

The development and determinants of euro currency in circulation in Germany

The issuance of banknotes and coins in Germany has undergone very dynamic growth since the euro cash change-over. This sharp increase, however, has less to do with a higher domestic demand for banknotes and coins to be used in payments than with an increased holding of cash as a means of storing value and with a stronger demand for euro cash on the part of non-residents. For statistical reasons, it is not possible to make an exact assessment of how much of the cash issued in Germany is held by non-residents. It is estimated that between 25% and 35% of the euro banknotes issued (net) in Germany are now located in other countries. This is due, among other things, to Germany's central geographical position in Europe and its traditionally strong involvement in the international wholesale banknote market. Holding cash as a store of value is also a key motive. This became apparent especially in the autumn of 2008 when there was a strong demand, above all, for the large denominations both in Germany and internationally. Looking ahead, despite declining growth rates, there is likely to be a continuing trend rise in currency in circulation.

Growth in currency in circulation in Germany

Following the euro cash changeover in 2002, the volume of banknotes in circulation

*Sharp rise
in banknotes
in circulation*

throughout the euro area increased from €221 billion initially to €763 billion at the end of 2008. During the same period, the volume of banknotes in circulation in Germany grew from €73 billion to €328 billion.¹ Consequently, banknotes issued in Germany as a share of the total volume issued by the Eurosystem went up from 33% to 43%. This growth was accompanied by a greater demand for higher denominations. Thus, the average value of the banknotes issued in Germany rose from just under €32 at the beginning of 2002 to roughly €48 in 2008.

This growth in cash issued in Germany took place despite the increasing options to replace cash payments with other forms of payment. Owing to the increasing number of outlets accepting card payments and as a result of technological innovations, there has been a steady decline over the past few years in the percentage of cash payments in German retail sales. The enormous growth in the volume of banknotes in circulation in Germany during the first few years following the launch of the euro is therefore unlikely to be due primarily to an increased need for payment purposes but rather to other factors. These include, above all, the replenishment of stocks of cash inside and outside the euro area owing to the euro cash changeover. Following this process, which is likely to have been a factor chiefly in the first few years of monetary union, the annual growth rates up to and including September 2008 slowly but steadily declined to what was still a considerable 10.3% in Germany and 7.3% in the Eurosystem as a whole. At the end of 2008, however, the financial market crisis led to a

sudden rise in the growth rates again to 15.9% and 12.7% respectively.

The pace of growth in the volume of German euro banknotes in circulation is very much faster than could have been expected on the basis of earlier growth rates for D-Mark currency (see chart on page 48). This rapid growth is due, not least, to demand from non-euro-area countries. Earlier, the D-Mark was used as a reserve currency by a number of these countries and such stocks have now been changed over to euro. Furthermore, owing to its large currency area, the euro is an attractive reserve currency. It may be assumed that the euro is now preferred by some market participants that used non-European reserve currencies prior to the launch of the euro.

Dividing the issuance of cash into banknotes and coins, it is striking that the value of euro coins issued in the euro area since the introduction of the single currency in 2002 has increased at a slower pace than the value of the banknotes in circulation. This is also the case for Germany.

*Declining
growth rates
in the volume
of coins
in circulation*

¹ When analysing the volume of cash in circulation in Germany, it should be noted that it is not possible to provide precise statistical data on currency in circulation domestically. This is due, in particular, to migration effects between countries (for example, as a result of international currency trading, tourism, and cash taken abroad by employees to their home countries). These are not captured or are captured only partially by the statistics and can therefore only be estimated. Hence, whenever reference is made in the text to "German cash in circulation" or "volume of cash in circulation in Germany" etc, this relates to the volume resulting from the difference between inpayments and outpayments at the Deutsche Bundesbank (net issuance). In the statistical section of the Deutsche Bundesbank's Monthly Report, the volume of banknotes in circulation is calculated in a different way because the banknotes in circulation are shown in accordance with the accounting rules of the Eurosystem.

In the period 2002-03, the value of the issued euro coins initially showed a sharp rise. By the end of 2002, the Eurosystem had brought coins to the value of around €12.4 billion into circulation. Germany accounted for €3.6 billion of this. In the following year, too, both Germany (+16.3%) and the euro area as a whole (+13.5%) recorded double-digit growth rates. Since 2004, there has been a trend decline in the annual growth rates; in 2008, they were still at 4.9% in Germany and 5.7% in the euro area as a whole.

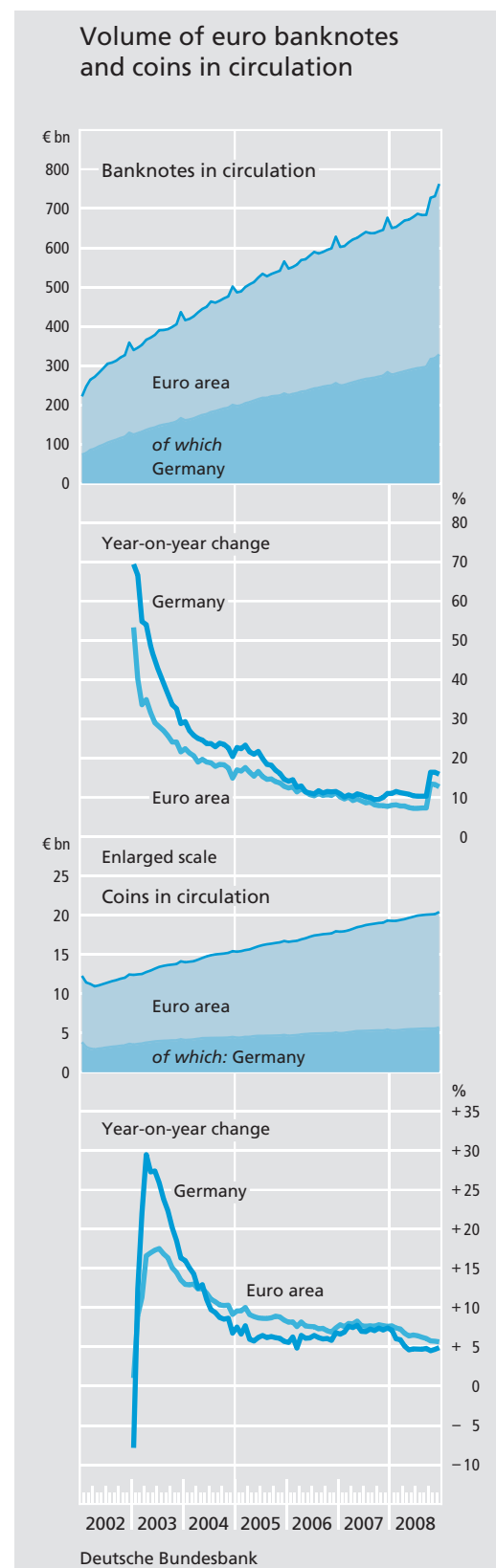
Determinants of euro banknote circulation in Germany

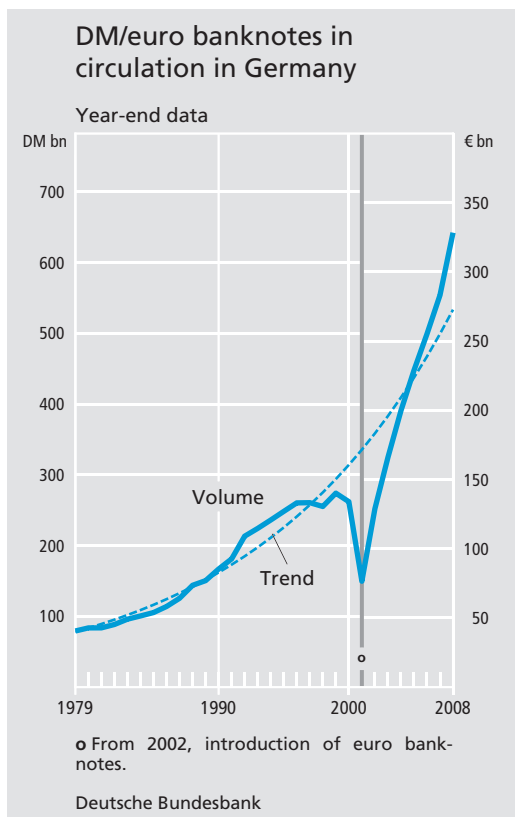
The rapid and persistent pace of growth in the volume of banknotes in circulation gives rise to the question of the reasons for this development. The motives behind the demand for cash and the part it plays in German banknote circulation will be investigated below. The key determinants of the demand for currency in this context are the transactions motive, demand from non-residents, and the desire to have a liquid medium for storing value.

Cash held for transaction purposes

Domestic transaction balances, as a component of German banknote circulation, comprises cash held for buying goods and services, which therefore has a direct relationship with transactions in the real economy. Cash used for transaction purposes circulates in the economy. The Bundesbank plays a key role in this cycle. Put simply, the commercial

*The cash cycle
in Germany*





banks receive banknotes from the Bundesbank. They then use these banknotes to fill their ATMs and cash desks. This cash is withdrawn by consumers. After a while, it finds its way into the cash boxes of retailers and service providers. Finally, for cost and security reasons, businesses pay it into the Bundesbank as soon as possible, often via one of the commercial banks.

Bundesbank survey on payment behaviour

A representative survey on “Payment behaviour in Germany”, which was conducted among the general public on behalf of the Bundesbank in 2008, showed that roughly 58% of all the transactions covered were paid in cash and only 26% with a debit card.² Cash is therefore still the dominant means of payment in Germany.

Nevertheless, the percentage of cash payments in retail sales has been falling for some years. It is uncertain, however, whether the observed decline in the share of cash payments³ will also continue to the same extent in the future. On the one hand, the number of outlets accepting card payments has already reached a high level. Payment habits appear to be changing only slowly, too.^{4,5} On the other hand, as time passes, those members of the general public who have grown up with alternative forms of payment and who are likely to go on using them until they reach an old age will constitute an ever greater percentage of the overall population. In view of this development, there could be a further, albeit – given unchanged underlying conditions – rather modest decline in the percentage of cash payments in the medium to long term. Furthermore, it remains to be seen whether new, innovative technologies, such as contactless payment by card or payment by fingerprint recognition will gain hold in Germany and what payment instruments they might replace.

² The study covered not only the retail trade in the narrower sense but also other sectors, such as filling stations, hotels and restaurants, pharmacies, services etc.

³ As shown by surveys conducted by the EHI Retail Institute, around 60% of all retail transactions were conducted in cash in 2008, albeit with a trend decline. The percentage of card-based payments rose to more than 35% in 2008. See EHI information (in German only) at <http://www.ehi.org/presse/pressemitteilungen/detailanzeige/article/rekordumsatz-per-karte-130-milliarden-euro-plastikgeld.html> and http://www.ehi.org/fileadmin/images/content_images/Presse/Kartenzahlung/Charts_Karte_09.pdf.

⁴ See also the results in Deutsche Bundesbank, Münzgeldentwicklung in Deutschland, 2003, p 129 (German only).

⁵ The Bundesbank study on “Payment behaviour in Germany” showed that “familiarity” was an essential or fairly important aspect of currency for more than 90% of those surveyed. Just as many surveyees stated that they regarded this characteristic as given in the case of banknotes and coins.

*Size of transaction balances
in Germany*

No statistics are available on the exact percentage of banknotes held on average in Germany as transaction balances. This therefore has to be estimated. To do this, the banknote stocks of banks, of the general public as well as of retailers and service providers have to be approximated.⁶ The stocks of banknotes held by banks for transaction purposes may be calculated from the stocks in ATMs and cash desks. In 2008, these amounted on average to some €14.5 billion.⁷ The stock of banknotes held by the general public to pay for goods and services may be derived from the aforementioned Bundesbank survey on payment behaviour in Germany, in which persons aged 18 years or over were asked how much they withdrew on average from an ATM or at the bank counter and how much cash they have left over before their next withdrawal. Assuming a linear reduction in the amount withdrawn until the next withdrawal, extrapolation of the data yielded an average stock of cash amounting to roughly €14.4 billion held for transactions purposes by the general public aged 18 or over.⁸ Using a number of simplified assumptions, banknote holdings of retailers and service providers, as calculated from the figures available for sales in the sector for 2007, resulted in a transaction cash stock of about €2.1 billion.⁹

These calculations thus yield a volume of banknotes in circulation for transaction purposes in Germany averaging approximately €31 billion, which corresponds to roughly 10% of the banknotes in circulation in Germany as at the end of 2008.¹⁰ This shows clearly that the transaction motive is of relatively minor importance for the overall cash

demand in Germany and scarcely played a part in the observed sharp rise in the volume of banknotes in circulation.

Cash demand from non-residents

There are various reasons why euro banknotes issued in Germany find their way to other countries. For example, a large number of foreign workers sending money back to their home country, close trading and financial links with other countries along with tourism lead to an outflow of euro banknotes to other countries. Furthermore, demand for euro banknotes from countries outside the euro area can be due to comparatively less favourable stability-oriented developments in the countries concerned. Non-residents' demand for euro banknotes also depends on geographical distance. Even before the introduction of the euro, countries in east and south-east Europe used the D-Mark as a reserve currency. Bundesbank estimates assumed that, in the mid-1990s, between 30% and 40% of D-Mark banknotes were in circu-

*Determinants
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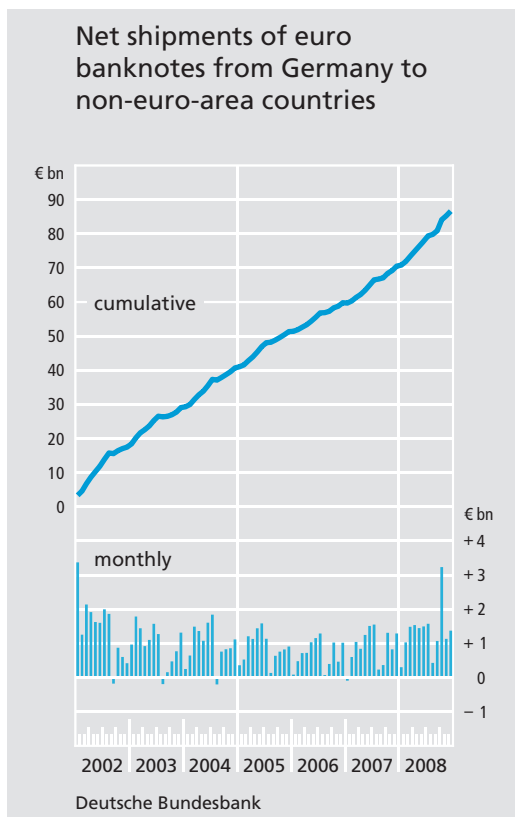
⁶ As CIT companies possess only small stocks of their own, they may be disregarded in this context.

⁷ Source: Deutsche Bundesbank, Statistical Section, IV, Monthly Report, February 2009, p 20*.

⁸ Based on these assumptions, average cash holdings are composed of one half of the amount withdrawn plus residual cash holdings. Furthermore, it is assumed that the amounts of cash which are typically withdrawn are also spent between two consecutive withdrawals and are not hoarded. See W Baumol (1952), The Transactions Demand for Cash: An Inventory Theoretic Approach, Quarterly Journal of Economics, Vol. 66, pp 545-556. Amount including the amounts of pocket money given to minors.

⁹ Bundesbank calculations. The estimate does not include cash held by enterprises for consumption and investment purposes, one reason being that the vast majority of payments in this area are not in cash.

¹⁰ This figure is consistent with calculations carried out for other countries. See H Stix (2004), Wie wirken sich Bankomatabhebungen und Zahlungsinnovationen auf die Bargeldhaltung in Österreich aus?, in Geldpolitik und Wirtschaft Q1/04, p 108.



lation outside Germany, especially in east and south-east Europe.¹¹ After the D-Mark was subsumed in the euro, the new single currency more than took over the former's role as a transaction currency and store of value in many countries outside the euro area.

Level of cash migration inside and outside the Eurosystem

Owing to the fact that payments are unrestricted, it is not possible to make an exact calculation or survey of the volume of German euro banknotes in circulation outside Germany.¹² In order to perform at least a rough estimation of the volume of cash in circulation outside the euro area, use is first made of the net shipments of euro banknotes to countries outside the euro area reported by the credit institutions.¹³ The cumulative net shipments from Germany make it clear that demand from non-residents outside the

euro area is a key driver of the growth in the volume of currency issued in Germany.

By the end of 2008, the value of the cumulative net shipments from Germany to countries outside the euro area had risen to around €87 billion. This means that banknotes in circulation outside the euro area as a percentage of German banknotes in circulation had increased from 14% to 26% since the end of 2002. Nevertheless, it should be borne in mind that banknote migration is not captured completely by the recorded net out-payments abroad via banks because banknotes also find their way abroad from Germany in other ways, such as tourism or money sent home by foreign workers. Assuming that this outflow from Germany is accompanied by a much smaller return flow from abroad, the cited figure would, in fact, have to be revised upwards.¹⁴ Under these assumptions, net banknote demand from non-euro-area countries could have gone up by the end of 2008 to between 25% and 35% of the volume of banknotes issued in Germany, thus playing a considerable part in its growth.

Under comparable assumptions, the ECB at the end of 2007 estimated the net volume of

¹¹ See F Seitz (1995), The circulation of Deutsche Mark abroad, Discussion Paper 1/95, Economic Research Group of the Deutsche Bundesbank.

¹² Various indirect methods of determining the percentage abroad are presented in B Fischer, P Kohler and F Seitz (2004), The Demand for Euro Area Currencies: Past, Present and Future, ECB Working Paper Series, No 330.

¹³ Net shipments of banknotes correspond to banknotes dispatched abroad less those received from abroad. The underlying statistics are based on voluntary information and therefore provide only an incomplete picture.

¹⁴ See European Central Bank, The euro in third countries, The international role of the euro, July 2008, p 50.

banknotes issued by the Eurosystem held by non-residents at between 10% and 20% in total.¹⁵ The fact that the figure is lower than for Germany can be explained by Germany's strong involvement in the international wholesale banknote market. First, ever since the D-Mark era, German credit institutions have had close links with countries where the euro is now widely used, especially in east and south-east Europe.¹⁶ Second, a major role is played by Germany's central geographical location in Europe.

Demand for currency because it is a store of value: hoarding

Characterisation and motives

Hoarding may be characterised essentially as the holding of currency as a store of value. On grounds of efficiency, high-denomination banknotes are most likely to be used for this purpose. The associated costs – such as forgoing interest income, the costs of storage in a locker, and the risk of loss – actually argue against saving in the form of cash. Nevertheless, there are reasons for keeping money in cash. For instance, cash is the asset with the highest degree of liquidity, which is important especially in times of heightened uncertainty. There was, for example, a sharp rise in the demand for cash during the financial crisis in October 2008.

Contribution made by hoarding to the volume of banknotes

The very sharp increase in the volume of banknotes in circulation in Germany during the first few years after the launch of the euro is closely connected with the liquidation of the D-Mark hoards in the run-up to the cash changeover. This is suggested by developments in the circulation of D-Mark and

euro banknotes, which point to a reduction in D-Mark cash holdings and a subsequent build-up of cash holdings in euro. This process lasted roughly until the end of 2003. After stocks of currency had been replenished owing to the euro cash changeover, banknote issuance in Germany was still much more dynamic than in the D-Mark era, however. The continuing strong growth in the large denominations (with the exception of the €200 banknote) suggests that the "store of value" motive was of major importance in this respect, too. Moreover, the underlying conditions in Germany during the past few years also support the assumption that the demand for cash has grown for "store of value" motives. Interest and inflation rates which, by historical standards, were extremely low following the introduction of the euro contributed to a decline in the opportunity cost of holding cash and thus encouraged the build-up of hoarded currency.¹⁷

Owing to its anonymous character, cash can also be held for illegal motives, however. Even so, currency held or used for dishonest purposes is not only hoarded but is also part of cash balances, for example, in the black economy or in drug dealing.¹⁸

The sensitivity of the subject and the explicit desire for anonymity – which by no means necessarily has any connection with illegal motives – means that determining the stocks

Level of banknote hoarding in Germany

¹⁵ See European Central Bank, *op cit*, p 50.

¹⁶ See European Central Bank, *op cit*, p 51.

¹⁷ See European Central Bank, Euro banknotes, Monthly Bulletin -10th anniversary of the ECB, June 2008, p 142.

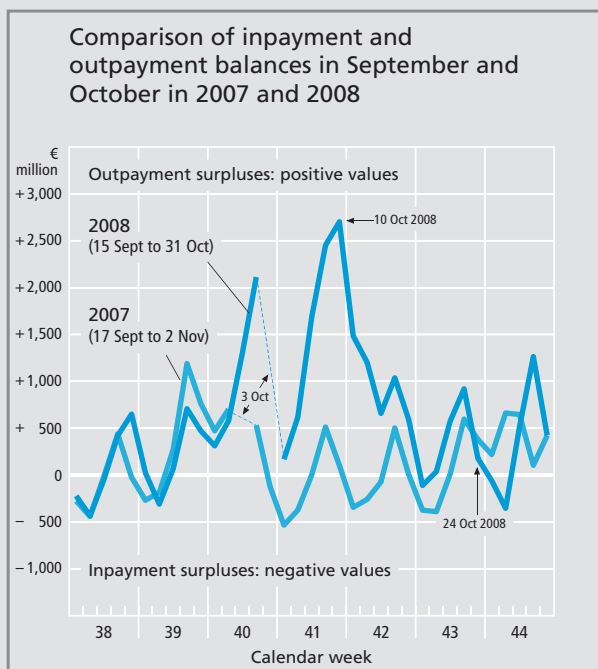
¹⁸ See ESTA (2008), Cash fuels the black economy, Newsletter No 59, ESTA – The Cash Industry Logistics Association, p 3.

Demand for banknotes during the financial crisis

As a result of the escalation of the financial market crisis in the autumn of 2008, the demand for banknotes and coins differed markedly from its pattern observed earlier. Between weeks 39 and 43 of 2008, the balance of inpayments and outpayments at the Bundesbank was noticeably different from that of the previous year.

Balance of inpayments and outpayments

As a rule, it is possible to discern a cyclical pattern in inpayments and outpayments over the course of the week. At the start of the week, inpayments predominate at the central bank. These originate mainly from retailers and are the result of consumer spending from the preceding weekend. As the week progresses, this inpayment surplus turns into an outpayment surplus.



1 Inpayments are usually made via a central account and are therefore not broken down into domestic and external demand. — 2 Figures for 2009 are not yet available.

Deutsche Bundesbank

The increase in outpayments at the end of the week is used by the commercial banks primarily to fill ATMs.

The end of September and early October 2008 saw an increase in demand for banknotes and coins compared with the previous year and a temporary change in the weekly pattern of daily inpayments and outpayments. Demand for banknotes and coins did not return to normal again until 24 October 2008, which was the first time that the outpayment balance was smaller than that for the same period one year earlier (see adjacent chart).

Daily outpayments in October 2008 were largely at a level comparable to the high demand for cash in the period before Christmas. What was striking was that the enormous increase in the value of outpayments was not offset by higher inpayments. For example, on 10 October 2008 – the day with the highest volume of outpayments during the financial crisis (€4.2 billion) – recorded inpayments merely stood at €1.5 billion. Overall, there were large value outpayments over a lengthy period in October 2008, whereas inpayments remained relatively stable compared with the previous year's figures.

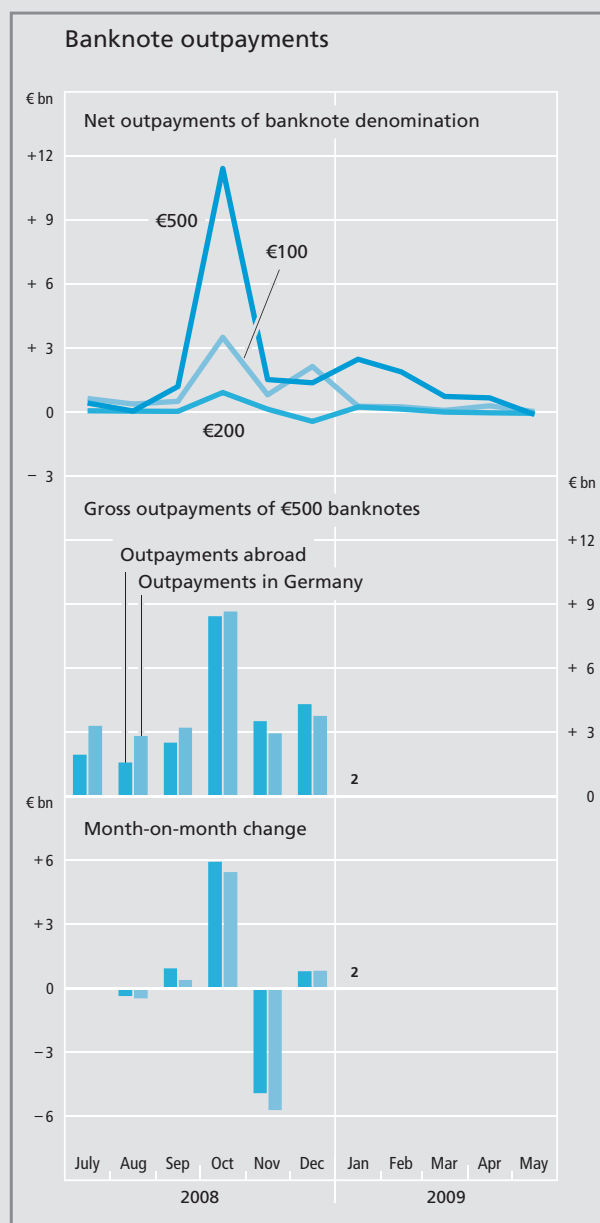
Particular demand for high denominations

During the financial crisis, large denominations, which are especially suitable as a store of value, were in much greater demand than medium and small denominations. For example, a slight increase in demand, particularly for €500 banknotes, was already apparent in September 2008. In October, there was a huge rise in net outpayments in this denomination and demand did not return to normal until the end of the month. Net outpayments of €500 banknotes amounted to €11.4 bil-

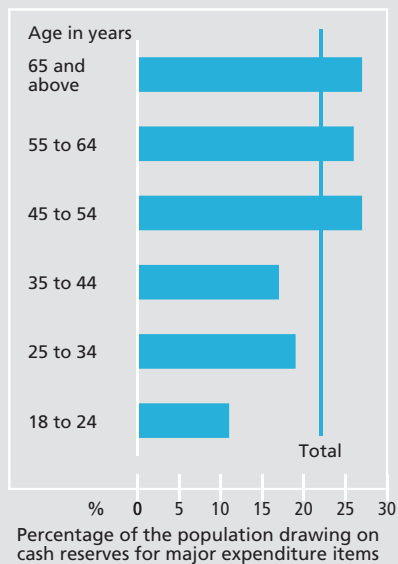
lion in October 2008 alone. By comparison, net outpayments of this denomination throughout 2008, excluding October, came to €10.3 billion. As at April 2009, the €500 banknotes that were paid out during October had not yet returned to the central bank (as is shown by the consistently positive outpayment balance). However, slight inpayment surpluses in May 2009 could be a sign that the €500 banknotes paid out during the financial crisis have now started to flow back.

Demand for €500 banknotes inside Germany and abroad

€500 banknotes generally account for a very large share of the cash outflows in the international wholesale banknote market. Hence, there is reason to believe that, in this case too, some of these banknotes flowed to non-euro-area countries as a result of the high outpayments of this denomination during the financial crisis. In order to determine this external demand more precisely, the account movements on accounts held by foreign banks at the Bundesbank and banks engaging in export business were analysed, with a considerable percentage of these account movements probably used to supply foreign credit institutions with cash.¹ The transactions conducted on these accounts are interpreted as external demand; if these amounts are deducted from outpayments as a whole, the residual figure that is obtained represents domestic demand. As can be seen from the adjacent chart, domestic demand for €500 banknotes in the third quarter of 2008 was still higher than the demand from non-residents. In October, outpayments were then distributed almost evenly between demand from residents and non-residents. This shows that, during the financial crisis, demand for banknotes suitable for the purpose of storing value rose equally in Germany and abroad.



Settlement of major expenditure items using cash reserves



Source: Bundesbank survey on payment behaviour in Germany.

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of hoarded banknotes in Germany on the basis of a direct survey of the general public does not produce robust results. Ultimately, only the residual produced by the volume of banknotes in circulation in Germany after subtracting transaction balances and demand from non-residents can be used as a rough estimate. Assuming a holding of transaction balances amounting to 10% of the volume of banknotes in circulation and based on a demand from non-residents amounting to between 25% and 35%, the lion's share of 55% to 66% is left over for hoarding. Such figures are subject to a great deal of uncertainty since they are calculated as residuals and the transaction and non-resident percentages can only be estimated, too.

Owing to these problems, the Bundesbank survey on "payment behaviour in Germany" attempted to capture indirectly the German general public's propensity to hoard. Specifying various response options, it was asked how major expenditure items, such as large purchases, were settled. In response to this question, it was stated by 22% of all those surveyed that they were able to draw on cash reserves. This may be interpreted as an indication of the widespread existence of hoarded stocks of cash in Germany, even though it is not possible to estimate their volume. The results of the study show that holding cash in this way is more prevalent among older members of the general public than among younger ones. By contrast, a breakdown by other socio-demographic factors, such as income or social background, failed to reveal any significant differences.

The fact that the holding of cash, as observed in the study, is more prevalent among persons aged 45 or over might be due in part to this age group possessing higher-than-average assets and therefore holding more of this wealth as cash. Furthermore, there is a distinct possibility that the older age groups in particular – not least because of their personal experience of crises – hold a larger part of their savings in the form of cash.

Although hoarding and demand from non-residents were analysed separately for methodological reasons, it is difficult to separate these two motives of cash demand in practice. Theoretically, demand from non-residents could be split even more accurately into "non-residents' transactions balances"

and “non-residents’ cash hoarding”. Precisely given the large percentage of hoarded items in the volume of German banknotes in circulation – which was calculated as a residual – it remains unclear how much of this may be hoarded or used for other purposes by non-residents and therefore ought to be added to the non-resident volume in circulation.

Taking all of the above factors into consideration, domestic hoarding and demand from non-residents combined account for 90% of the volume of banknotes in circulation. The experience of the euro cash changeover suggests that this figure is not implausible. The volume of banknotes in circulation peaked as early as the end of 1999 – two years before the introduction of euro banknotes and coins. By the end of 2001, the figures for banknote circulation had fallen by 45%. These stocks were evidently not needed for transaction purposes. Rather, domestic and non-residents’ hoards of cash were liquidated. During the first nine days of 2002, the volume of D-Mark banknotes in circulation declined by a further 21% compared with its peak in late 1999. Very early in 2002, more than 90% of domestic cash payments were being made in euro.¹⁹ In other words, the decline in D-Mark banknotes in circulation in the first few days of January 2002 means the majority of domestic cash balances had already been converted to euro. The ensuing fall in D-Mark in circulation can therefore be attributed more to hoards of cash being liquidated or to inpayments from non-residents. Finally, it should be noted that D-Mark banknotes to the value of DM 6.8 billion were still outstanding at the end of 2008.

A considerable part of these may be regarded as hoarded permanently or lost.

Determinants of euro coin circulation in Germany

The volume of coins in circulation depends mainly on transaction balances and hoarding; demand from non-residents plays a much smaller role than in banknote circulation.²⁰ Owing to the low amounts involved, coins are not hoarded so much as a store of value. In addition to saving in the classical sense (money boxes, for example), coin collecting is significant to a certain extent. Finally, many coins which have been lost over the years are also recorded as part of the volume of coins in circulation.

The euro cash changeover provides some clues about the breakdown of the volume of coins in circulation in terms of the purposes for which they are used. Many D-Mark coins that were being hoarded temporarily were liquidated either in the run-up to or immediately after the euro cash changeover by being paid into a bank account. As a result, during the course of 2001, the volume of coins in circulation fell from roughly DM 16 billion to DM 12.5 billion, ie by 22%.²¹ It should also be noted that, at the end of 2008, D-Mark coins worth DM 7 billion had still not been ex-

¹⁹ See Deutsche Bundesbank, Zum Stand der Euro-Bargeldeinführung in Deutschland, press release of 11 January 2002 (German only).

²⁰ See Deutsche Bundesbank, Münzgeldentwicklung in Deutschland, 2003, p 141 (German only).

²¹ The volume of coins in circulation did not peak until the end of 2000 – not the end of 1999 as in the case of banknotes.

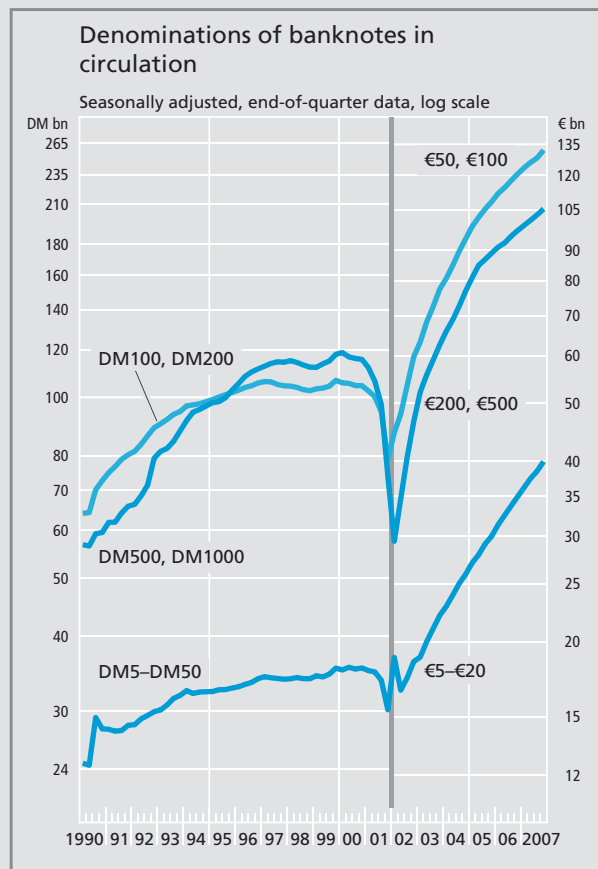
Econometric structural model of banknote demand

The contribution made by various determinants to the volume of banknotes in circulation can be captured in econometric models. For this purpose, the Bundesbank has developed a structural model (vector error correction model). The estimation period for this model is from the beginning of 1991 to the end of 2007. Seasonally adjusted quarterly data are used. The selected model makes it possible to analyse both the long-term equilibrium relationships (cointegration relationships) and the short-term dynamics. The latter are the fluctuations in demand for the respective cash components around the long-term equilibrium values. The estimation takes place in real terms, which implies that the cash holders gear their demand for banknotes to their purchasing power. However, in principle, a short-term deviation from this assumed behaviour is permitted. The

demand for smaller, medium and large denominations is investigated. Banknote denominations of €5 to €20 as well as of DM5 to DM50 are classified as "small", those of €50 and €100 as well as of DM100 and DM200 are classified as "medium", and the two highest-value banknotes of €200 and €500 as well as DM500 and DM1,000 are classified as "large".¹ See the adjacent chart.²

In order to take due account of the special circumstances for the period of the euro cash changeover, differently specified dummy variables are incorporated into the estimation approach.

Cash consumption is counted among the determinants of cash demand. Cash consumption is considered to be those subcategories of private consumption that are largely settled in cash.³ The opportunity cost of holding cash is taken into account via the interest rate level. The complete interest rate range is incorporated into the analysis, as a shift parameter from an estimated yield curve is included to represent the generally prevailing interest rate level. An increase in this parameter means that it shifts the entire interest rate range upwards. Motives of demand from non-residents are integrated into the respective estimates using a variety of variables. Demand from non-euro-area countries for banknotes issued in Germany is captured via an exchange rate argument. An appreciation of the euro should make it more attractive as a store of value and should therefore be accompanied by a higher demand for euro currency in non-euro-area countries. The best results were achieved with the real effective external value of the euro vis-à-vis the 22 most important trading partners. External factors influencing developments in euro-area countries excluding Germany were taken into account via house prices and private consumption. The BIS housing price indicator for the euro area, whose dynamics are determined solely by developments outside Germany, was chosen as the variable for the house prices. This is likely to be a good proxy for the preference for cash payments, as real property purchases are often made in cash. Private consumption models the transaction balances.⁴ The possible impact of the shadow economy on cash demand was captured via an estimated share of this area in gross domestic product.⁵ Finally, the unemployment rate in Germany was also taken into account as a variable for explaining transactions in large denominations. With increasing unemployment, there is a growing incentive to move economic activities to the shadow economy by means of illicit work. This, in turn, leads to a rise in the demand for cash in the form of large denominations. Alternative payment methods as a substitute for cash payments are incorporated into the estimation equations via the number of settled card payments.



1 Minor changes to this classification did not result in any major qualitative changes in the estimation results. — 2 The changeover from D-Mark to euro was made at the fixed conversion rate of €1 = DM1.95583. — 3 In this case, these are the expenses for accommodation, clothing and footwear, leisure, entertainment and culture, food, beverages and tobacco as well as other expenses. — 4 An alternative proxy for the transaction motive is tourist travel between Germany and the other euro-area coun-

tries. — 5 Professor Friedrich Schneider (University of Linz) was kind enough to make the relevant time series available. He uses various estimation approaches which all produce similar results regarding the scale of activities in the shadow economy in Germany. — 6 The relatively high coefficient in the case of the small denominations indicates that it was not possible to model some determinants adequately in empirical terms, and this effect is reflected in cash consumption. — 7 See M Drehmann

The table below shows the estimation results, broken down into short and long-term determinants and the three groups of banknotes.

In the case of the small and medium denominations, what stands out in the result is an obvious impact of the transaction volume in Germany, captured via cash consumption.⁶ The large denominations, by contrast, appear to be unaffected by this. In their case, however, non-resident motives are important: first, via a long-term impact of the house prices in the euro area, whose dynamics are determined mainly by the real estate market outside Germany, and second, via private consumption in the euro area excluding Germany. The importance of German transactions in terms of the demand for large denominations is noticeable, at most, in the short-term impact of unemployment. Additionally, demand from non-euro-area countries is important in the long term for all denominations. Moreover, an influence of the shadow economy⁷ on banknote demand cannot be ruled out for any of the three banknote categories. In the case of the small denominations, the effect can be seen directly in the short-term influence of the shadow economy's share of GDP. In the two other categories, the shadow economy could be

reflected indirectly in the house price and unemployment variables. Finally, opportunity costs in the form of the interest rate level seem to be of relevance only for the small denominations. Alternative means of payment, too, evidently influence only the small denominations. Alternative payment media determine the fluctuations around the long-term equilibrium, which is defined by cash consumption, demand from non-residents, and interest rates. The cash changeover dummies show a highly significant influence in all the specifications.

The adjustment to the long-term equilibrium is reflected in the error correction term. This term states how much of an existing disequilibrium is reduced within one quarter. It is obvious that the amount of time in which this adjustment takes place varies depending on the denomination. It is shortest for the small denominations and longest for the high denominations. In the case of the latter, 40% of the imbalance is corrected in one quarter. The highly significant error correction terms in all the equations indicate that the respective long-term relationships actually constitute a banknote demand function.⁸ The test statistics show satisfactory characteristics.

Estimation results from the structural model of banknote demand⁹

Item	Small denominations (€5 to €20 or DM5 to DM50)	Medium denominations (€50 and €100 or DM100 and DM200)	Large denominations (€200 and €500 or DM500 and DM1,000)
Long-term equilibrium relationship (cointegration relationship)	Cash consumption 7.50 (3.1)	Cash consumption 1.15 (2.5)	Euro-area house prices 1.75 (23.2)
	Non-euro area (exchange rate) 3.31 (6.1)	Non-euro area (exchange rate) 1.13 (7.1)	Non-euro area (exchange rate) 0.75 (10.1)
	Opportunity costs (general interest rate level) - 0.1 (2.2)	-	-
Short-term dynamics	Error correction term - 0.07 (11.5)	Error correction term - 0.19 (7.7)	Error correction term - 0.40 (13.0)
	Card payments - 0.02 (3.5)	Euro-area house prices 0.10 (3.3)	Unemployment 0.17 (6.8)
	Shadow economy (share of GDP) 0.05 (1.6)	Intra-euro area (private consumption in euro area excluding Germany) 0.21 (9.7)	Intra-euro area (private consumption in euro area excluding Germany) 0.01 (2.5)
Test statistics			
R ²	0.93	0.95	0.97
SE	0.01	0.01	0.01
LM(1)	0.16	0.96	0.65
White	0.13	0.88	0.16
JB	0.10	0.37	0.00

and C A E Goodhart (2000), Is Cash Becoming Technologically Outmoded? Or Does it Remain Necessary to Facilitate "Bad Behaviour"? An Empirical Investigation into the Determinants of Cash Holdings, LSE Financial Markets Group, Discussion Paper 358. Determinants of Cash Holdings, LSE Financial Markets Group, Discussion Paper 358. — 8 In the equations for the other long-term variables, the error correction terms are insignificant. — 9 Remarks: The variable is followed by the coefficient and - in

brackets - the absolute t-value (all the coefficients are significant at least at the 10% level). R²: corrected coefficient of determination; SE: standard error; LM(1): multivariate Lagrange multiplier test for first-order autocorrelation; White: multivariate test of heteroscedasticity according to White; JB: multivariate Jarque-Bera test for normality of residuals (specifying the p-value of the test of the corresponding null hypothesis).

changed for euro. That corresponds to almost 44% of the volume of D-Mark coins in circulation at the end of 2000. It is very likely that most of these coins are permanently lost or form part of permanent collections. As a residual for determining transaction balances, this gives a share of roughly one-third of the coins in circulation, which is a figure roughly comparable to those in earlier studies on the volume of coins in circulation.²² Accordingly, prior to the adoption of the euro, some 30% to 40% of the volume of D-Mark coins in circulation could be attributed to transaction balances, roughly 40% were to be regarded as lost or permanently hoarded, and 20% to 30% were stored in temporary hoards. As a result of the euro cash changeover, this picture changed at first. Immediately after the

introduction of euro coins, the transaction motive was predominant in the demand for coins. One major reason for the sharp increase in the volume of coins in circulation from 2003 onwards, however, was the gradual replenishment of hoarded stocks of coins. This is indicated, not least, by the fact that almost two-thirds of the growth in 2003 was in coins of lower nominal values. In the following years, too, the rates of growth for the small denominations were higher than average. All things considered, therefore, how the volume of coins in circulation is distributed in terms of the intended uses may be expected to resemble the distribution in the D-Mark era over time.

²² See Deutsche Bundesbank, Münzgeldentwicklung in Deutschland, 2003, p 160 (German only).