electronic credit transfers).

The overall trend is the decreasing share of cash payment in the total number of payments in Poland, but probably changes will occur faster in remote transactions and slower at Points-Of-Sale transactions. The intense promotion of payment cards may accelerate the change and the Polish society's perception can become similar to the perception of the societies from Western Europe. Perhaps also some benefits of cash will erode, e.g. the unique cash feature that allows for consumer-to-consumer payments. At present, payment cards may migrate to the mobile form of an electronic wallet, which will make initiating P2P/C2C payments from mobile devices far more easy.

Moreover, the acceptance base of cards is also growing, although in Poland the process is seriously impeded by high merchant discount fees and other merchant charges.

On the other hand, Poles still value anonymity a lot and cards warrant it less than cash. Perhaps an introduction of new payment solutions (e.g. based on electronic money) ensuring more privacy would prompt customers to stop using cash and start using the new payment method. Truthfully, however, current anti-money laundering laws in Europe hamper business initiatives that would launch payment solutions characterised by high level of anonymity. Perhaps Polish consumers may with time start holding anonymity in lower esteem or may agree to sacrifice this benefit in exchange for other benefits, e.g. convenience. This is a deeper sociological issue not only concerning payments. People worldwide begin to share pub-

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licly very private things, for example through social networks. They are ready to sell their personal data for a discount in a shop or for a possibility to use a computer application or an operational system "for free". In exchange for a benefit of using some products, like for example maps and GPS on their mobile phone, they are ready to allow tracking their location and activities, so the companies may build their behaviour profile and use it later. People are often not aware what terms of contract they accept and what threats are associated with their decisions. Sometimes they accept terms of contract feeling that they must do it and depreciating possible negative consequences of their decisions. Sometimes consumers are not even asked for permission, but their personal data are processed and used anyway. In payments new technologies are breaking their way. When The RFID and NFC (Near-Field-Communication) technology expands, it will bring many convenient benefits. Individuals will not only pay over-the-air in an instant, but will also benefit from a constant flow of information about products, promotions, etc. It will only suffice to have a mobile device with a digital wallet activated. The obvious trade off will, however, be less privacy and anonymity.

Research shows that Poles treat cash as an important means of storing wealth. They trust the issuer of currency (the National Bank of Poland). This is another important cash feature which tempers the pace of superseding cash from money circulation.

Conclusions

The best evidence for how consumers (payers) value costs and benefits of payment instruments is to look at the statistics of usage. Cash is still held in high esteem by Poles. Partly, the popularity of cash results from the price policies of commercial banks which do not charge consumers for cash operations. In effect, consumers perceive cash free. On the other hand, costs of cards are also hidden from consumers and Poland suffers from the highest in Europe merchant card fees. Together

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with cardholder fees they make the Polish card industry very costly for consumers and merchants and in parallel very profitable for banks and payment card organisations.

The author is under the impression that two biggest card organisations and several commercial banks operating in Poland treat the domestic payment market as a lucrative testing ground. This thesis is supported by interchange fee tiers on card payments in Poland, which have been extremely high for years, recent reductions of interchange fee tiers on ATM withdrawals and significant licence, marketing and processing fees of payment card organisations (the latter not publicly available). The author believes that Poland (and Europe) lacks the competitive, cost-efficient non-cash payment scheme that would successfully challenge existing card payment schemes.

In the article the author promotes the idea that the cost-benefit approach towards payment instruments embracing all the parties in the payment chain is the most advantageous because it best describes the parties' interests and reciprocal relations. In his view in order to appropriately measure the costs and revenues of institutions of the supply side of the market (the central bank, commercial banks and payment subcontractors) the method containing elements of the Activity Based Costing would be most suitable. On the other hand, quantifying non pecuniary benefits and costs of payment instrument poses serious difficulties and may be disputable.

Facing problems with undertaking extensive studies of the profitability of payment instruments for the central bank and commercial banks the author seeks to find proxy measures.

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The list of merchants' and consumers' costs and benefits related to cash and cards contains numerous items which may be unequally internalised by different merchants and consumers. Typically, entities are more sensitive to pecuniary costs and benefits. Therefore, merchants in Poland strongly oppose cards due to their high fees, indicating that cash is cheaper and consumers receiving little signals about the price of banknotes and coins from banks regard cards as more costly than cash. Judging by the perception of cash and cards and by the usage of payment instruments in Poland it seems that benefits of cash still dominate their costs and the benefits of cards.

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Russell Krueger
On a Blank Slate: Cash and Cash Requirements for Future Currency Unions in Africa and the Gulf

Russell Krueger
International Monetary Fund

The usage, costs, and benefits of cash:
Theory and evidence from macro and micro data

The Bundesbank is providing a valuable service to future monetary unions by sponsoring this conference, which will help clarify future trends and challenges.

This paper reviews issues surrounding policies on currency and cash demand that will be faced by four currency unions being formed in Africa and the Gulf.

During the next half decade, four future currency unions[1] comprising 30 countries
will set cash policy for their new unions and design their currencies. New
union currencies will completely replace the preexisting national currencies, and all
issues related to currency design, production, and use will be under consideration.
Key issues that will be considered include overall cash demand, usage in low
income and rural populations, cash durability and replacement under severe
conditions, setting denominations, the coin-bill boundary, acceptability require-
ments, competition from cocirculating currencies, and competition from e-money.
This list of issues facing new unions appears more demanding than those facing
the European Monetary Institute when it was designing the new euro.

In undertaking these weighty tasks, each union begins with a blank slate on which
they must write out their strategies for their currencies and cash policies. In doing
so, four stages can be foreseen;

1. Understanding how cash policy for the Euroarea was handled and how cash
   issues for unions differ from those of single countries.

2. Adjusting lessons from the European experience to reflect the unique
   conditions, institutions, and policy frameworks in each region building new
   monetary unions.

3. Evaluating cash policies in future unions to reflect recent market and technical
   innovations – a key theme of this conference.

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1 Currently, four regions (East African Community, Gulf Cooperation Council, Southern African
Development Community, and West African Monetary Zone) have active programs to build new
currency unions. The problems currently facing the Euroarea have caused each to modify elements
of their programs, but have not caused them to defer their initiatives. Launches will be in 2016 at
the earliest; thus, about five years preparatory work on cash and currency issues is envisioned, which
roughly corresponds to the timeframe for development of euro cash.

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4. Anticipate innovations in cash and its use and make appropriate changes to the
   cash policies of the new unions.

This paper will review currency issues facing future unions. First, the process
followed in Europe will be reviewed to provide a sense to new unions of the many
tasks to address and resolve. The following section notes key differences likely in
future unions, which will call for new answers. A third section covers the role of
e-money as it may pertain to future unions – it is assumed that e-money will be an
important part of the monetary arrangements for all future unions by their start-up
dates six to ten years from now. The final section looks at the process ahead for
future unions.

Two appendices follow that discuss of some specific issues that will face future
unions – the impact of creation of new unions on the banknote printing and
minting industries, and the possible role of e-money in facilitating the changeover
to the new union currencies.

A. Creating the euro

The challenge

A country's currency has long been a symbol of the country's sovereignty. The
creation of the European Monetary Union challenged the long-standing identity
between a country and its currency. The new currency, the euro, would have to
transcend national sentiments and provide a new transnational symbol of the new
union.

A long, detailed process to create the euro was followed that dealt with three
challenging issues – the technical requirements of a new currency, dealing with
usage patterns for a bigger and more diverse economy than in any member

country, and changing the perception of the currency to fit the concept of a new, unified Europe in which the single currency was to be the capstone.

A similar process will need to be followed by new unions – first, the usability requirements of the currency must be determined; second, technical aspects of currency design and production must be worked out in a process that can be expected to take at least 5 to 6 years; and third, the politically sensitive process of creating the image of the new currency will proceed. As was done on Europe, all these elements should be handled by a single committee or process to ensure a successful synthesis.

Creating the euro

The European Monetary Institute recognized that creating a new currency would be a long process and thus work began early in the planning process. The process from beginning to circulation of the new currency took about nine years. Work began in 1994 with the set up of the "Working Group on Printing and Issuing a European Banknote", which was later called the Banknote Working Group (BNWG).

An early decision was that the euro banknote should be extremely high quality and that banknote production should be continually monitored and improved. This had many advantages – it encouraged acceptance, counterfeiting was discouraged, and use in vending machines and money handling machines was improved.

Development of high quality standards also facilitated the production of banknotes because most of the likely Euroarea countries produced their own banknotes. Each country had its own quality standards and security features; the purchasing power of each unit of national currency differed; denominations varied; and size, color, and designs differed. In contrast, the euro would be a common currency produced in multiple sites and the features and quality standards had to be specified in detail

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and tightly monitored. Thus, strict production standards were needed and the
output of each of the printing facilities in different countries would be monitored
to ensure quality. This quality assurance process was challenging given the tight
production schedule and massive number of banknotes to be produced – little time
existed to recover in the event of errors.

Reflecting the pan-European aspirations of the new currency, a decision was made
that the new currency should be free of national symbols or references.[2] The
decision reflected an urge to convey the unity of the continent under the new
currency and also avoid potential problems using banknotes in countries other
than where they were issued. The name euro was selected because of its
applicability in all member countries and because it was not named after any
current or historical European currencies.

A deliberative, inclusive process was followed to design the new currency.[3] The
BNWG held a competition for design themes for the new currency. It collaborated
with a group of central bank experts and external experts and set up a Theme
Advisory Group. The Group's terms of reference included evaluating themes that
cover the family of seven planned banknotes and ensuring that each theme
provides maximum protection against counterfeiting. The BNWG retained the right
to modify or reject any recommendation. The Advisory Group was given 6 months
to make recommendations so that the BNWG would have time to reach agree-
ment within a one year time frame.

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2 Design of the new euro banknotes began prior to the decision to avoid arry national identification
or references. Initially, euro banknotes included a space to the lower left of the map of Europe where
national identification could have been made. Instead, the first position on each note's serial number is
an alphabetic character that indicates the country that issued the banknote, but the public is generally
unaware of this.
3 EMI Theme Selection Advisory Group. "Interim Report on the Selection of a Theme for the European
Banknote Series." 1994.

The Advisory Group was mandated to create themes that symbolize Europe and its unity in a visual presentation, be aware of sensitivities of EU countries that remain outside the euro system, meet legal requirements, and serve as a means of payment acceptable to the public. Moreover, themes had to be broadly acceptable throughout the EU, be legible and widely understood, avoid national or gender bias, and have an aesthetic appearance. Finally, because there would be a period in which the new currency would cocirculate with the national currencies, it would need to be immediately recognized and acceptable to the broad public. The European Union flag and stars were accepted as a widely recognized symbol that should be included on the banknotes.

In 1996, a design competition was held in which entries were solicited for a common design theme that would run through all denominations of bills. Forty-four entries were judged anonymously by a jury of marketing, design, and art history experts, which was followed by a public consultation. The final design decision was made in 1998, after which the technical production of the banknotes began.

Parallel to the work on visual design of the banknotes, work proceeded on security and anti-counterfeiting features of the banknotes. The sophistication of counterfeiters and the availability of technology capable of producing very high quality reproductions required using multiple security features. Some security features must be available for use by the public to routinely decide that banknotes are genuine. Other features are needed by vendors and cash handlers to verify currency during automatic processing. Some features based on sophisticated

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technologies were known only to authorities and used as ultimate tests of the authenticity of the currency.[4]

The ECB carefully investigated the usability features of the euro, including elements such as coin-banknote threshold, unit size, color, size, feel, machine acceptability, etc.

Coin-banknote threshold – An important aspect of currency use is the coin-banknote threshold, which is the where the break is made between the largest value coin and the smallest value banknote and the size of the gap between the largest coin and the smallest bill. The boundary is affected by usage patterns. For example, economies with large low-income populations will have many small cash transactions daily. Coins have better durability, but market traders often prefer small value banknotes that are lighter and easier to handle. In contrast, in Europe and Japan, high value coins facilitate use of coins for fairly large retail transactions. In other economies where currency is often dispensed in automatic teller machines, banknotes may be used very commonly with coins used primarily for making change.[5] [6]

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4 A general rule of cash design is that regardless of precautions ultimately counterfeiters can develop passable fake banknotes. However, this takes time, money, and involves risks. Banknote designers therefore include multiple security features to make the counterfeiting process as difficult and costly as possible and thus discourage production of passable counterfeits. The ECB established stringent rules and procedures to detect counterfeits and remove them from circulation and to document the extent of counterfeiting. Typically over time counterfeiting increases and it becomes necessary to introduce a new version of the currency, but counterfeiting of the euro banknotes has remained insignificant, which has permitted deferring introduction of a new generation of euro banknotes.
5 The coin-banknote gap in the Euroarea has been strongly criticized. At least four countries have requested one euro banknotes, and a majority of the European Parliament has also made this request. These criticisms may grow as lower income countries in East Europe join the Euroarea. In Slovakia for example, the euro banknote threshold is over seven times higher than for the koruna. (Kubusova, 2009) This type of issue will face new unions with countries with highly varied incomes.
6 The coin-banknote gap affects the legal issuance of currency because often central banks issue banknotes and national governments coins. This affects the balance sheets of the institutions, but more importantly affects the amount and distribution of seignorage.

Unit size – The purchasing power of one unit of the union currency needs to be decided to provide the nominal base to set all other banknotes and coins. The level should be set at a point that avoids heavy use of coins for everyday purchases and also avoids use of high denomination banknotes for small purchases, which will incur high costs to replace worn-out low value banknotes. Europe was able to examine the clustering of values of national units in terms of purchasing power, but this will be difficult where wide income differences exist between union member countries – a comfortable level in one country could be a nuisance in others.

Size and color – As noted above, Europe followed a careful process to assure that notes were clearly identifiable in use by size, color, and design.

Special needs – Consultations were held with the European Blind Union and special design features were added to assist visually impaired users. Color, denomination size, and tactile feel were adjusted to assist visually impaired users. For example, coins each differ in size, weight, thickness, and milling around the edge, all of which permit identification by the blind.

Durability – The durability of paper stock and the permanence of ink and security features were considered in designing the currency.

ATM and cash handling machine acceptability – These were important features in Europe, where most currency is distributed by ATMs and banks routinely process currency by machine. These needs place a premium on high quality, durability, and cleanliness of the currency, which led to strict requirements that damaged or dirty currency be removed from circulation.

Vending machine use – The currency designers worked with suppliers of vending machines to ensure that machines could identify coins and banknotes, and

conversely reject counterfeits, slugs, and noneuro coins. One standard achieved
was the ability to identify banknotes regardless of which of the four possible ways
the notes can be entered into the machine.

Languages – Banknotes will need to convey information in languages understood
by users. For example, the original euro used the Latin and Greek alphabets for the
abbreviation of the ECB, and Cyrillic characters were introduced when Bulgaria
joined the EU in 2007.

Toxicity – Banknotes were expected to meet the most stringent European health
and safety regulations. Tests were made on all denomination banknotes, all
printers were investigated, and production materials were tested. This included
investigations of the use of Tributyltin (TBT) as a possible danger to health of users
that concluded that TBT was present at far too low levels to pose any threats.
Investigations of nickel exposure from one and two euro coins have also been
made. The usability investigations cited above and others have resulted in produc-
tion of very high quality banknotes and coins that robustly serve many purposes.
Important considerations were use of the currency in Europe's high-income, highly
automated environment. Elsewhere, very different income, environmental, and
usage situations could result in different currency requirements than in Europe – an
issue discussed further below.

Currency production

Two factors dominated decisions regarding the printing of euro banknotes and
minting of coins – preexisting national printing presses and mints that politically
could not be abandoned, and very high quality standards that required close over-
sight of the dispersed production of the currency. Initially, eleven printing sites were
used, with each site specializing in production of a maximum of two denomina-
tions. Concentrating production in a limited number of centers made controls

easier, helped coordinate production, helped ensure quality, was more secure, and kept costs down because of efficiencies of scale. These advantages helped produce a very large number of banknotes and coins under a tight production schedule. At the start of the union, each country was responsible for producing or obtaining the stock of currency needed.

Following the design process, final designs and technical specifications for the euro were set in February 1988, almost four years prior to circulation of the currency. Production of the printing materials began, including creating dies, films, holograms, and software files, based on manufacturing of printing plates from a single source. Arrangements were made in parallel to obtain raw materials and security devices. Materials needed to be continuously available and multiple sources were sought to avoid potential bottlenecks. Forty different suppliers of raw materials were involved.

Rather quickly, materials were gathered by September 1998 for test printing of several million banknotes under standard operating conditions. This test established the flow and quality of raw materials, tested the quality management system, and allowed examination of the output.

The initial production phase rested on efforts of the national central banks, which recognized that many of the countries had their own national printing operation that they wished to continue.[7] Each country was responsible for producing or

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7 This was an application of the principle of "subsidiarity" enthroned in the Maastricht Treaty, which holds that many union functions should be performed on a decentralized basis by member countries in lieu of centralizing the work. Given the complexity of the union building process, subsidiarity greatly facilitated the start of the union by placing reliance on preexisting national capabilities rather than creating new centralized institutions and procedures – many centralized activities and institutions were introduced but less so than if subsidiarity had not been followed. However, a cost of subsidiarity is a greater burden to fashion and apply common rules and coordinate activities undertaken in multiple countries.

obtaining its own stock prior to the launch of the union. Banknotes could be obtained from other countries, or countries could pool efforts.

The ECB set initial production at 13 billion banknotes totaling about 600 billion Euros in value.[8] This included stocks for use by businesses and the public, which had to be distributed and in place throughout the union prior to the startup date. Small working stocks were provided to businesses and consumers beginning the month before startup, which was called "frontloading". Reserve stocks also had to be in place to deal with unexpected demands. And finally, some currency had to be available to build working stocks in countries outside the Euroarea.

Advantages for the euro

This section reviews conditions for currency use and currency design and production in Europe that facilitated (mostly) or hindered introduction and current use of the euro. This section lists key advantages to illustrate the extent of challenges for future currency unions that will not share the same advantages. For future unions, the conditions on the ground, currency usage patterns, and how they interact with currency design, production, and cash management can be expected to be very different. Many of the usage issues listed below will be reexamined later in the paper to discuss plausible responses by future unions.

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8 Estimates of the production run in total and by denomination depended on calculations to convert the stocks of national currencies into a common measure of value, which was possible because of the existence of the European Monetary Unit (EMU) (which provided conversion rates from national currencies into a common value) and an implicit assumption that the euro would be set to be equal to one EMU. The setting of the euro at par with the EMU was not formally agreed until just before the start of the union, but a rate at par or near to it had to be in mind well before then in order to produce the stock of banknotes and coins prior to the start of the union. Neither of these conditions will necessarily hold for future unions.

– The Euroarea began with many advantages – it is high income, relatively compact, has a large and competent bureaucracy, and has high literacy. Europe's high income provided the collective wealth for governments, banks, businesses, and households to easily absorb the costs of transition to a new currency.

– Europe has a high population in a compact area, which provides efficiencies in introducing a new currency.

– Europe's many languages created costs in communicating information about the new currency.

– The Euroarea is part of the larger European Union which handled heavy lifting in terms of setting the overarching legal and regulatory framework and promoting regional integration.

– The Euroarea is highly integrated and thus cash flows readily across national boundaries. Likewise, (although there was some fencing into national boundaries) financial institutions can operate freely across national boundaries to support free capital movement within the zone.

– A strong financial infrastructure existed that provided the broad range of financial services, including cash processing.

– The economies were highly integrated prior to the union start-up due to application of "convergence criteria", which minimized prospects of disruptions due to introduction of the new currency.

– The public had easy access to banks and other formal financial facilities. ATM use was very heavy.

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– The deutsche mark was the lead currency and was held for safekeeping or speculative purposes throughout the future Euroarea and especially outside the zone.

– Compactness, travel patterns, and vacations created large intra-zone currency flows, as well as flows outside the zone. In some cases, clear seasonal patterns of flows and return flows could be identified.

– Prior to the Euroarea, currency crises were regular features in Europe, which resulted in some speculative currency holdings.

– Advances in payments technology, including EU-mandated cross-border facilities, changed payments patterns and probably reduced the need for cash holdings.

– Credit card and e-money will affect future cash requirements and usage patterns.

– Anticipation of expansion of the Euroarea fostered holdings of euros in potential future members. In some cases, such as Poland, the euro supplanted dollar holdings to a large extent.

– High quality national printing presses and mints existed.

– Counterfeiting was an important, but not overwhelming problem. National authorities had preexisting partially successful programs to deal with counterfeiting. Counterfeiting of the euro has been limited and thus a new version has not had to be introduced.

– Underground and criminal activity existed, giving rise to unrecorded cash flows that often favored use of relatively high denomination banknotes.

– Hoarding existed for various purposes. Demand for very high denomination euro banknotes was strong, much of which may have gone into hoards to replace national currencies (especially the DM), the dollar, and other favored currencies.

– Cocirculation of non-eurozone currencies was limited.

– The euro existed for three years as a "virtual currency" used for government accounts, bank deposits, financial accounting, statistics, etc.. This transition period allowed banks, businesses, and the public to become familiar with the purchasing power of the euro prior to emission of physical currency.

– A modest upward spike in consumer prices occurred when physical euros were introduced.

– Conditions described above permitted the introduction of physical euros in a "Big Bang" that replaced national currencies within a short period, which minimized costs and confusion because of use of two currencies simultaneously.

– Finally, countries adopting the euro after the start of the union easily adopted it because they were very familiar with it due to tourism and other cross-border flows and already had working stocks.

The long list of conditions above contributed to successful and rapid introduction of the euro. Glitches were minor and the public quickly accepted the new currency and adjusted to it. However, as will be discussed in the next section, many of these conditions are absent in future unions. Many new solutions will need to be found and introduced simultaneously with the introduction of the new union currencies and all the changes in economic behavior that will accompany the start up of a monetary union.

B. Currency usage in future monetary unions

This section looks at issues associated with creation on new currencies in future monetary unions, where conditions differ greatly from those surrounding the euro. There are important implications for the design, production, and use of the new currencies. To take one salient example, e-money has become very important in some future union areas and new unions will need to directly consider its relevance to their overall cash policies – the next section provides a separate discussion of e-money.

The cash usage conditions of the four monetary unions now being formed differ greatly from those in Europe and indeed often from each other.

– Income and wealth – The three African unions include some of the poorest countries in the world, with high illiteracy, inadequate infrastructure, and under-trained and under-staffed bureaucracy. The costs of the transition to a new currency could be a major hurdle for central banks, governments, banks, businesses, and households. The Gulf region is a major exception where ample funds are available in total, but which might not be distributed in ways that can support the union project. In the GCC, subsidies may be possible for communities not able to easily absorb transition costs; subsidies in the other union projects are unlikely.

– Compactness – The EAC and GCC are compact and contiguous entities. The SADC and WAMZ areas in contrast are very widely dispersed, and in the case of WAMZ not even contiguous. Reaching rural populations will be an issue in all cases and a major problem for SADC and WAMZ.

– Languages – The EAC and GCC have simple language situations: information about the currency can be conveyed in English and Swahili and Arabic and

English, respectively. The WAMZ might be able to operate only with English, but French and some native languages might also be considered. The SADC situation is very complex with English, French, Portuguese, and Afrikaans as official languages and with many native languages, some of which are quite widely used.

– Overarching frameworks – Each of the planned monetary unions exists within the context of more encompassing economic, political and social organizations. In all cases, institutions are less developed than in the EU and the powers of the regional bodies are less than those of the EU – whether the frameworks are sufficient to handle the full range of cash and currency issues remains to be seen. The GCC has deep political interrelationships and *de facto* leadership of Saudi Arabia in some areas could promote policy convergence.

– Economic and Financial Integration – The GCC countries have many economic and financial similarities, and economic convergence is well advanced. Formally, the national currencies can be used interchangeably, but actual cross-border use lags. The EAC has numerous areas of potential economic integration, but much more can be done. Excepting the SADC countries within the existing Common Monetary Area (CMA) where currencies trade at par, labor migration is extensive, and commerce flows via South Africa, integration in the SADC and WAMI is very limited.

– Convergence criteria – All regions have convergence requirements. Convergence in the GCC is well advanced[9], is incomplete but progressing in the EAC, and a remaining challenge in the other two areas.

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9 See Kamar, B. and S. Ben Naceur. "GCC Monetary Union and the Degree of Macroeconomic Policy Coordination," IMF Working Paper 07/249, International Monetary Fund. 2007.

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– In the new regions, much financial infrastructure remains to be built. For example, payments system development is underway, much supported by international assistance. As new systems many will be up to date with international standards, but systems are mostly national oriented and a transition to a regional basis will be needed.

– Public access to banks and other formal financial facilities such as ATMs is good in many areas of the GCC, but limited in rural areas. Access is a major problem in the other regions – a gap being filled by e-money.

– Regarding cocirculation, in the GCC and SADC, the Saudi riyal and South African rand respectively might serve as lead currencies and be held for transactions, safekeeping, or speculative purposes throughout their regions. The Nigerian naira is clearly the dominant currency within its region, reflecting the size of Nigeria's economy within the zone, but it does not penetrate the other economies deeply.

– Intraregional labor travel is extensive in all the African unions which generates substantial flows of cash across borders.

– E-money will affect future cash requirements and usage patterns. One issue will be whether systems will be privately operated but regulated, or integrated into the official monetary system. Use of debit cards, credit cards, and prepaid cards for goods and services will increase – in some cases they will be in competition with e-money and in other cases will serve different purposes.

– Production of banknotes and coins will be largely outsourced to European or Asian firms, which may increase costs and restrict capacity in comparison to the situation in Europe, and there might be a lack of redundancy to overcome problems. Banknote printers exist in Nigeria and Kenya, and coins are produced

by the South Africa mint. This is much more restricted than in Europe, but it does provide a basis for limited production of the new union currencies. Capacity can be built, both to produce mass quantities of low value banknotes and coins, but also to gradually incorporate high quality production and security features needed to produce top quality high value instruments.

– Counterfeiting will be a problem in all areas, but might be controllable. Contributing to the problem is that lower value banknotes will be heavily used largely outside the formal banking system, which means that they will deteriorate in use and thus security features will be obscured. Poor communications and illiteracy will make it hard to educate the public about currency security features.

– The role of underground and criminal activity affecting use of the new union currencies is unknown. Initially, it is possible that hoards of high denomination banknotes will be in foreign currencies, which would deny new unions of substantial seignorage income that countries issuing the euro were able to capture.

– For a variety of reasons, like the euro new union currencies might have initial periods as "virtual currencies" used for government accounts, bank deposits, financial accounting, statistics, etc.. This transition period allowed banks, businesses, and the public to become familiar with the purchasing power of the euro prior to emission of physical currency.

– Conditions in Europe that permitted the introduction of physical euros in a quick "Big Bang" may be absent in future unions that may face limited production capacity, large rural and isolated population, limited access to formal banking institutions, illiteracy, etc.. Future unions may need to seriously consider gradual introduction of the new currency on a cocirculating basis.

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– The underlying real conversion rates of currencies into the new currencies will be less certain than in Europe where currencies were tied (although with some flexibility) to the ECU for long periods which permitted the European economies to integrate their price structures.

C. Electronic Money (e-money)

Electronic money comprises a variety of encoded measures of value used by computers or other electronic devices to store value and make transactions. To be deemed e-money, it must be usable for a broad range of transactions, and not be limited to transactions for a limited range of goods or services or firms. For example, cards used by transportation systems that store value that can only be used for travel on the system are not e-money, but prepayments for future services. In contrast, electronic stores of values that can be used for transactions with many different types of vendors are e-money. The boundaries are not always well defined. Many different devices could be used as carriers for the money – computers, mobile phones, swipe cards, electronic chips, and others.

The European Monetary Institute examined issues of possible use of e-money for the conduct of monetary policy in the Euroarea. In 1997, the EMI reviewed the state of work on electronic money and provided an opinion to the European Commission in March 1998 that electronic money would significantly affect monetary policy in the future and that rules governing its issuance are needed.[10]

The EMI defined electronic money as an electronic store of monetary value on a technical device that may be widely used as a prepaid bearer instrument for making payments for undertakings other than with the issuer without necessarily involving bank accounts in the transactions. Such devices must operate as general

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10 EMI. "Opinion of the EMI Council on the issuance of electronic money" transmitted to the European Commission. March 2, 1998. <u>EMI Annual Report 1997</u>. pp. 74-75.

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purpose payment instruments. Another important criterion is whether value can be transferred between electronic money systems without involving banks to debit and recharge value to the device.

The EMI recognized that e-money could have monetary policy impacts – for example by substituting for use of physical currency and thus it raises monetary policy issues.

A wide variety of e-money devices are in place or proposed. Mobile phone-based systems, in which a means of storing value is linked with a communications device, are gaining wide acceptance.

– The e-money technology is linked to current communications practices and much physical infrastructure is already in place. Adoption can be rapid.

– This technology appears to be well suited to facilitate financial transactions in rural and developing areas where transportation is limited and few formal banking institutions exist.[11] Thus, electronic currency can be one component of development of banking systems that can reach many millions of people without access to formal bank facilities.

– Electronic money systems can be operated by computer companies or tele-communications companies as extensions of their existing businesses, which could dramatically change monetary conditions and create new types of monetary institutions.

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11 For example, in lieu of fixed line phone communications in Africa, there are an estimated 225 million mobile phone users who could potentially be provided payments services through cellphone e-money facilities. This is already reported to be commonly used by small traders and firms in West Africa. Kenya and Tanzania have adopted cellphone money transfer systems that are used by millions of customers.

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– A group of mobile phone operators with networks in about 100 countries cover-
ing about 600 million customers have plans to set up systems for international
transmission of remittances between cellphones. These arrangements will
require linkages between international payments companies, such as Master-
charge, and between local banks and cell phone operators. It is expected that
the high costs of international remittances can be dramatically cut and service
will be quicker and more convenient.

Other types of e-money systems exist, such as for transfers over the internet
or other special e-money devices. Moreover, simple prepaid cards often can be
accepted by a wide range of vendors giving them a quasi-monetary role, and if
they can be easily reloaded with value, it is hard to draw a sharp line between
genuine e-money devices and close competitors. Thus, efforts to develop or
regulate e-money systems should be viewed as covering a range of different
channels and devices that will evolve quickly. This means that rules should be
general to cover a range of systems and flexible enough to deal with innovations
and new markets.

The wide availability of e-money could bring about major changes in the operation
of money and financial markets. First, it can make access to financial markets avail-
able for much wider segments of populations, especially in less wealthy countries.
Second, it competes with banknotes and coins for use in transactions, which can
cause structural changes in the demand for money and in seignorage. Third, new
types of financial institutions could evolve to increase market competition, lower
costs, support product innovation, and force changes in regulation and oversight.
New instruments and changes in the channels of transmission may change
monetary relationships in the economy and loosen the control of authorities over
monetary conditions.

Moreover, new forms of risk could develop such as new forms of operational risk because of the use of sophisticated electronic systems to handle the e-money. Interoperability of systems will be needed to prevent the possibility of failures of transactions between operators of systems. Electronic theft or fraud must be treated as possibilities and security systems developed to deal with them. There could also be a wide range of new issuers or agents for e-money, which will require new rules to register them, supervise them, and guarantee their proper operation. Any lengthy breakdown of an e-money system, for example, after a natural disaster, could be economically disastrous.

E-money systems might compete in issuing money substitutes with the official monetary system based on use of central bank money and oversight by the central bank and other authorities. The central bank and government could lose their ability to control the monetary base and the monetary stock, with potentially major effects on monetary and economic policy. E-money also potentially threatens the seignorage income of government if it reduces demand for banknotes and coins.

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M-Pesa digital money system in Kenya

Several digital money schemes have developed in Africa, where they can occupy niches not being served by formal financial institutions. The M-Pesa system in Kenya has grown exceptionally quickly and has penetrated national financial markets deeply, including in rural areas where large parts of the population were not served by formal financial institutions. Many businesses and households have directly benefitted.

Importantly, M-pesa is not operated by the central bank or by a bank, but by Safaricom, a telecommunications company that originated the scheme to promote its mobile phone service. As such it fell outside of the preexisting regulatory authority of banks and thus a new regulatory framework is being developed.

M-pesa involves a widely dispersed system in which customers visit local agents to exchange cash for transferrable mobile phone credits (or conversely exchange credits for cash). Many small, village-level businesses have become agents, which provide access to wide swaths of the population to use the system. M-pesa has become widely used for commerce and remittances. It is commonly used for current depositing and transfers, including supporting large net flows of remittances from urban areas to rural areas. The agents carry out the daily cash netting operations and generate regular cash shipments through intermediaries who interact with the bank that supports the system. The system has very quickly and strongly changed currency usage patterns and will have large, still-developing implications on cash management and on the formal financial system.

The system will have a major impact on monetary cash management policies, and also raises important operational and security risks. The important role of M-pesa as a payments institution for millions of customers requires that effective central bank oversight be established and that its practices be subject to regular audits and risk assessments. In sharp contrast to the situation for cash holdings, the operational risk of a breakdown of a mobile phone e-money system affecting commerce for millions of people must be effectively addressed and multiple layers of backup must be in place.

In light of such concerns above, in 1998 the ECB published the "Report on electronic money" that covered reasons for regulation of issuance of electronic money and issuers, the role of electronic money in payment and settlement systems, prudential supervision, and set out minimum requirements for electronic money systems;

– Issuers of electronic money must be subject to prudential supervision
– Issuance must be subject to sound and transparent legal arrangements
– Technical security must be assured, including the ability to detect counterfeits
– Protection against criminal abuse is needed
– Monetary statistics reporting is required and companies must supply whatever information is needed for monetary policy purposes
– Issuers of electronic money must be legally obliged upon request to redeem electronic money against central bank money at par
– Central banks can impose reserve requirements on all issuers of electronic money
– Electronic money systems should be interoperable, and
– Insurance, guarantees, or loss-sharing schemes are needed to protect the holders of electronic money.

This foundation work undertaken in Europe seems highly applicable for future unions. In Europe, e-money system development has been limited to date; in contrast, development in other regions has been extensive and the four current union projects will have to seriously address its role in their regions – more seriously than has been the case to date in the Euroarea.

– Interoperability and regional regulatory systems will be required. Diverse national systems that have developed will need to be merged or made interoperable and transactions and their clearing must be seamless across the union. In itself, this can promote financial integration of the member economies in much the same way as the euro integrated currency markets in Europe.

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– E-money will affect monetary policy. At present, there is no consensus on the definition of e-money, how to measure it, how to aggregate it into money stock measures, and what its role will be in monetary policy. The linkage between e-money and standard monetary instruments must be very strong – from a policy perspective, e-money should operate as a single market linked with the official monetary market and without the possibility of the market operating with different liquidity or risk conditions from the overall market or between systems. The speed of growth of e-money in future union regions appears to be sufficiently rapid that it could generate major implications for monetary policy. The effort to investigate the implications for union monetary policy will find parallels in the process of designing the monetary policy framework for the Euroarea.

– E-money will affect monetary behavior and by serving as a new form of financial agent accelerating transactions, cutting costs, and supporting economic transactions that were previously not feasible could also affect real economic behavior.

– New channels of saving and investment could open up.

– E-money could be a key element of strategies to introduce the union currency as a virtual currency. Conversely, local agents for e-money systems could serve some of the functions performed by banks in Europe in retiring the old physical currency in exchange for the euro.

– In some cases, the union itself might choose to operate e-money systems itself in order to maintain tight controls, link conventional and e-money policies, and capture seignorage. Also, union sponsorship could be a means of gaining "buy-in" of businesses and the public to the new union and the new currency.

D. Closing Remarks

The creation of the euro provides many lessons for future monetary unions
developing their currency policies. The new unions must understand what was
done in Europe, why, and how their cash policies fit into the overall process of
creating the monetary union. This provides a foundation to build their own systems,
but this paper suggests that the building constructed on that foundation will look
very different for several reasons, which include among others.

– The economies are quite different from Europe and currency use patterns differ.

– Many advantages that Europe had in creating the euro are lacking in other
  regions. Other regions face harder challenges that will require innovative solu-
  tions, which usually will also usually need to be less expensive than in Europe.

– Currency usage patterns will differ, which affects design features, cash manage-
  ment, and methods of transitioning to the new currency. Perhaps not in the Gulf,
  but in Africa relatively more low value banknotes will probably be needed.

– E-money is coming rapidly and to a far greater extent than in Europe. Policies for
  e-money and physical currency must be co-developed.

– Currency production facilities are far more limited and less sophisticated.

– The transition to a new currency will be much more difficult than in Europe
  because of stunted banking systems, dispersed and rural populations, and
  poverty and illiteracy.

The effort to create a new currency in future unions will be driven by the schedule
to launch each union. The process in Europe took nine years to assess the user

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requirements for banknotes and coins, design the new currency, set up production, produce the stock of currency, establish the conversion rates from national currency into the union currency, and introduce the currency to the country. Three years of the process was dedicated to introduction of a virtual currency that set the stage for introduction of the physical currency.

The process in future unions could plausibly take that long. We could envision a process similar to that in Europe in which three full years were spent to produce the comprehensive plan for the union, after which the specific timetable for start-up could be set and the implementation process begun. Given the challenges future unions will face, especially those in Africa, three years of implementation work to create an operational virtual currency is plausible. In addition to what was done in Europe, new unions' *virtual currencies should also operate as a form of e-money on mobile phone systems.*[12] The physical currency would be introduced in due course.

The start-up schedule above is longer than politicians in most future unions appear to want. There may be flexibility to speed up the process, but the technicians involved (the cash people among others) should not permit themselves to be pushed into a schedule that could jeopardize prospects for success in their respective fields, because a union can fail if not all pieces are in place and functioning well at the start of the union – individually, in conjunction with the other processes of the union, and at the union and national levels.

For the participants in this conference – the doers and thinkers on matters related to cash – the currency and cash issues in future unions need your attention. Help

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12 An advantage of having mobile phone e-money during the virtual currency phase in which physical national currencies will still circulate is that the phone can simultaneously inform the user of value in both the national and union currencies.

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is needed to assess needs, design and produce the currency, integrate physical
and virtual currencies, create a cash management policy, and introduce the new
currency. This will require analytical skills and technical expertise in different mixes
at various phases of the process. Much of the work can be based on the experi-
ences in Europe, but the work must also simultaneously deal with the different
conditions affecting cash within each union and also insights on the role of cash
in the future. These are challenges of the first degree – it can be hoped, with
gratitude to the Bundesbank for sponsoring this conference, that participants
(along with their governments and international bodies) will be willing to step
forward and help future unions address them.

Appendix 1 – Impacts on the banknote printing and minting industries

The international banknote printing and minting industries could be dramatically affected by new monetary unions in Africa and the Gulf. Factors include greater uncertainties than in Europe, consolidation of the current highly fragmented market, and restructuring contracting processes.

Uncertainties

Future unions face greater uncertainties regarding banknote and coin production than was experienced in Europe. The uncertainties could affect costs and scheduling.

– Union-wide usage patterns have not yet been fully investigated. As has been emphasized in this paper, Europe can provide guidance on the types of usage factors to consider, but different conditions in each future union could result in different answers – printers and mints will need more specific guidance before serious currency design work can begin.

– In Europe, the likely start-up dates for the euro were fixed by treaty, but start-up dates in the future unions have not been firmly set, and one or more of the possible unions might not materialize. Printers and mints will be hesitant to undertake work "on spec" years before uncertain union start-up dates.

– Ultimate membership of the future unions is not settled.

– The conversion rates from national currencies into the union currency and the sizes of the nominal units have not yet been set, in contrast to Europe where the ECU provided guidance. Possibly, the Nigerian naira, Saudi riyal, and South African rand could serve as lead currencies for their respective unions for their

regions, but no similar leader is available in East Africa. Until the conversion rates, nominal unit size, and coin-banknote gaps are set, the volume of production runs cannot be set.

– Unlike Europe, banknote and coin production will interact intimately with e-money conditions and potentially could result in less demand for physical cash in total or for specific denominations. Rapid evolution in the e-money industry complicates the picture.

Consolidation

Printing and minting markets for new unions differ greatly from those in Europe when the euro was created. Most potential Euroarea countries had existing public operations adequate for domestic demand that were converted to euro production under official surveillance. National officials had long experience and skills to undertake the transition in a timely, effective manner. In contrast, most African and Gulf countries rely on negotiated contracts with international printers and mints (Crane, de la Rue, Giesecke & Devrient, etc.), on whom the countries are heavily dependent for printing capacity and expertise. As many as two dozen currencies could disappear to be replaced by a handful of larger currencies.

Renegotiation of printing and minting contracts

Contracts with existing currency producers will be renegotiated. Countries in a new union will begin with a diverse range of contracts for banknotes and coins with different conditions and costs, which might involve multiple printers or mints. Ultimately, these fragmented arrangements will be replaced with a single contract, a process that might not run smoothly and which could upset vested interests.

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A power shift will be involved as new negotiating teams representing multiple countries acting under regional oversight come to the table. Individual small-country negotiators potentially subject to undue suasion by printers and mints (as suggested by recent press reports that the Austrian national printing press had bribed national authorities to get contracts) will have diminished roles. Importantly, negotiations must be undertaken with regional, multicountry oversight and audit to assure each of the participating countries. On the other side of the table, the currency producers will be negotiating for bigger contracts to replace sometimes very small country production runs. These more lucrative prizes might attract greater attention by official national producers.

Efficiencies of scale

The shift to contracts representing many countries could result in important efficiencies of scale. The costs to market and design perhaps two-dozen currencies will be eliminated, and production runs will be larger – potentially much larger.

Congestion

Finally, complicating the picture is that four unions might approach printing presses and mints simultaneously. If capacity is limited, which is possible for large new currency runs, currency production could be a definitive impediment to launching a union.

Conversely, future unions might be able to collaborate on some aspects (such as investigation and selection of security features) to make the design process more efficient and potentially minimize bottlenecks.

Own capacity

As printing and minting runs become larger in new unions, it becomes more
feasible for new unions to develop their own capacity. Logically, widely used lower
value banknotes and coins with less sophisticated security features should be
produced first, with an intention to increasingly produce higher value notes and
coins as expertise is gained.

Appendix 2 – E-money and the changeover to union currencies

When new unions start up, it can be assumed that e-money systems will already
exist within each union and thus physical cash and e-money policies for the union
must be jointly set. Different variants of e-money systems could have different
implications for demand for physical currency and for changeover strategies.

– Union planners will need to know the types of systems that will exist within the
  union prior to settling on cash policies. A policy of simultaneous introduction of
  e-money and new union physical currency might prove unsatisfactory because
  the total public demand for the e-money and the channels for its use will be
  unknown.

– The regulatory scheme for e-money could matter. Will privately-operated
  systems continue and be allowed market flexibility, or will they be tightly
  controlled and perhaps even run by the union? Less regulated systems might
  better respond to technical or market innovations, but more control could allow
  better integration of e-money and cash strategies.

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E-money systems can directly contribute to the cash changeover

– E-money systems can instantaneously convert between national currency and
union currency values. National currency values entered into the system can
automatically be displayed in the union currency (or also in other national
currencies).

– Record keeping accompanying e-money systems can be readily redenominated
into the new currency.

– The existing e-money systems can provide information about the cash change-
over throughout the country using mobile phone facilities.

– E-money systems can internally operate as the union currency during any virtual
currency phase for the new union currency.

E-money agents spread across the country can become channels to receive old
national currencies and distribute the new union currency. For example, in the
M-pesa system, the system of retail agents spread throughout the country can
serve to collect old currencies and distribute the new union currency.

Finally, developers of currency policies in future unions must be aware that they
must create a currency that is useful and which will be readily accepted by the
public and businesses. Packaging the new union currency within a useful e-money
system could be important in achieving a widespread "buy-in" by the public and
businesses.

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The impact of private banknote deposit systems on the monetary income and profit of the national central banks of the Eurosystem

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1 Introduction

In recent years more and more central banks took effort to reduce their cash costs by installing private cash deposit systems such as notes-held-to-order (NHTO) schemes and deposit bank systems. This paper examines the impact which the introduction of such systems has on the redistribution of monetary income among the national central banks (NCBs) of the Eurosystem and their profit.

The paper is structured as follows. After introducing remarks the second chapter starts by distinguishing between various types of cash deposit systems and then the third chapter goes on to examine the extent to which such systems change

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banknote circulation and thus the basis for the creation of monetary income. The allocation effects among the NCBs that this creates are analysed separately for notes-held-to-order systems (NHTO schemes) in chapter 4 and deposit bank systems in chapter 5 respectively. To this end, the paper develops a theoretical analysis framework, which describes, first, the allocation effects among NCBs when monetary income is pooled under such deposit systems and, second, formalises the impact this has on NCB profits. This also helps identify the conditions that must be met to avoid, or at least mitigate, any undesired allocation among the NCBs as a result of deposit systems. With the help of this framework it is also possible to identify the criteria which have to be met to ensure the equivalence of NHTO and deposit bank systems against the background of seigniorage pooling within the Eurosystem. This is done in chapter 6. Section 7 summarises the results of the study.

2 Types of banknote deposit systems

The growing debate about a more efficient cash supply has resulted in an increasing number of countries introducing private banknote deposit systems. The basic concept is that the central bank instructs credit institutions or cash-in-transit companies (CITs) with holding banknotes in custody at their premises and putting them into or withdrawing them from circulation on behalf of its NCB. The private cash handlers often also provide other services, such as checking the banknotes for authenticity and fitness. Another important characteristic of such banknote deposit systems is that the institutions holding banknotes in custody on behalf of the central bank do not incur any opportunity costs for holding the cash. In practice, there are a large number of private banknote deposit systems, which can be categorised as follows[1]:

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[1] For further information, see also the Summary of the Deposit System Seminar in Tallinn, September 2009.

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Figure 1

Types of private banknote deposit systems

Notes-held-to-order (NHTO) schemes   **Modified NHTO schemes**   **Deposit bank systems**
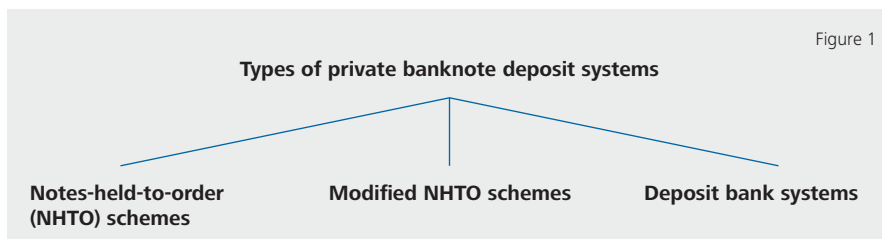
According to the ECB definition[2], an NHTO scheme is a "scheme consisting of individual contractual arrangements between an NCB and certain credit institutions ("NHTO banks") in the NCB's participating Member State, whereby the NCB

a) supplies the NHTO banks with euro banknotes which they hold in custody at their premises for the purpose of putting them into circulation; and

b) credits the NHTO banks for euro banknotes which are deposited by their customers, checked for authenticity and fitness, held in custody and notified to the NCB. Banknotes transferred from the NCB to NHTO banks form part of the NCB's created banknotes. Banknotes held in custody by NHTO banks do not form part of the NCB's national net issuance of banknotes."

NHTO banks are therefore a kind of "virtual central bank branch", as they are not considered the owners of the banknotes they hold in custody on behalf of the central bank. Consequently, the stocks of banknotes held in custody by the credit institution on behalf of the central bank are not included in the volume of banknotes in circulation either. As the table below shows, within the Eurosystem or the EU in general, Ireland, Malta and Slovenia currently have typical NHTO schemes[3].

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2 Guideline of the European Central Bank of 11 September 2008 (ECB/2008/8) on data collection regarding the euro and the operation of the Currency Information System 2 (CIS 2), Glossary.
3 See also Bank of Finland, Summary of the Deposit System Questionnaire 2009, Table 2 as well as the overview documents of the IWG AD HOC Group, A description of notes held to order schemes operated by central banks in the European union (2005).

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In addition, there is the Extended custodial inventory programme (ECI programme), a programme set up by the ECB, consisting of contractual arrangements between the Eurosystem central banks and individual credit institutions (ECI banks), whereby the ECB supplies the ECI banks with euro banknotes, which they hold in custody outside Europe for the purpose of putting them into or withdrawing them from circulation[4].

Deposit system classification within EU													Table 1
	GR	**M**	**D**	**EC**	**A**	**NL**	**U**	**S**	**H**	**S**	**E**	**F**	**I**	**Sum**
Typical NHTO		X		X				X					X	4
Modified NHTO					X	X	X		X		X			5
Depot			X							X		X		3
Cannot say or no	X													1

Source: Bank of Finland (2009), Summary of the Deposit System Seminar in Tallinn, September 2009, page 3

Furthermore, there are a number of modified NHTO schemes, which in some ways do more than simply holding cash in custody on behalf of the central bank. For example, in some countries unsorted banknotes may also be included in the NHTO deposit, while in the United States, for instance, only banknotes that will be required again for withdrawals within the same working week may be submitted.[5] Moreover, the transfer of ownership of the banknotes from the credit institutions lodging/withdrawing them to/from the central bank does not necessarily always take place on the same day that the banknotes are lodged/withdrawn. Hence,

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4 There are currently 2 ECI schemes in Hong Kong and Singapore, which are managed by the Bundesbank on behalf of the Eurosystem.
5 See Bank of Finland, Summary of the Deposit System Questionnaire 2009.

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some NCBs have introduced value date rules, whereby lodgements and withdrawals at the central bank take place with a time lag: lodgements are credited before physical lodgement takes place and withdrawals are debited from the NHTO bank's central bank account with a time lag.[6] This is an attempt to compensate the participating NHTO banks for the opportunity costs incurred by holding the cash. As the respective NCB rules differ greatly, reference should be made to the relevant overview presentations.[7] Within Europe, such modified NHTO schemes are currently in operation in Austria, the Netherlands, the United Kingdom, Hungary and Spain.

Deposit bank systems are another "pure" form of private banknote deposit system. The most important difference between them and the (modified) NHTO schemes is that the deposit banks retain ownership of the entire volume of banknotes in circulation[8] and the NCB pays interest to the deposit bank's central bank account for a separate stock of banknotes by way of compensation for the opportunity costs incurred by holding the banknotes. This interest-bearing banknote stock is generally the stock that is held in the deposit bank's vaults overnight. However, it may also include banknotes held in ATMs. Such systems are currently in operation in Denmark, Sweden and Finland. An interesting feature is that the Finnish central bank pays interest on the stocks of banknotes held in custody by deposit banks on its behalf at the one-month rate on the interbank market, whereas other central banks pay interest based on the respective main refinancing rate of the ECB.

This directly raises the question of the extent to which the monetary income of the Eurosystem and the central bank profits of the Eurosystem central banks are affected by the introduction of the deposit systems described above.

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6 The Banque centrale du Luxembourg also has in place a value date rule of this kind, although it has not actually introduced an NHTO scheme in the true sense.
7 See Bank of Finland, Summary of the Deposit System Questionnaire 2009.
8 However, the ECB points out that in practice the contracts between the NCBs and private operators do not strictly adhere to this categorical distinction. See also Summary of the Deposit System Seminar in Tallinn, September 2009, p 6.

3 Banknote deposit systems and their impact on banknote circulation

Installing private banknote deposit systems affects the profitability of NCBs in various ways. For example, on the revenue side, the income of the NCBs from assets covering banknotes in circulation and thus the allocation of the NCBs' monetary income can change if the introduction of such systems results in a change in banknote circulation. However, without knowing the specifics of the banknote deposit systems, it is impossible to predict beforehand whether banknote circulation will rise or fall. This is because, in practice, banknote deposit systems complement rather than completely replacing NCBs and their branches.

For example, whether or not cash handlers can lodge their banknote holdings more quickly and easily in a hybrid system of NHTO points and NCB branches than in a system consisting purely of branches is crucial for the future development of banknote circulation under an NHTO scheme. The contractionary effect of the hybrid system on the volume of banknotes in circulation is greater, the easier it is to reach and access NHTO points compared with the closed NCB branches. This is more likely to be the case,

– the more NHTO points there are,
– the longer the opening times of the NHTO points are,
– the easier it is to reach the NHTO points (geographical location),
– the fewer requirements there are regarding storage, collateralisation and volume
   limitations of the stocks eligible for the NHTO

compared with the closed NCB branches. However, as mentioned above, the impact of an NHTO scheme on banknote circulation can be cancelled out or even reversed if the NHTO scheme is an inadequate replacement of the previous branch system.

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In the case of deposit bank systems, too, the resulting hybrid system of deposit banks and NCB branches does not necessarily lead to a change in banknote circulation. The deposit banks have less incentive to reduce their surplus cash holdings by quickly lodging them at the NCB branches the more of these holdings are counted towards the NCB deposit. And since the deposit banks retain ownership of these surplus banknote holdings, the volume of banknotes in circulation can increase sharply as a result of hoarding in the wake of the changeover in the cash supply system. This is because the deposit banks do not incur opportunity costs on surplus banknote holdings owing to the interest payments made by the central bank on the banknotes held in custody. Nevertheless, the example of Finland shows that if the contracts between the central bank and the deposit banks are properly worded, there can even be a significant reduction in the volume of banknotes in circulation. Naturally, the amount of eligible banknote holdings at the deposit banks plays a crucial role.

The following diagrammatic breakdown of banknote circulation presents the basic channels through which deposit systems influence banknote circulation (BNC). If banknote circulation is conceptually divided into domestic (in the sense of national or within the euro area) and foreign banknote circulation, it appears appropriate to assume that national cash deposit systems initially only influence the domestic circulation of cash. Banknote circulation outside the euro area should conceptually be assigned to the ECB's ECI programme as the supranational NHTO scheme.

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Conceptual breakdown of banknotes in circulation

Figure 2
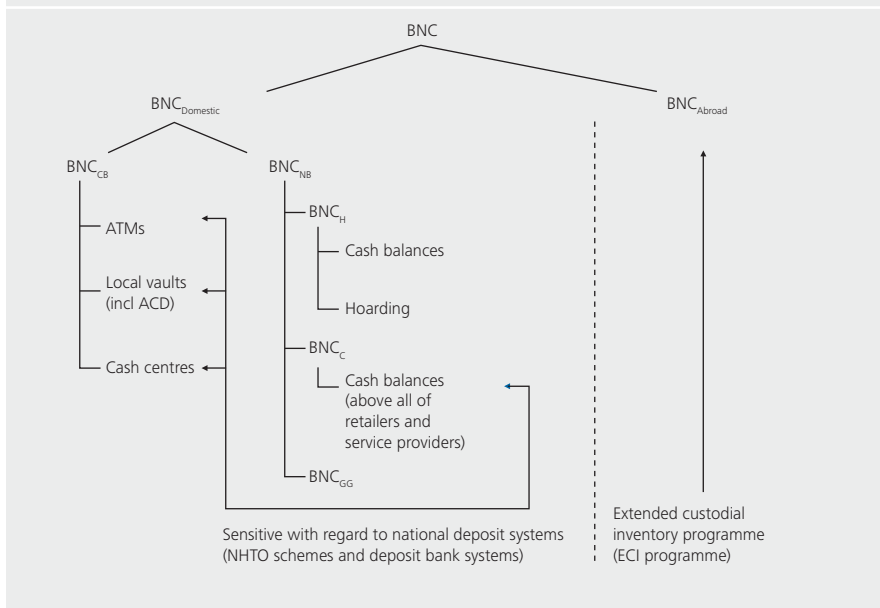
Domestic banknote circulation can, in turn, be broken down into banknote holdings in the hands of commercial banks (BNC_{CB}), which store them in ATMs, vaults on their premises (including automated cash dispensers (ACD) and in national cash centres, and into banknotes in circulation held by non-banks (BNC_{NB}). Depending on the specific design of the deposit system, credit institutions' cash balances respond immediately to the introduction of NHTO schemes or deposit bank systems as their holdings are eligible. However, in the case of non-banks, probably only the transaction balances of retailers and service providers (BNU_C) are affected. The possibility of disposing of surplus cash holdings comparatively faster results in average cash holdings tending to decrease and thus to a declining volume of banknotes in circulation in the hands of these holders of money. The cash holdings

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of households (BNU_H) and general government (BNU_{GG}) are unlikely to be affected by the installation of deposit systems.

4 Impact of NHTO schemes on the allocation of monetary income and central bank profits in the Eurosystem

In the following section, it is always assumed that Eurosystem NCBs that introduce NHTO schemes see a *decline* in the volume of banknotes in circulation. This seems to be the most likely scenario, as experience shows that central banks take corrective action relatively quickly if the NHTO scheme does not yield the desired cost savings.[9] The allocation effects with regard to the pooling of monetary income that result from a decline in the volume of banknotes in circulation are described mathematically, and then various methods are used to simulate and calculate the allocation effects for individual NCBs. Finally, the question is addressed as to how the respective decline in monetary income caused by NHTO schemes and NHTO-induced cost reductions is reflected in the NCBs' profits.

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9 Nevertheless, the following mathematical description also permits an analysis of the impact of NHTO schemes and deposit bank systems on the allocation of monetary income if the NCB's banknote circulation increases as a result of the scheme's design.

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4.1 Analytical framework

To ensure that the analysis remains clear and concise, simplifying assumptions are made.[10] It shall be assumed that the contributions made by the NCBs to the pool, ie monetary income, stem solely from interest on assets that are held against the *banknotes in circulation* issued by the respective NCB as "earmarked assets". It is not difficult to justify this assumption as it is easy to demonstrate that the interest on the relevant intra-Eurosystem balances and on NCBs' liabilities to credit institutions (items 2, 3, 4 and 6 of the liability base) means that, in practice, the liability base for calculating monetary income is effectively reduced to banknote circulation.[11] Furthermore, non-interest-bearing gold receivables shall not be included as they do not alter the net allocation arising from the pooling of monetary income among the NCBs.[12] The in any case artificial balance sheet ex post allocation of aggregated banknote circulation to the NCBs and the ECB (Capital Share Mechanism, CSM), which then results in corresponding intra-Eurosystem claims and liabilities from banknote circulation among the central banks, can also easily be disregarded. Thus, for the purposes of this analysis, the ECB, which in practice does not issue any banknotes anyway, is not considered a banknote issuer.[13] Therefore, only NCBs' banknote circulation according to their actual issuance remains as a liability base in the balance sheets. Initially, we will abstract from the existence of NHTO schemes.

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10 A detailed analysis of the creation and allocation of monetary income is provided by Rösl (2012). For the discussion on the redistribution effects of socialising pre-EMU-assets of the NCBs see Sinn, H.-W./Feist, H. (1997), Sinn, H.-W. (1997), Rösl, G./Schäfer W. (2000), Sinn, H.-W./Feist, H. (2000) and Rösl, G. (2002).

11 The Eurosystem receives additional net monetary income from a positive difference between the interest income from assets that are held against credit institutions' deposits and the interest expenditure which NCBs pay on these deposits, such as interest income from Eurosystem monetary policy claims and interest expenditure from interest on the deposit facility and non-interest-bearing excess reserves. However, apart from during the financial crisis, credit institutions held only relatively few deposits with the Eurosystem.

12 For proof, see Rösl (2002), p 217.

13 It can be shown that the ex post allocation of banknotes in favour to the ECB's balance sheet does not affect the effective net pooling position of the NCBs within the pooling of monetary income of the Eurosystem.

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The monetary income and the individual contribution to the pool made by each national central bank is thus the product of the banknotes in circulation B_i issued by an NCB i multiplied by the uniform main refinancing rate for all NCBs r:

$$P_i = B_i \cdot r.$$ (pool financing contribution of the NCB i, no NHTO)

The sum of monetary income (= pool mass) corresponds to the interest income of the NCBs from the issuance of the aggregate banknotes in circulation B:

$$P = \sum_{i=1}^{n} P_i = \sum_{i=1}^{n} B_i \cdot r = B \cdot r.$$ (Pool mass, no NHTO)

As is well-known, the allocation of the pool mass takes place in accordance with the shares of the NCBs k in the capital of the ECB ($\sum_{i=1}^{n} k_i = 1$ with $0 < k_i < 1$). An NCB i therefore receives the following amount from the pool

$$k_i \cdot B \cdot r.$$ (amount distributed to NCB i, no NHTO)

The net position of the respective NCB in the pooling of monetary income is therefore

$$x_i = B_i \cdot r - k_i \cdot B \cdot r.$$ (net contribution to the pool of NCB i, no NHTO)

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The sum of the net contributions to the pool is zero, ie the accumulated monetary income is distributed in full to the NCBs:[14]

$$\sum_{i=1}^{n} x_i = \sum_{1=1}^{n} B_i \cdot r - \sum_{i=1}^{n} k_i \cdot B \cdot r = B \cdot r - B \cdot r = 0.$$

The NCBs shall now be granted permission to introduce NHTO schemes. Consequently, the respective volume of banknotes in circulation issued by the NCBs falls. This is because, since banknotes are now more rapidly available, banks can now reduce their own holdings of banknotes. Furthermore, a drop in the banknote holdings held by non-banks would also be conceivable, if, for example, a comparatively large number of NHTO points means that a better distribution of banknotes across the country could be achieved and the velocity of circulation of the banknotes thus increases, as, for example, commercial enterprises can now dispose of their excess cash holdings more quickly.

The monetary income of each NCB therefore declines, compared with the situation without an NHTO scheme, by the amount of income foregone $B_i^{NHTO} \cdot r$ as a result of the decrease B_i^{NHTO} in the "national" volume of banknotes in circulation. Monetary income now amounts to

$$P_i^* = (B_i - B_i^{NHTO}) \cdot r \qquad \text{(contribution to the pool by NCB i, with NHTO)}$$

---

14 In practice, the ECB can access the monetary income of the NCBs to finance provisions and cover a possible ECB loss. Within this analytical framework, this can be interpreted as using monetary income that has already been distributed to the NCBs.

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and the pool mass with an NHTO then amounts to

$$P^* = \sum_{i=1}^{n} P_i^* = (\sum_{i=1}^{n} B_i - \sum_{i=1}^{n} B_i^{NHTO}) \cdot r = B \cdot r - B^{NHTO} \cdot r = (B - B^{NHTO}) \cdot r$$

where $B^{NHTO} = \sum_{i=1}^{n} B_i^{NHTO}$.

A comparison of the pool masses with and without NHTO schemes produces the NHTO-induced loss of monetary income for the Eurosystem:

$$B^{NHTO} \cdot r.$$

It corresponds to the Eurosystem's foregone interest income that would have accrued had there been no NHTO schemes because the volume of banknotes in circulation would then have been B^{NHTO} greater. However, this interest loss is spread neutrally among the members of the Eurosystem only under very specific conditions. In fact, there is generally an ultimately unjustifiable reallocation of seigniorage among the NCBs. To demonstrate this, the first step is to determine the net contribution to the pool by the respective NCB i for the scenario with NHTO schemes:

$$x_i^* = (B_i - B_i^{NHTO}) \cdot r - k_i (B - B^{NHTO}) \cdot r$$

(net contribution to the pool of NCB i),

where the sum of the net pool positions is once again zero ($\sum_{i=1}^{n} x_i^* = 0$).

Nevertheless, an NCB can receive NHTO-induced interest subsidy payments from other NCBs or can be forced to make NHTO-induced subsidy payments to other NCBs. The individual position of an NCB i in this NHTO-induced inter-NCB subsidy

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system can be calculated using the difference in the net pool positions with and without an NHTO scheme:

$$\tilde{x}_i = x_i - x_i^* = B_i^{NHTO} \cdot r - k_i \cdot B^{NHTO} \cdot r = (B_i^{NHTO} - k_i \cdot B^{NHTO}) \cdot r \ .$$

(Net position of NCB i in the NHTO-induced inter-NCB subsidy system).

Hence, an NCB i receives an NHTO-induced subsidy from the other NCBs if the loss of monetary income generated for the entire Eurosystem as a result of the introduction of the national NHTO scheme ($B_i^{NHTO} \cdot r$) is greater than the NCB i's participation in the losses of monetary income arising from the sum of the NHTO schemes of all NCBs ($k_i \cdot B^{NHTO} \cdot r$). In other words, an NCB is a "winner" in the NHTO-induced subsidy system if its national share in the NHTO-induced reduction in the volume of banknotes in circulation in the Eurosystem is greater than its ECB capital share ($B_i^{NHTO}/B^{NHTO} > k_i$). Such "profits" or, more precisely, "avoided NHTO-induced losses" of monetary income for an NHTO-NCB are, of course, financed by the other Eurosystem NCBs. The following calculation shows that this is in fact a zero-sum game.

$$\sum_{i=1}^{n} \tilde{x}_i = \sum_{i=1}^{n} (x_i - x_i^*) = \sum_{i=1}^{n} x_i - \sum_{i=1}^{n} x_i^* = 0 \ .$$

What would an NHTO scheme need to look like to ensure that it causes no NHTO-induced redistribution of monetary income among the NCBs in the Eurosystem? The equation for calculating the net pool position for any NCB i derived above provides the basis for answering this question:

$$\tilde{x}_i = (B_i^{NHTO} - k_i \cdot B^{NHTO}) \cdot r_{\ .}$$

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If this equation is set to zero, three potential solutions are found:[15]

1. The ECB sets the main refinancing rate to zero ($r = 0$). This would mean that both the credit institutions and the non-banks would incur no opportunity costs for holding central bank money, as they would receive the banknotes free of charge as it were. There would be no monetary income and therefore also no redistribution problems owing to the NHTO scheme. However, overriding monetary policy reasons mean this possibility cannot be implemented in practice.

2. The ECB bans NHTO schemes in all countries ($B_i^{NHTO} = B^{NHTO} = 0$). In practice, this possibility also appears to be unrealistic, as some NCBs have already introduced such NHTO schemes and other NCBs are apparently considering setting up such a scheme.

3. The ECB ensures that *all* NCBs introduce an NHTO scheme and that each NCB's national share in the NHTO-induced decline in the volume of banknotes in circulation in the Eurosystem corresponds to its ECB capital share ($B_i^{NHTO} / B^{NHTO} = k_i$).

Finally, the impact of NHTO schemes on the NCBs' operating result, ie on the central bank profit after pooling of monetary income and taking account of NHTO-induced cost savings, is to be formalised. On the income side, the NHTO-induced drop in monetary income for an NCB i amounts to ($-k_i \cdot B^{NHTO} \cdot r$). This compares to NHTO-induced cost savings of $l \cdot B_i^{NHTO}$ on the expenditure side. In simplified terms, a linear total costs function of cash operations (with l as a measure of unit costs per banknote) is assumed. The NHTO-induced change in the NCB's operating result therefore amounts to

$$Z_i = l \cdot B_i^{NHTO} - k_i \cdot B^{NHTO} \cdot r \quad \text{(NHTO-induced change in NCB operating result)}$$

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15 The fourth possibility, namely that the Eurosystem consists of one NCB only ($k_1 = 1$ and thus by inference $B_i^{NHTO} = B^{NHTO}$) is ruled out by definition here.

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An NCB can thus improve its operating result by introducing an NHTO scheme, if the cost savings from introducing its own NHTO scheme ($l \cdot B_i^{NHTO}$) are greater than the ensuing decline in monetary income ($-k_i \cdot B^{NHTO} \cdot r$).

4.2 NHTO-induced redistribution of monetary income among the NCBs

In order to present the above-mentioned system of cross subsidies among the NCBs in a more concrete manner, the following section examines a system of 3 NCBs and analyses, by way of example, some possible inter-NCB redistribution effects when first one, then two and finally all three NCBs introduce an NHTO scheme. However, the reader should bear in mind that the NHTO-induced redistribution among the NCBs always involves a redistribution of *losses from monetary income foregone* and – with regard to the distribution of monetary income – an NHTO-NCB will ultimately *however* experience a loss in seigniorage as a result of the introduction of an NHTO scheme.[16] The assumption that the introduction of an NHTO scheme will result in a decrease in the volume of banknotes in circulation still applies. It is therefore not possible for an NHTO-NCB to suddenly receive just as much or even more from the monetary income pool following the introduction of the NHTO scheme than it did before.

4.2.1 Simulation: precisely one of three NCBs has NHTO

The above mathematical calculations can now be simplified as follows for the case of three NCBs. To obtain the positions of the NCBs in the NHTO-induced inter-NCB subsidy system, the differences in the net pool positions without the NHTO scheme and following the introduction of an NHTO scheme must be calculated.

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16 However, as mentioned above, this does not mean that the introduction of an NHTO scheme necessarily also leads to a decline in the NCB's operating result. This is because the NHTO-induced cost savings of the NCB remain at a national level and are not distributed within the Eurosystem. See also the section on the impact of NHTO schemes on NCB profits.

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This produces:

NCB 1: $\tilde{x}_1 = x_1 - x_1^* = B_1^{NHTO} \cdot r - k_1 \cdot B_1^{NHTO} \cdot r$
NCB 2: $\tilde{x}_2 = x_2 - x_2^* = -k_2 \cdot B_1^{NHTO} \cdot r$
NCB 3: $\tilde{x}_3 = x_3 - x_3^* = -k_3 \cdot B_1^{NHTO} \cdot r$

Thus, by introducing an NHTO scheme, NCB 1 causes a loss of monetary income in the amount of $B_1^{NHTO} \cdot r$, which it would have had to bear in full alone if there were no pooling of monetary income. However, the pooling process means that, in accordance with its capital share, NCB 1 is left with only an "excess" or "retention" of interest foregone in the amount of $k_1 \cdot B_1^{NHTO} \cdot r$. The part of the interest loss that NCB 1 has avoided in the amount of $\tilde{x}_1 = x_1 - x_1^* = B_1^{NHTO} \cdot r - k_1 \cdot B_1^{NHTO} \cdot r$ is now financed by NCBs 2 and 3 in accordance with their capital shares by foregoing monetary income they would have received in a scenario with no pooling ($-k_2 \cdot B_1^{NHTO} \cdot r$ and $-k_3 \cdot B_1^{NHTO} \cdot r$, respectively).

The following sample calculation illustrates the above considerations. Thereby, it is additionally assumed that the three NCBs in the Eurosystem have an identical ECB capital share of 1/3 each and in the beginning an identical monetary base of 100 and as a reference scenario no NHTO scheme is installed. Given a main refinancing rate (r) of 10% and an aggregate monetary base of 300, the monetary income pool would be 30. Each of the NCBs would finance one-third of the pool in accounting terms and receive one-third of the distribution. There would be no allocation of seigniorage among the NCBs.

However, if – as assumed here – NCB 1 introduces an NHTO scheme in isolation, the resident credit institutions can now permanently lodge banknotes in the amount of 30 at the NHTO, causing the "national" volume of banknotes in circulation to fall by this amount.

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Simulation of NHTO-induced effects on monetary income, precisely one of three NCBs has NHTO

Table 2

	NCB1	NCB2	NCB3	Total	Pool (P)
Capital share (k_i)	0.333	0.333	0.333	1.000	27.0
National share in total NHTO-induced decline in the volume of banknotes in circulation in the Eurosystem (B_i^{NHTO}/B^{NHTO})	1.000	0.000	0.000	1.000	Interest rate (r)
Monetary base without NHTO (B_i)	100.0	100.0	100.0	300.0	0.1
NHTO-induced decline in the monetary base (B_i^{NHTO})	30.0	0.0	0.0	30.0	
Monetary base without NHTO ($B_i - B_i^{NHTO}$)	70.0	100.0	100.0	270.0	
Contribution to the pool $P_i = (B_i - B_i^{NHTO}) \cdot r$	7.0	10.0	10.0	27.0	
Amount distributed ($k_i \cdot P$)	9.0	9.0	9.0	27.0	
Change in monetary income caused by NHTO ($-k_i \cdot B_{NHTO} \cdot r$)	−1.0	−1.0	−1.0	−3.0	
Inter-NCB subsidy (balance) $x_i - x_i^*$	2.0	−1.0	−1.0	0.0	
Change in seigniorage for NHTO without EMU ($-B_i^{NHTO} \cdot r$)	−3.0	0.0	0.0	−3.0	

The national monetary base in country 1 now amounts to only 70 and NCB 1's contribution to the pool decreases by 3 from 10 to 7. This loss of monetary income must now be borne by all NCBs in accordance with their respective capital share (in this case, each must bear one-third). Consequently, the amount distributed to the NCBs declines by 1 in each case, from 10 to 9 due to the introduction of the NHTO scheme. However, from an opportunity point of view, this process leads to NCBs 2 and 3 subsidising NCB 1. This is because, in a world without pooling of monetary income, the interest loss caused by the introduction of the NHTO scheme of 3 would have been borne in full by NCB 1. As the pooling process means that NCB 1 only suffers a drop in monetary income of 1, it receives an inter-NCB subsidy

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of 2, which is financed on a *pro rata* basis by NCBs 2 and 3, with each foregoing interest of 1.

In line with the theoretical considerations, the positive net position in the amount of 2 $(\tilde{x}_1 = x_1 - x_1^* = 2)$ of NCB 1 in the NHTO-induced inter-NCB subsidy system can thus be broken down into the interest loss which NCB 1 would have had to bear alone without pooling of monetary income $(\left|-B_1^{NHTO} \cdot r\right| = 3)$ less the share of the loss arising from the reduction in the pool mass to be borne by NCB 1 after pooling $(\left|-k_1 \cdot B_1^{NHTO} \cdot r\right| = 1)$. This subsidy payment in favour of NCB 1 is financed through the loss participation of NCBs 2 and 3 in the amount of $\tilde{x}_2 = x_2 - x_2^* = -k_2 \cdot B_1^{NHTO} \cdot r = -1$ or $\tilde{x}_3 = x_3 - x_3^* = -k_3 \cdot B_1^{NHTO} \cdot r = -1$ in the form of monetary income foregone. Generalising this result, it can be said that each NHTO-NCB forces the other NCBs to make subsidy payments, as the decline in the volume of banknotes in circulation means that the NHTO-NCB socialises the resulting seigniorage loss. In a system with precisely one NHTO-NCB, the latter is consequently the sole net subsidy recipient in the NHTO-induced inter-NCB subsidy system.

4.2.2 Simulation: precisely two of three NCBs have NHTO

However, in a *system of several NHTO-NCBs*, the NHTO-induced net allocation effects among Eurosystem NCBs can no longer be clearly determined beforehand. It therefore cannot simply be claimed that each individual NHTO-NCB will indeed always receive *net* NHTO-induced subsidy payments from the other Eurosystem NCBs. It can only be stated that the *sum of the NHTO-NCBs* will receive such implied net payments from non-NHTO-NCBs. This is because, following the introduction of their respective national NHTO schemes, the NHTO-NCBs force one another to make gross subsidy payments. As the next example shows, this can result in one NCB (below, NCB 2) becoming an NHTO-induced net subsidy payer even if it introduces an NHTO scheme itself and thus imposes gross interest losses on other NCBs. By contrast, those NCBs that categorically reject an NHTO scheme

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always become net subsidy payers (see NCB 3) as soon as just one NCB introduces an NHTO scheme. In the following sample calculation, the same conditions apply as in the previous simulation (identical NCB monetary bases and capital shares) but with one difference, namely that NCB 1 is now assumed to have sustained an NHTO-induced reduction in the volume of banknotes in circulation in the amount of 43 and NCB 2 introduces an NHTO scheme, which causes a decline in its "national" volume of banknotes in circulation in the amount of 20.

Simulation of NHTO-induced effects on monetary income, precisely two of three NCBs have NHTO, net subsidy payments by NCB2 despite own NHTO					Table 3
	NCB1	NCB2	NCB3	Total	Pool (P)
Capital share (k_i)	0.333	0.333	0.333	1.000	23.7
National share in total NHTO-induced decline in the volume of banknotes in circulation in the Eurosystem (B_i^{NHTO}/B^{NHTO})	0.683	0.317	0.000	1.000	Interest rate (r)
Monetary base without NHTO (B_i)	100.0	100.0	100.0	300.0	0.1
NHTO-induced decline in the monetary base (B_i^{NHTO})	43.0	20.0	0.0	63.0	
Monetary base without NHTO ($B_i - B_i^{NHTO}$)	57.0	80.0	100.0	237.0	
Contribution to the pool $P_i = (B_i - B_i^{NHTO}) \cdot r$	5.7	8.0	10.0	23.7	
Amount distributed ($k_i \cdot P$)	7.9	7.9	7.9	23.7	
Change in monetary income caused by NHTO ($-k_i \cdot B_{NHTO} \cdot r$)	−2.1	−2.1	−2.1	−6.3	
Inter-NCB subsidy (balance) $x_i - x_i{}^*$	2.2	−0.1	−2.1	0.0	
Change in seigniorage for NHTO without EMU ($-B_i^{NHTO} \cdot r$)	−4.3	−2.0	0.0	−6.3	

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The resulting positions of the NCBs in the NHTO-induced inter-NCB subsidy system are now formally as follows:

NCB 1:

$$\tilde{x}_1 = x_1 - x_1^* = B_1^{NHTO} \cdot r - k_1 \cdot B_1^{NHTO} \cdot r - k_1 \cdot B_2^{NHTO} \cdot r = B_1^{NHTO} \cdot r - k_1 \cdot B^{NHTO} \cdot r$$

Overall, NCB 1 receives from the other NCBs in the central bank system an implied NHTO-induced subsidy payment in the form of seigniorage losses avoided in the amount of $\tilde{x}_1 = x_1 - x_1^* = 2.2$. This is because, if NCB 1 had introduced a national NHTO scheme in isolation, ie with no pooling of monetary income, it would have sustained interest losses in the amount of $\left| -B_1^{NHTO} \cdot r \right| = 4.3$. However, its effective seigniorage loss in the form of lower monetary income now amounts to only 2.1. This decline in monetary income for NCB 1 $(-k_1 \cdot B^{NHTO} \cdot r = -1/3 \cdot 6.3 = -2.1)$ is the result of the participation of NCB 1 $(k_1 = 1/3)$ in the NHTO-induced interest loss of the *entire* Eurosystem $(-B^{NHTO} \cdot r = -6.3)$ and can be subdivided into the participation of NCB 1 in the NHTO-induced interest loss it generated itself $(-k_1 \cdot B_1^{NHTO} \cdot r = -1.43)$ and its participation in the NHTO-induced interest loss generated by NCB 2 $(-k_1 \cdot B_2^{NHTO} \cdot r = -0.67)$. The latter arises as, in this example, NCB 2 has now also introduced an NHTO scheme, resulting in a decline in the volume of banknotes in circulation, and NCB 2 forces NCB 1 to make an NHTO-induced subsidy payment in accordance with its capital share.

NCB 2:

$$\tilde{x}_2 = x_2 - x_2^* = B_2^{NHTO} \cdot r - k_2 \cdot B_1^{NHTO} \cdot r - k_2 \cdot B_2^{NHTO} \cdot r = B_2^{NHTO} \cdot r - k_2 \cdot B^{NHTO} \cdot r$$

Although it has introduced an NHTO scheme itself and should therefore tend to be a net recipient of subsidy payments, NCB 2 must now make net transfers of 0.1 to NCB 1. While the national NHTO scheme would in any case have lowered the monetary income of NCB 2 by 2.0 in a world without monetary union

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$(-B_2^{NHTO} \cdot r = -2.0)$, this is only a consolation in part, as the pooling of monetary income results in NCB 2 sustaining a reduction in monetary income of 2.1 $(-k_2 \cdot B^{NHTO} \cdot r = -2.1)$. Thus, in accordance with its capital share, NCB 2 must participate in the NHTO-induced losses in monetary income following the introduction of an NHTO scheme at NCB 1 in the amount of $-k_2 \cdot B_1^{NHTO} \cdot r = -1.43$ and, at the same time, it must bear the "excess" of the interest losses in the amount of $-k_2 \cdot B_2^{NHTO} \cdot r = -0.67$ caused by its own NHTO scheme $(-k_2 \cdot B_1^{NHTO} \cdot r - k_2 \cdot B_2^{NHTO} \cdot r = -k_2 \cdot B^{NHTO} \cdot r = -2.1)$.

NCB 3: $x_3 - x_3^* = -k_3 \cdot B_1^{NHTO} \cdot r - k_3 \cdot B_2^{NHTO} \cdot r = -k_3 \cdot B^{NHTO} \cdot r$

NCB 3, which has not introduced an NHTO scheme of its own, turns out to be the biggest net payer in the NHTO-induced subsidy system among the NCBs in this example. In accordance with its capital share, it must bear both the NHTO-induced interest losses generated by NCB 1 $(-k_3 \cdot B_1^{NHTO} \cdot r = -1.43)$ and the NHTO-induced interest losses generated by NCB 2 $(-k_3 \cdot B_2^{NHTO} \cdot r = -0.67)$. As NCB 3 has not introduced an NHTO scheme, the interest losses of which it would have been able to pass on to NCBs 1 and 2 on a *pro rata* basis at $2/3 = 1 - k_3$, it must bear the full NHTO-induced interest loss of the entire central bank system alone $(-k_3 \cdot B^{NHTO} \cdot r = -2.1)$.

Nevertheless, it is quite conceivable that – as long as not all NCBs introduce an NHTO scheme – *all NHTO-NCBs* will receive *net subsidy payments* from the non-NHTO-NCBs. This will be the case wherever the national share in the NHTO-induced decline in the volume of banknotes in circulation in the central bank system is, *for all NHTO-NCBs*, larger than their respective ECB capital share $(B_i^{NHTO} / B^{NHTO} > k_i)$. The following sample calculation shows such a constellation.

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Simulation of NHTO-induced effects on monetary income, precisely two of three NCBs have NHTO, no net subsidy payments by both NHTO-NCBs					Table 4
	NCB1	NCB2	NCB3	Total	Pool (P)
Capital share (k_i)	0.333	0.333	0.333	1.000	21.7
National share in total NHTO-induced decline in the volume of banknotes in circulation in the Eurosystem (B_i^{NHTO}/B^{NHTO})	0.518	0.482	0.000	1.000	Interest rate (r)
Monetary base without NHTO (B_i)	100.0	100.0	100.0	300.0	0.1
NHTO-induced decline in the monetary base (B_i^{NHTO})	43.0	40.0	0.0	83.0	
Monetary base without NHTO ($B_i - B_i^{NHTO}$)	57.0	60.0	100.0	217.0	
Contribution to the pool $P_i = (B_i - B_i^{NHTO}) \cdot r$	5.7	6.0	10.0	21.7	
Amount distributed ($k_i \cdot P$)	7.2	7.2	7.2	21.7	
Change in monetary income caused by NHTO ($-k_i \cdot B_{NHTO} \cdot r$)	−2.8	−2.8	−2.8	−8.3	
Inter-NCB subsidy (balance) $x_i - x_i^*$	1.5	1.2	−2.8	0.0	
Change in seigniorage for NHTO without EMU ($-B_i^{NHTO} \cdot r$)	−4.3	−4.0	0.0	−8.3	

A detailed analysis of the NHTO-induced redistribution effects will not be carried out here, as it is immediately clear that NCB 3, as the only non-NHTO-NCB, finances all of the intra-Eurosystem subsidy payments in favour of the NHTO-NCBs by fore-going interest in the amount of 2.8.

4.2.3 Simulation: all three NCBs have NHTO

However, if *all* NCBs introduce an NHTO which reduces the volume of banknotes in circulation, this does not necessarily lead to net subsidy payments among the NCBs. This can be demonstrated by having another look at the mathematical

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description of the net position of an NCB i in the NHTO-induced inter-NCB subsidy system:

$$\tilde{x}_i = x_i - x_i^* = B_i^{NHTO} \cdot r - k_i \cdot B^{NHTO} \cdot r = (B_i^{NHTO} - k_i \cdot B^{NHTO}) \cdot r$$

An NCB has a neutral position in the NHTO-induced inter-NCB subsidy system if the interest loss for the Eurosystem, which the NCB generates by introducing a national NHTO scheme, $(B_i^{NHTO} \cdot r)$ is equal in size to the NCB's participation in the cumulated interest loss, which results from the sum of all the NHTO schemes of the NCBs (including the NCB's own NHTO scheme) $(k_i \cdot B^{NHTO})$. In other words: an NCB is "neutral" in the NHTO-induced subsidy system if its national share in the NHTO-induced drop in the volume of banknotes in circulation in the Eurosystem corresponds to its ECB capital share $(B_i^{NHTO} / B^{NHTO} = k_i)$. If this condition is fulfilled for all NCBs, then the net positions of the NCBs are all zero – as confirmed by the following example.

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Simulation of NHTO-induced effects on monetary income, all NCBs have NHTO, no net subsidy payments despite NHTO

Table 5

	NCB1	NCB2	NCB3	Total	Pool (P)
Capital share (k_i)	0.333	0.333	0.333	1.000	18.0
National share in total NHTO-induced decline in the volume of banknotes in circulation in the Eurosystem (B_i^{NHTO}/B^{NHTO})	0.333	0.333	0.333	1.000	Interest rate (r)
Monetary base without NHTO (B_i)	100.0	100.0	100.0	300.0	0.1
NHTO-induced decline in the monetary base (B_i^{NHTO})	40.0	40.0	40.0	120.0	
Monetary base without NHTO ($B_i - B_i^{NHTO}$)	60.0	60.0	60.0	180.0	
Contribution to the pool $P_i = (B_i - B_i^{NHTO}) \cdot r$	6.0	6.0	6.0	18.0	
Amount distributed ($k_i \cdot P$)	6.0	6.0	6.0	18.0	
Change in monetary income caused by NHTO ($-k_i \cdot B_{NHTO} \cdot r$)	−4.0	−4.0	−4.0	−12.0	
Inter-NCB subsidy (balance) $x_i - x_i^*$	0.0	0.0	0.0	0.0	
Change in seigniorage for NHTO without EMU ($-B_i^{NHTO} \cdot r$)	−4.0	−4.0	−4.0	−12.0w	

The above demonstrates that there will necessarily be NHTO-induced subsidy payments among the NCBs if not all of the NCBs introduce such a scheme that reduces the volume of banknotes in circulation. Each individual NCB that does not introduce such an NHTO scheme becomes a net payer, while the NHTO-NCBs in sum are winners. Whether *each NHTO-NCB* does actually receive *net* subsidy payments depends, in turn, on whether the national share in the total NHTO-induced decline in the volume of banknotes in circulation in the Eurosystem is greater than the corresponding ECB capital share of the NHTO-NCB. However, it would at least theoretically be possible to introduce an NHTO scheme that does not generate NHTO-induced net subsidy payments among the NCBs. The ECB would have to

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All NCBs introduce an NHTO scheme, NHTO-induced decline in credit institutions' cash balances of 100%							Table 6
	SLK	AT	BE	FI	FR	GR	IE
Capital share (k_i) since 1.1.2009, in %	0.99	0.278	3.48	1.80	20.38	2.82	1.59
National share in total NHTO-induced decline in credit institutions' cash balances (B_i^{NHTO}/B^{NHTO}), in %	1.16	4.41	3.23	0.54	13.74	4.27	2.17
NHTO-induced decline (of 100 %) in credit institutions' cash balances (B_i^{NHTO}) in million EUR, all NCBs have NHTO	596	2,263	1,657	275	7,047	2,189	1,113
Change in monetary income as a result of NHTO in million EUR	−13	−36	−45	−23	−261	−36	−20
Net subsidy balance in million EUR	2	21	−3	−16	−85	19	7

ensure that *all* NCBs introduce an NHTO scheme and that each NCB's national share in the NHTO-induced fall in the volume of banknotes in circulation in the Eurosystem corresponds to its ECB capital share. But it is likely to prove fairly difficult to implement this rule in practice.

4.3 Calculations of the NHTO-induced subsidy payments within the Eurosystem and the changes in monetary income following the introduction of NHTO schemes

The following calculations show the impact on the monetary income of the Eurosystem that would be expected if such a system were to be introduced throughout the euro area. Such a scenario is unlikely to occur in this form anytime soon, but it shows the maximum NHTO-induced seigniorage losses that the Eurosystem could sustain and the allocation effects among the NCBs that such a system would imply. The calculations are based on the average annual cash balances of the credit institutions in 2009 with an assumed main refinancing rate of 2.5%. In such an

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	IT	LU	MT	NL	PT	SLO	ES	CYP	D	Eurosystem	Interest rate
	17.91	0.25	0.09	5.71	2.51	0.47	11.90	0.20	27.13	100.00	2.50
	19.25	0.55	0.12	3.58	2.94	0.42	14.60	0.54	28.48	100.00	
	9,875	282	60	1,838	1,507	217	7,488	275	14,605	51,286	
	−230	−3	−1	−73	−32	−6	−153	−3	−348	−1,282	
	17	4	0	−27	6	−1	35	4	17	0	

extreme scenario, the Eurosystem would lose out on monetary income in the amount of just under 1.3 billion Euro per year, as the volume of euro banknotes in circulation would decline by the amount of the credit institutions' cash balances of just over 51 billion Euro which in turm can be interpreted as a measure of the present value of all future and present NHTO-induced losses in monetary income for the Eurosystem.

The Bundesbank would sustain an annual decline in monetary income, in accordance with its ECB capital share of 27.13%, of 348 million Euro. Surprisingly, the German central bank would even receive implied NHTO-induced net subsidy payments of 17 million Euro annually from the other Eurosystem NCBs. This is because, with no pooling of monetary income, its monetary income would have declined by as much as $B_D^{NHTO} \cdot r = 14,605 \cdot 2.5\% = €365$ million. Yet, since German credit institutions hold 28.48% of all cash balances of banks in the Eurosystem and thus the Bundesbank would absorb 28.48% of the decline in the aggregate volume of banknotes in circulation in the Eurosystem, but would participate in the NHTO-

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induced overall interest loss for the Eurosystem in the amount of 27.13% only (= German ECB capital share), all other things being equal, the Bundesbank would therefore avoid an interest loss of 17 million Euro per year. However, the above table also shows that the NHTO-induced NCB subsidy payments would probably generally remain within fairly narrow bounds if *all* Eurosystem central banks were to introduce an NHTO scheme. This would be the case at least if there were no discrimination among the NHTO schemes within the euro area with regard to administrative rules (opening times, lodgement and withdrawal conditions etc). Then the distribution of the cash balances of the credit institutions in the individual euro area countries would probably remain quite similar to the monetary income allocation key. Admittedly, the above picture suddenly changes if *not all NCBs* introduce an NHTO scheme resulting in a decline in the volume of banknotes in circulation.

If it is assumed that all NCBs in the Eurosystem introduce an NHTO scheme and this results in a decline in the cash balances of credit institutions of 50% or even 10%[17], the drop in the volume of banknotes in circulation with corresponding losses of monetary income in the amount of 641 million Euro or 128 million Euro per year given an assumed annual interest rate of 2.5%. The lion's share of these seigniorage losses would once again be borne by the Deutsche Bundesbank with a decline in monetary income of 174 million Euro and 35 million Euro per year, respectively. However, the Bundesbank would again receive implied NHTO-induced subsidy payments from the other Eurosystem NCBs in the amount of 9 million Euro and 2 million Euro per year. The biggest payer of transfers would be the Banque de France with intra-Eurosystem net subsidy payments in the amount of 43 million Euro and 9 million Euro per year, respectively.

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17 These figures seem plausible if credit institutions' cash balances in ATMs or even cash centres are not allowed to be attributed to NHTO stocks.

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As a next step, we will analyse the possible effects on monetary income which could arise as a result of the lower volume of banknotes in circulation if retailers and service providers could dispose of their cash holdings more quickly under the NHTO schemes. However, this analysis is much more difficult than the previous analysis of the change in credit institutions' cash balances, as the size of the transaction balances of retailers and service providers in the respective euro area countries is not clear. However, studies for Germany indicate that, measured against the total volume of banknotes in circulation, these holdings are likely to be comparatively small.[18] Thus the value of the transaction balances held by retailers and service providers, which was estimated on the basis of sectoral sales data for 2007, amounted to only just over 2 billion Euro, while the cash balances of credit institutions and the transaction balances of households and general government each accounted for around 14 billion Euro. At that point in time, the cash balances of retailers and service providers as a percentage of the total net issuance of euro banknotes put into circulation by the Deutsche Bundesbank in 2007 (283 billion Euro) was 0.7%. The introduction of a German NHTO scheme could cause the average cash holdings of retailers and service providers in Germany to fall by up to 80% (to 415 million Euro). However, at an interest rate of 2.5% pa, all other things being equal, this would correspond to an annual interest loss for the Eurosystem and the Bundesbank of 43 million Euro and 12 million Euro, respectively.[19]

By contrast, it is hardly possible to reliably estimate the amount of monetary income that the Bundesbank would additionally lose if an NHTO scheme with a similar impact on the transaction balances of the retailers and service providers were to be introduced in all the other euro area countries. If, by way of example, it is assumed

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18 See Deutsche Bundesbank, Monthly Report, June 2009, p 49 ff, Bartzsch/Rösl/Seitz (2011a,b). The demand for euro area currencies is discussed in Fischer, B./Köhler, P./Seitz F. (2004).
19 Compare: $1{,}702 \cdot 0.025 \approx 43$ million euro or $1{,}702 \cdot 0.025 \cdot 0.2713 \approx 12$ million euro with a 1,702 million euro NHTO-induced decline in the volume of banknotes in circulation held by retailers and service providers, given a German ECB capital share of 27.13%.

that the average transaction balances in the euro area account for 10% of euro banknote circulation and, in turn, 10% of this is held by retailers and service providers, then, based on the year 2007, the NHTO-induced interest foregone by the Eurosystem would amount to around 135 million Euro per year with a corresponding present value of 5,413 million Euro.[20] Consequently, Germany would then sustain a decline in monetary income of around 37 million Euro per year.

The following table summarises the findings of the estimated effects on monetary income resulting from the euro area wide introduction of NHTO schemes. The first column shows the expected **maximum** annual losses of monetary income at a given refinancing rate of 2.5%. As metioned above it is assumed that credit institutions are allowed to attribute their cash deposits fully to the national NHTO system and retailers and other cash prone companies can reduce their cash holdings by 80% due to quicker lodgements at NHTO points compared to lodgements at NCB branches. The second column shows the corresponding present values of these losses represented by the expected reduction of banknotes in circulation.

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20 The calculations are based on data from 2007 not only for reasons of consistency. Owing to extensive hoarding in 2009-2010, more recent data on banknote circulation distort the measurement of the transaction-related cash holdings of retailers and service providers. The following data were used: banknotes in circulation held by retailers and service providers as a percentage of the total volume of banknotes in circulation: 1%, NHTO-induced decline in the volume of banknotes in circulation held by retailers and service providers: 80%, volume of banknotes in circulation in the euro area at the end of 2007: 676,621 million Euro monetary policy interest rate: 2.5% pa. See $676{,}621 \cdot 0.01 \cdot 0.8 \cdot 0.025 \approx$ 135 million EUR annual loss and $676{,}621 \cdot 0.01 \cdot 0.8 \approx 5{,}413$ million EUR present value.

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Eurosystem's estimated maximum losses from installing NHTO schemes in the euro area		Table 7
	Annual losses* (in million EUR)	Present value (in million EUR)
Credit institutions	1,282	51,286
Retailers and service providers	135	5,413
Total	1,418	56,699

* Calculated on the following assumptions. Reduction of cash holdings by credit institutions (100%) and by retailers and service providers (80%). Refinancing rate 2.5% pa.

It is obvious that these figures have to be interpreted properly as an upper limit of expected NHTO-induced losses of monetary income of the Eurosystem. At any rate, however, this estimate shows that the introduction of NHTO schemes have to be organised well before sending into action. Otherwise it could easily happen that the cost savings from these cash deposit systems are offset by a dramatic reductions in NCBs' seigniorage income.

4.4 The impact of NHTO schemes on NCB profit

So far, we have only examined the impact of the introduction of NHTO schemes on monetary income and the allocation thereof among the Eurosystem NCBs. However, this analysis is not extensive enough to examine the impact of NHTO schemes on the central bank profit of the individual NCBs. A clear distinction must be made between NHTO-NCBs and non-NHTO-NCBs. As described above, the NHTO-NCBs force the NCBs that do not introduce an NHTO scheme to make net subsidy payments, which take the form of a decline in the amounts distributed from the pool of monetary income and directly lower the operating result. These interest losses are currently not compensated for. Furthermore, these NCBs cannot make any NHTO-induced cost savings ($l \cdot B_i^{NHTO}$), such as savings on personnel costs or banknote printing, etc. This is also demonstrated by the general formula

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for the NHTO-induced change in an NCB's operating result

$$Z_i = l \cdot B_i^{NHTO} - k_i \cdot B^{NHTO} \cdot r ,$$

which can be simplified for those NCBs j that do not introduce an NHTO scheme to

$$Z_j^{no\_NHTO} = -k_j \cdot B^{NHTO} \cdot r$$

The decline in the operating result therefore corresponds to the monetary income lost by these NCBs, which finance the interest foregone by the Eurosystem as a result of the NHTO scheme $(-B^{NHTO} \cdot r)$ in accordance with their ECB capital shares (k_j). Although each NHTO-NCB m also always sees monetary income decline (by $Z_m^{NHTO} = -k_m \cdot B^{NHTO} \cdot r$), this decrease on the income side of each NHTO-NCB can be more than offset by the cost savings arising from the introduction of a national NHTO scheme ($l \cdot B_m^{NHTO}$), and therefore the NHTO schemes ultimately lead to an improvement in the operating results of the NHTO-NCBs:[21]

$$Z_m^{NHTO} = l \cdot B_m^{NHTO} - k_m \cdot B^{NHTO} \cdot r .$$

It is therefore more likely that an NHTO-NCB will ultimately see an improvement in its profit situation as a result of introducing an NHTO scheme, the more of the NHTO-induced net subsidy payments it receives. The higher these implied subsidies to the NHTO-NCB concerned are, the lower the NHTO-induced decline in monetary income for this NCB, all other things being equal, and the easier it is for NHTO-induced cost savings to overcompensate this fall in income. Thus, the design of the NHTO schemes at the *other* NCBs has a direct impact on the NCB's own profit situation.

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21 See also ECB (2009), Impact of deposit systems on seigniorage income, slide handout.

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However, whether or not the introduction of a national NHTO scheme improves an NCB's operating result also crucially depends on the specific design of its *own* NHTO scheme. It is self-evident that the NCB's profit situation will improve the more it manages to pass on NHTO-related costs (eg banknote processing costs, transport costs, personnel costs, etc) to the NHTO banks. However, as the example of Bank of England's original NHTO scheme shows that the NHTO-NCB will not necessarily achieve cost savings. In this case, because commercial banks no longer incurred opportunity costs for holding banknotes, the stocks of banknotes in credit institutions' vaults rose considerably due to hoarding, and thus, instead of the hoped-for cost savings, the Bank of England actually incurred additional banknote printing expenses. Possible unexpected costs from the loss in control and quality, which the NCBs can even incur subsequently, represent a further problem.

5 Impact of deposit bank systems on the allocation of monetary income and central bank profits in the Eurosystem

In addition to NHTO schemes, there are also deposit bank systems, which, within the EU, are currently in operation in Denmark, Sweden and Finland. However, the banknotes held in custody at deposit banks on behalf of the NCB do not reduce the volume of banknotes in circulation, as the deposit banks retain ownership of these holdings. To compensate for the opportunity costs incurred by holding the banknotes, the NCB (referred to hereinafter as "deposit-bank-NCB") pays interest to the deposit bank's central bank account for a separate stock of banknotes. In Finland, the only euro area country that has a procedure of this kind in place, the Finnish central bank remunerates the stocks of banknotes held in custody at deposit banks on its behalf at the one-month interbank rate. These expenses are borne by the Bank of Finland (BoF) alone; they have so far not been included as expense items in the calculation of monetary income. Nevertheless, it cannot be claimed that the introduction of deposit bank systems does not affect the monetary income of the Eurosystem. Like NHTO schemes, the introduction of such systems can have a

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lasting impact on banknote circulation. In Finland, for example, the introduction of private deposit banks has clearly improved the number of ways to lodge surplus banknotes and the possibilities for commercial banks to readily access additional banknotes. Credit institutions have therefore been able to reduce their own holdings of banknotes. However, the stocks of banknotes lodged at the deposit banks remain the property of those banks that jointly operate the deposit bank system, meaning that, seen in isolation, neither deposit lodgements nor withdrawals lower the volume of banknotes in circulation. Since, in addition, interest is paid on the banknotes held in custody at the deposit banks at the money market rate for one-month money by crediting the current account of the deposit banks at the BoF, there is actually no incentive for the deposit banks to efficiently manage the stocks of banknotes held on behalf of the BoF. However, to prevent any undesired hoarding of banknotes by the deposit banks, the Finnish central bank sets an upper limit for the amount of banknote stocks that can be lodged at each deposit bank.[22] The desired decline in the average cash balances of credit institutions (in relation to growing GDP) has probably been achieved only because these restrictions are in place.

These comments once again show that, as with NHTO schemes, the effect of deposit bank systems on banknote circulation and thus on monetary income cannot be predicted in advance. However, assuming that the respective NCB is able to introduce a deposit bank system that does actually result in the desired fall in the volume of banknotes in circulation, then the impact on monetary income or the allocation thereof would be the same as for the NHTO schemes. In a deposit bank system (without NHTOs) a deposit-bank-NCB's contribution to the pool can therefore be formulated as

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22 See: A description of notes-held-to-order schemes operated by central banks in the European Union, IWG ad hoc Group, 1 December 2005, p 18.

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$$P_i^{Depot,*} = (B_i - B_i^{Depot}) \cdot r$$

and the pool mass with the deposit bank system amounts to

$$P^{Depot,*} = \sum_{i=1}^{n} P_i^{Depot,*} = (B - B^{Depot}) \cdot r,$$

where $B = \sum_{i=1}^{n} B_i$ and $B^{Depot} = \sum_{i=1}^{n} B_i^{Depot}$,

resulting in a deposit-bank-induced loss in monetary income for the Eurosystem of $B^{Depot} \cdot r$. The net contribution to the pool of an NCB i is then

$$x_i^{Depot,*} = (B_i - B_i^{Depot}) \cdot r - k_i (B - B^{Depot}) \cdot r$$

and the respective net position of NCB i in the deposit-bank-induced inter-NCB subsidy system is

$$\tilde{x}_i^{Depot} = (B_i^{Depot} - k_i \cdot B^{Depot}) \cdot r.$$

However, there is an important difference, namely that, according to the current procedure, an NCB that introduces such a deposit bank system (deposit-bank-NCB) must bear the expenses from the interest paid on the deposit bank holdings ($r^{Depot} \cdot B_i^{Depot}$) itself. The change in the operating result following the intro-duction of a national deposit bank system is thus

$$Z_i^{Depot} = l \cdot B_i^{Depot} - k_i \cdot B^{Depot} \cdot r - r^{Depot} \cdot B_i^{Depot}.$$

This puts the deposit-bank-NCB at a clear disadvantage. The same decline in the volume of banknotes in circulation could also be achieved through an NHTO scheme. Yet with an NHTO scheme, the NCBs would not have to pay interest on the deposit bank holdings ($r^{Depot} \cdot B_i^{Depot}$).

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6 Equivalence between NHTO schemes and deposit bank systems

The following section will examine on a theoretical basis under which conditions deposit bank systems and NHTO schemes are equivalent with regard to the redistribution of monetary income and the NCB operating result. If a deposit-bank-NCB should be equivalent to an NHTO-NCB in terms of income, the deposit-bank-NCBs would first have to ensure that the introduction of the deposit bank system has no impact on banknote circulation. In a second step, the deposit-bank-related interest expenses of the NCBs would have to be made deductible when calculating monetary income and the underlying interest rate r^{Depot} would have to be brought into line with the main refinancing rate r. The contribution to the pool of a deposit-bank-NCB j would then be:

$$P_j^{Depot,*} = B_j \cdot r - B_j^{Depot} \cdot r = (B_j - B_j^{Depot}) \cdot r.$$

The NHTO-NCBs would not need to make any adjustments. The NHTO-induced drop in the volume of banknotes in circulation thus still results in a contribution to the pool for each NHTO-NCB i of

$$P_i^{NHTO,*} = (B_i - B_i^{NHTO}) \cdot r.$$

A comparison of the contributions to the pool of the deposit-bank-NCB and the NHTO-NCB immediately shows that the NCBs are equivalent in terms of income in the monetary income pooling process. This is not surprising, as the deduction of NCBs' interest expenses from the monetary income liability base is *de facto* equivalent to a decrease in the liability base.

However, as soon as the introduction of a deposit bank system lowers the national volume of banknotes in circulation, like NHTO schemes do, this results in a distortion of the NCBs' income statements. Either, as is currently the case in the Eurosys-

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tem, the deposit-bank-NCBs pay the interest payments deemed unnecessary given the desired decline in the volume of banknotes in circulation ($r^{Depot} \cdot B_i^{Depot}$) and the structural differences in the operating results of NHTO-NCBs and deposit-bank-NCBs are accepted, or the deposit bank interest expenses are distributed among all NCBs in accordance with their respective ECB capital shares. Although this removes the structural differences between NHTO-NCBs and deposit-bank-NCBs, the NHTO-NCBs ultimately incur unnecessary costs. Of course, the same is true for all NCBs that introduce neither an NHTO scheme nor a deposit bank system. Their position as net payers in the inter-NCB subsidy system deteriorates further by their share in interest expenses.

7 Summary of the results

The introduction of private cash deposit systems, such as the notes-held-to-order schemes and deposit bank systems, generally changes the national contribution of a NCB to the overall volume of banknotes in circulation and thus leads to distortions in the pooling of monetary income. The corresponding redistribution effects, which are caused by the change in the volume of banknotes in circulation when pooling monetary income, can be described in general mathematical terms. It becomes evident that there is always a deposit-system-induced redistribution of seigniorage losses, which implicitly means subsidy payments among the NCBs if not *all* NCBs introduce such a system that changes the volume of banknotes in circulation. If it is assumed that the introduction of a national deposit system lowers the banknote circulation of an NCB, then each individual NCB that does not introduce such a deposit system automatically becomes a net payer, while the deposit-system NCBs in sum are winners. Whether *each deposit-system NCB* actually receives *net* subsidy payments depends, in turn, on whether the national share in the total deposit-system-induced decline in the volume of banknotes in circulation in the Eurosystem is greater than the corresponding ECB capital share of the deposit-system NCB.

For a specific NCB, this means that the more NCBs introduce deposit systems and the income from aggregate euro banknote circulation consequently decreases, the more its losses from the pooling of monetary income. An NCB can only avoid the resulting net subsidy payments to the NHTO-NCBs by introducing a deposit system itself or if it were to receive subsequent compensation payments from the deposit-system NCBs. However, as yet, there are no plans for the latter.

Summarising the calculation results of the expected NHTO-induced losses for the Eurosystem from the decline in the volume of banknotes in circulation, it would appear to make sense to set the upper limit of annual amounts of around 1.4 billion Euro, which correspond to a present value of interest income foregone (measured by an expected decline of banknotes in circulation) of just under 57 billion Euro. This calculation assumes that NHTO schemes are introduced throughout the euro area and result in the cash holdings of credit institutions declining by 100% and those of retailers and service providers falling by 80%. Although such a scenario cannot be ruled out beforehand, since it is not known what form a possible euro-area-wide NHTO scheme would take, it is not exactly likely to happen. However, this estimate shows at any rate that the introduction of NHTO schemes have to be organised well before sending into action. Otherwise it could easily happen that the cost savings from these cash deposit systems are offset by a dramatic reductions in NCBs' seigniorage income. With the mathematical formalism presented here, however, it is very easy to calculate the effects on the allocation and redistribution of monetary income and resulting from various NHTO and other banknote deposit systems.

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NHTO schemes and deposit bank systems do not differ *per se* in terms of their impact on the creation and allocation of monetary income. What is decisive is their respective impact on "national" banknote circulation. Although the theoretical analysis shows that NHTO schemes tend to reduce the volume of banknotes in circulation, whereas deposit bank systems tend to increase it, in practice the contracts between the central banks and deposit system operators can be worded so that in principle any desired change in the volume of banknotes in circulation can probably be achieved. This could be of crucial importance if NHTO schemes and deposit bank systems are to continue to be allowed to operate side by side within the euro area. In theory, at least, conditions can be established under which deposit bank systems are equivalent to NHTO schemes not only against the backdrop of pooling monetary income but also with regard to the NCB operating result.

With deposit bank systems, NCBs incur interest expenses as a result of paying interest on eligible deposit holdings. These interest expenses directly lower the NCB operating result, but, in line with current practice, cannot be deducted when pooling monetary income. By contrast, under NHTO schemes, these expenses, which are ultimately unnecessary, are avoided. Yet it is possible for both NHTO-NCBs and deposit-bank-NCBs to see an improvement in their operating result, ie the NCB profit, by introducing such systems, provided the deposit-system-induced cost savings more than compensate for the decline in monetary income. This is not the case for those NCBs that reject the introduction of such systems. In accordance with their ECB capital share, they must bear the deposit-system-induced decline in the total volume of euro banknotes in circulation and thus also in monetary income.

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Epilogue

Helmut Rittgen
Head of the Deutsche Bundesbank's
Cash Department

Personally, I believe that this cash conference has been a great success. We have heard some very interesting presentations on a wide range of different topics and have experienced some exciting debates. I am very pleased that so many challenging and multifaceted papers are being written on the topic of "cash"; this only serves to underscore the importance of this area of research. In general, I consider the scientific study of the subject of "cash" to be tremendously important. It is not just economic analysis that counts, rather monetary analysis is also important, for, as we all know; inflation is ultimately a monetary phenomenon.

During this conference we have learned that there is a real need for society to learn more about the use of cash as this is by no means a negligible issue. The aim of cash conferences is to give legitimacy to that research. For my part, I very much welcome the enthusiasm you have shown and the lively discussions that have been

generated. Members of the audience used the opportunity to challenge the assumptions, methods and findings of individual speakers and these presenters had to defend their work. As such, I think we have made a lot of progress in the past few days.

However, this conference can only serve as a first step on the path toward a continuing academic analysis of cash. This will be a long-term process and will entail continued efforts on all our parts. In order to sustain our contribution to research on the subject of cash in the future, we intend to hold a follow-up conference in 2014. The success of this start-up conference has played a large part in motivating us to take this decision. In our estimation, it makes sense to hold such a conference at two-year intervals in order to allow the relevant academic community to generate substantiated, high-quality research in the intervening period. Bearing that in mind, I look forward to seeing you all again in the not too distant future.

Yours Helmut Rittgen

Photographs
Official Dinner 28 February 2012
Knyphausen

Conference Programme 2012
27 – 29 February 2012

Monday, 27 February

12:00 – 13:30   Lunch

Chair: Helmut Rittgen (Deutsche Bundesbank, Frankfurt a.M.)

13:30 – 14:30   *Cash and the underground economy* [1]
Michael Pickhardt (Brandenburg University of Technology, Cottbus)
Jordi Sardà (Universitat Rovira i Virgili, Reus)

14:30 – 15:30   *Do unofficial cash uses threaten official cash provision?*
Gerhard Graf (Johannes-Gutenberg-Universität Mainz)

15:30 – 16:00   Coffee Break

16:00 – 17:00   *Crisis and calm: demand for U.S. currency at home and abroad from the fall of the Berlin wall to 2011*
Ruth Judson (Federal Reserve Board, Washington DC)

17:00 – 18:00   *Whatever happened to the "cashless society"? New evidence on "dollarization" and America's cash underground economy* [1]
Edgar L Feige (University of Wisconsin-Madison)

19:00 – 22:00   Dinner

Speaker: Helmut Rittgen (Deutsche Bundesbank, Frankfurt a.M.)
Chair: Franz Seitz (University of Applied Sciences Amberg-Weiden)

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1 The provisional papers that were submitted, have since been revised.

Tuesday, 28 February

09:00 – 10:00   *Why do people save in cash? Distrust, memories of banking crises, weak institutions and dollarization*[2]
Helmut Stix (Österreichische Nationalbank, Vienna)
Publication of paper not approved

10:00 – 11:00   *Estimating the usage of cash in the euro area*
Kari Takala, Matti Viren (Bank of Finland, Helsinki)

11:00 – 11:30   Coffee Break

11:30 – 12:30   *The foreign demand for euro banknotes: implication for domestic welfare costs*[1]
Andrea Zaghini (Banca d'Italia, Rome)
Alessandro Calza (ECB, Frankfurt a.M.)

12:30 – 14:00   Lunch Break
Chair: Ulf von Kalckreuth (Deutsche Bundesbank, Frankfurt a.M.)

14:00 – 15:00   *The impact of retail payment innovations on cash usage: evidence from survey data*[3]
Kim P. Huynh, Ben S.C. Fung (Bank of Canada, Ottawa),
Leonard Sabetti (George Mason University, Fairfax)

15:00 – 16:00   *Point-of-sale payment transactions in 2009*[1]
Frans Pleijster, Arjan Ruis
(EIM Business & Policy Research, Zoetermeer)

16:00 – 16:30   Coffee Break

16:30 – 17:30   *Payment behaviour in Poland – benefits and costs of cash, cards, other non-cash payment instruments*
Jakub Górka (University of Warsaw)

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1 The provisional papers that were submitted, have since been revised.
2 The publication of the paper was not permitted.
3 The publication of the original paper was not permitted. This book contains a shortened non-technical version of the original.

19:00 – 22:00   Dinner

Speaker: Carl-Ludwig Thiele

(Board member of the Deutsche Bundesbank, Frankfurt a.M.)

Wednesday, 29 February

Chair: Helmut Stix (Österreichische Nationalbank, Vienna)

09:00 – 10:00   *U.S. consumers' demand for cash in the era of electronic payments* [2]

Scott Schuh, Tamas Briglevics (Federal Reserve Bank of Boston)

Publication of paper not approved

10:00 – 11:00   *On a blank slate: cash and cash requirements for future currency unions in Africa and the Gulf*

Russell C. Krueger (International Monetary Fund, Washington DC)

11:00 – 11:30   Coffee Break

11:30 – 12:30   *The impact of notes-held-to-order schemes and deposit bank systems on the monetary income and profit of the national central banks of the Eurosystem* [1]

Gerhard Rösl (University of Applied Sciences Regensburg)

12:30 – 13:00   Concluding remarks

13:00 – 14:00   Lunch

Jakub Górka (University of Warsaw)

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1 The provisional papers that were submitted, have since been revised.
2 The publication of the paper was not permitted.

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