

## Foreign demand for euro banknotes issued in Germany

Since the introduction of euro cash, the outstanding volume of euro banknotes issued by the Deutsche Bundesbank has increased sharply. Cash held for domestic transactions by no means accounts for this development, however. It is more likely to be due to domestic hoarding and, in particular, foreign demand for euro banknotes. In addition to helping to explain the increase in circulation, determining the volume of German euro banknotes in circulation outside Germany is important for a number of other reasons. Firstly, banknotes in circulation outside Germany have no impact on domestic demand, or at least a much smaller impact than those circulating in Germany. This is a fundamental point to bear in mind when analysing the development of monetary aggregates. Secondly, foreign demand for banknotes influences the way in which central banks manage the money market. Thirdly, banknotes in circulation outside Germany are not returned to the Bundesbank for processing as quickly as those paid in from domestic cash transactions. This is relevant for measuring the Bundesbank's participation in cash processing.

This article is the first detailed analysis and calculation of the foreign demand for euro banknotes issued in Germany. However, one fundamental problem must be addressed, namely the impossibility of precisely measuring the amount of cash in circulation outside Germany. It is thus appropriate to adopt an approach comprising a range of different, independent methods. This article considers both direct approaches, based on existing surveys and statistics, as well as indirect approaches. The latter exploit the different properties of domestic and foreign demand. It transpires that the percentage of the Bundesbank's cumulated net issuance of euro banknotes in circulation outside Germany has been increasing steadily and noticeably since 2002 when it amounted to a mere 20%. At the end of 2009, an estimated 65% to 70% of Germany's cumulated net issuance of euro banknotes was in circulation outside Germany, mostly in non-euro-area countries. Between 15% and 25% of Bundesbank-issued euro banknotes were outstanding in other euro-area countries, however. In addition to the banknotes in circulation outside Germany, the stocks of German euro banknotes accounted for by domestic hoarding and transaction balances were also estimated. These estimates put the percentage of the total volume of German euro banknotes outstanding that was being hoarded in Germany at the end of 2009 at between 10% and 30%. At 10% to 15%, the share of Bundesbank-issued banknotes estimated as being held for domestic transaction purposes is relatively small. Hence it is important that measures of the central bank's degree of participation in the national cash processing cycle are not based on the total outstanding stock of banknotes but are restricted to that portion held for domestic cash transactions, that is the banknotes that actually circulate in the national cash cycle and return relatively quickly to the central bank for processing.

## Background

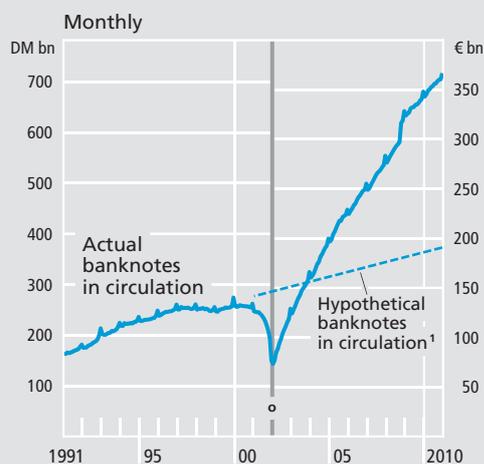
*Reasons for sharp rise in banknotes outstanding*

Following the introduction of euro cash at the start of 2002, the volume of German euro banknotes outstanding<sup>1</sup> increased from an initial €73 billion to €367 billion at last report. The chart opposite shows that the volume of German euro banknotes outstanding has grown very much faster than could have been expected on the basis of earlier growth rates for D-Mark currency. This growth cannot be explained alone by an increased holding of transaction balances – that is cash held for buying goods and services – as domestic private consumption in the period under consideration was weak and there was a steady decline in the percentage of cash payments in German retail sales.<sup>2</sup> This huge surge is therefore likely to be due to domestic hoarding and foreign demand for euro banknotes issued by the Bundesbank. For the first two years after the launch of euro cash, this hypothesis is substantiated by the need to replenish stocks of banknotes both inside and outside the euro area after the currency changeover.

However, this should have ceased to have an effect at the end of 2003 when the volume of German banknotes outstanding was back up to the hypothetical level where it would have been had euro cash not been introduced. But the pace of growth in the volume of banknotes outstanding continued thereafter to be much more dynamic than in the D-Mark era in the 1990s.

In addition to helping to explain the increase in circulation, determining the volume of Ger-

### Circulation of German banknotes



<sup>1</sup> Volume of banknotes that would have been in circulation since January 2001 had euro cash not been introduced. Calculated by extrapolating the circulation of D-Mark banknotes using its linear trend from January 1991 to December 2000. The introduction of euro cash did not start to affect the circulation of banknotes until January 2001. — ○ From 2002, introduction of euro banknotes.

Deutsche Bundesbank

man euro banknotes in circulation outside Germany is important for a number of other reasons. Firstly, banknotes in circulation outside Germany have no impact on domestic demand, or at least a much smaller impact than those in circulation in Germany. This is a fundamental point to bear in mind when analysing the development of monetary aggre-

*Understanding foreign demand important for other reasons, too*

<sup>1</sup> The outstanding volume of euro banknotes issued by the Deutsche Bundesbank is the volume resulting from the cumulated difference between monthly lodgements and withdrawals at the Deutsche Bundesbank (cumulated net issuance). In this text, this volume is also abbreviated to the "volume of German euro banknotes outstanding". In the statistical section of the Deutsche Bundesbank's Monthly Report, the volume of German euro 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.

<sup>2</sup> See EHI Retail Institute: Kartengestützte Zahlungssysteme im Einzelhandel 2010, Cologne 2010 (in German only).

gates.<sup>3</sup> Secondly, foreign demand for banknotes influences the way in which central banks manage the money market. In terms of value, the volume of banknotes outstanding is the largest autonomous factor determining liquidity and is also relatively difficult to forecast. Thirdly, banknotes in circulation outside Germany are not returned to the Bundesbank for processing as quickly as those paid in from domestic transaction balances. This is relevant for measuring the Bundesbank's participation in cash processing.<sup>4</sup>

This article takes a closer look at the role that foreign demand played in the rise in circulation. In addition to calculating the global volume of German euro banknotes in circulation outside Germany, it includes a regional breakdown into other euro-area countries (cumulated domestic migration) and non-euro-area countries. These analyses also enable us to approximately gauge the relative shares of domestic and foreign circulation of German euro banknotes being used in transaction balances and being hoarded.<sup>5</sup>

### Approaches to measuring banknotes in circulation outside Germany

*Direct and indirect approaches*

The fundamental problem of calculating the exact volume of German euro banknotes outstanding is that this figure cannot be recorded statistically, or at least not to a reliable enough degree, and must therefore be estimated. As a result, the figures calculated in this way are always subject to uncertainty. To reduce this uncertainty and maximise the results' robustness, it is advisable to use a

variety of empirical instruments and methods. The methods used can be divided into direct and indirect approaches. The aim of the former is to use those statistics and surveys that are already available to arrive at approximate figures for banknotes in circulation outside Germany. The latter exploit either the different properties of domestic and foreign demand or make use of particular events, such as the introduction of euro cash. This article presents the results of selected direct and indirect approaches.

### Direct approach 1: net shipments of euro banknotes from Germany to non-euro-area countries and foreign travel

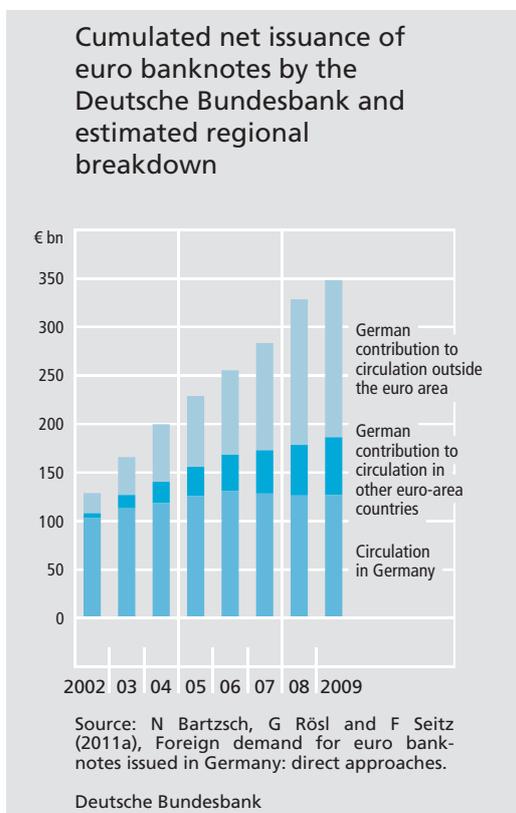
One possible way of gaining information about the volume of German euro banknotes in circulation outside Germany is to use data and surveys that enable conclusions to be drawn about the unobservable volume of cash in circulation outside Germany. For in-

*Use of statistics and surveys*

<sup>3</sup> This is naturally complicated by the fact that Germany's contributions to Eurosystem monetary aggregates do not contain currency in circulation and can certainly not be interpreted as its own national monetary aggregates. Neither are they comparable with the earlier German monetary aggregates M1, M2 and M3.

<sup>4</sup> See Deutsche Bundesbank, The banknote cycle and banknote recycling in Germany, Monthly Report, January 2011, pp 17-27.

<sup>5</sup> Initial rough estimates of the components of German euro banknotes outstanding are already available. See Deutsche Bundesbank, The development and determinants of euro currency in circulation in Germany, Monthly Report, June 2009, pp 45-58. The more precise information presented here is based on the following studies, which contain additional estimation approaches: N Bartzsch, G Rösl and F Seitz (2011a), Foreign demand for euro banknotes issued in Germany: direct approaches, unpublished, as well as N Bartzsch, G Rösl and F Seitz (2011b), Foreign demand for euro banknotes issued in Germany: indirect approaches, unpublished. These studies are planned for publication as Deutsche Bundesbank Research Centre discussion papers as part of Series 1 "Economic Studies".



stance, certain information can be obtained from a household survey on foreign travel conducted by the Bundesbank and from existing data on banks' net shipments of euro banknotes from Germany to non-euro-area countries.<sup>6</sup>

*Foreign travel*

On the basis of information from this survey and an additional estimate of banknotes being brought to Germany by travellers, the cumulated volume of travel-related German net exports of euro banknotes is estimated to have amounted to €122 billion at the end of 2009. Roughly half of this is attributable to other euro-area countries and the other half to non-euro-area countries. For more information, see the box on page 33.

The official net shipments of euro banknotes from Germany to non-euro-area countries comprise withdrawals and lodgements of euro banknotes at the Bundesbank by big banks active in the global market for currency dealing. The cumulated value of these German net shipments to non-euro-area countries has been rising steadily since the introduction of euro cash in 2002 and amounted to €99 billion at the end of 2009. This means that approximately 95% of the total net shipments of the euro area comes from Germany.

*Official net shipments*

Taken together, the estimated travel-related outflows of banknotes and the official net shipment figures made up a foreign share of around 65% of the total volume of German euro banknotes outstanding at the end of 2009. The bulk (roughly €220 billion) of the total volume of banknotes outstanding (just short of €350 billion) was thus circulating outside Germany's borders. Non-euro-area countries accounted for the largest share (approximately €160 billion) of foreign banknote demand, while the cumulated net exports of euro banknotes from Germany to other euro-area countries amounted to €60 billion. The residual amount of almost €130 billion can thus be attributed to banknotes in circulation in Germany (see the chart above).

*Total foreign share of 65% largely outside euro area*

**Direct approach 2: calculating the foreign demand for euro banknotes as a residual**

As mentioned at the outset of this analysis, the above calculations regarding the volume

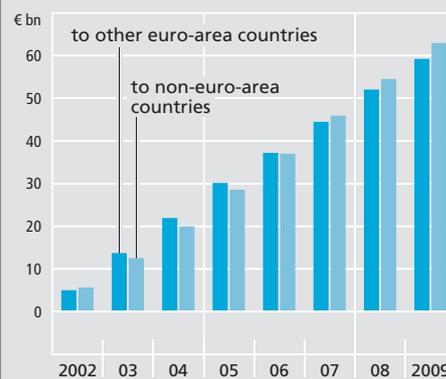
<sup>6</sup> However, these do not include all important transactions, for example, cash taken home by foreign workers.

## Travel-related net exports of euro banknotes issued by the Deutsche Bundesbank

When compiling the balance of payments statistics, the Bundesbank regularly carries out a household survey wherein respondents are asked about their travel expenditure and the sums of cash they take with them when going abroad (see table below<sup>1</sup>). This covers trips to both euro-area and non-euro-area countries.

According to the collected data, euro cash totalling €167 billion migrated to foreign countries between 2002 and the end of 2009 as a result of trips abroad by German travellers. This constitutes 36% of total travel expenditure by German private and business travellers, which stood at €471 billion during the period under review. Of this amount, €95 billion flowed to other euro-area countries and around €73 billion to non-euro-area countries. By contrast, the amount of euro cash inflows to Germany resulting from foreign visitors is unknown. In order to estimate the level of these inflows, foreign visitors to Germany are assumed to exhibit the same payment behaviour as Germans travelling abroad and are accordingly ascribed the corresponding ratio of cash to total travel expenditure.<sup>2</sup> The volume of euro banknotes imported by travellers from the euro area and from non-euro-area countries can then be estimated on the basis of Germany's known total travel receipts from these regions. These calculations indicate that between 2002 and the end of 2009, travel-related imports of euro cash into Germany

Estimated travel-related cumulated net exports of euro banknotes from Germany<sup>2</sup>



totalled €45 billion. Of this amount, €36 billion is likely to have emanated from the euro area.

As the above chart shows, Germany's cumulated travel-related net exports of euro banknotes thus amounted to €122 billion over the period under review. The euro area accounted for roughly half of this total (€59 billion).

## Results from the household survey relating to travel expenditure

€ million

Year	Euro cash taken abroad, then changed into foreign currency	Cash payments made abroad using euro imported from Germany			Foreign cash taken abroad which was originally acquired in Germany or left over from previous journeys	German travel expenditure		
		Total	Euro-area countries	Non-euro-area countries		Total	Euro-area countries	Non-euro-area countries
2002	3,745	9,959 <sup>3</sup>	7,197 <sup>3</sup>	2,762	1,872	55,904	31,014	24,890
2003	4,618	16,041	12,446	3,595	3,208	57,757	32,493	25,265
2004	4,506	16,735	12,561	4,174	2,858	57,545	30,380	27,164
2005	4,738	17,839	12,793	5,046	2,816	59,766	31,080	28,686
2006	4,689	17,135	12,021	5,114	2,837	58,895	30,252	28,643
2007	4,745	17,933	12,525	5,408	2,786	60,619	30,572	30,047
2008	4,727	17,950	12,793	5,157	2,719	61,854	32,226	29,628
2009	4,452	17,487	12,393	5,094	2,538	58,183	29,311	28,872
2002 to 2009	36,220	131,079	94,729	36,350	21,634	470,524	247,327	223,197

<sup>1</sup> See also: Deutsche Bundesbank, "Capturing foreign travel in the balance of payments statistics from January 2001", Monthly Report, March 2003, pp 60-61, and Deutsche Bundesbank, Recording cross-border cash transactions in the balance of payments, Monthly Report, March 2005, p 37. Since most cash amounts taken abroad are likely to take the

form of banknotes, no distinction is made in the following analysis between banknotes and cash in circulation. — <sup>2</sup> See: N Bartzsch, G Rösl and F Seitz (2011a), Foreign demand for euro banknotes issued in Germany: direct approaches. — <sup>3</sup> Estimated value taken from N Bartzsch, G Rösl and F Seitz (2011a), op cit, as no data are available.

*Volume of transaction balances in Germany*

of German euro banknotes in circulation outside Germany are only estimates. An alternative method of determining foreign demand is to subtract the sum of German euro banknotes circulating in Germany from the Bundesbank's cumulated net issuance. Although the former is likewise an unknown value, it can be approximated by estimating the total volume of euro banknotes in circulation in Germany.<sup>7</sup> This, in turn, comprises domestic transaction balances and the stocks of banknotes being hoarded. Domestic transaction balances are made up of cash balances held by banks, the general public, retailers and service providers. On an annual average for 2008, an estimated €30 billion circulated in Germany for transaction purposes.<sup>8</sup>

*Volume of hoarded banknotes in Germany*

There are similarly no official statistics or surveys concerning the stocks of euro banknotes being hoarded in Germany; however, there is a household survey from 2008 that was conducted by TNS opinion on behalf of the European Central Bank but never published. This survey is representative of German nationals older than 14 years of age. In this survey, 1,042 people were asked how much cash they keep as a store of value. From their responses one can estimate that the total amount of cash being hoarded by all (adult) persons in Germany in 2008 was just under €20 billion. This corresponds to a mere 5% of the Bundesbank's cumulated net issuance of euro banknotes at the end of 2008. However, the figures derived from the household survey are likely to significantly understate the levels of cash actually hoarded in Germany and are thus taken as only the lower bound. It is likely, for instance, that some respond-

ents were reluctant to disclose the full amount of their cash hoardings.

The estimates of domestic transaction balances (approximately €30 billion) and euro banknotes hoarded in Germany (just under €20 billion) add up to a lower bound of just under €50 billion for the volume of banknotes in circulation in Germany at the end of 2008. This corresponds to an upper bound for the total volume of German euro banknotes in circulation outside Germany of an estimated €280 billion, which equates to 85% of cumulated net issuance at the end of 2008.

*Upper bound for total foreign demand*

As with the first direct approach, this approach also proves incapable of obtaining a more accurate estimate of the volume of German euro banknotes in circulation outside Germany using the statistics and surveys available. More precise estimates can be yielded only if additional assumptions are made, as in the first direct approach, or indirect approaches are applied, as in the following methods.

*Additional assumptions or indirect approaches yield more precise estimates*

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<sup>7</sup> Owing to domestic migration among euro-area countries, the volume of German euro banknotes in circulation in Germany does not necessarily correspond to the volume of all euro banknotes in circulation in Germany, ie the (actual) domestic circulation of banknotes. As demonstrated in the first direct approach, however, one can assume that Germany is a net exporter of euro banknotes to other euro-area countries. In other words, there are more German euro banknotes circulating in other euro-area countries than euro-area euro banknotes in Germany. In net terms, the outstanding volume of German euro banknotes in Germany thus equates to the domestic circulation of banknotes.

<sup>8</sup> See Deutsche Bundesbank (2009), op cit, p 49.

### Indirect approach 1: seasonal method

*Domestic and foreign banknote demand have different seasonal patterns*

The aim of the seasonal method is to filter out information about banknotes in circulation outside Germany from the seasonal structure of banknotes outstanding. For this purpose, it is assumed that foreign demand for German euro banknotes has little or no seasonality.<sup>9</sup> Hence, foreign and domestic demand exhibit different seasonal patterns, and the seasonal component of the total volume outstanding is dampened by the foreign share. The volume of German euro banknotes in circulation outside Germany can then be derived by estimating the unknown seasonal component of domestic circulation. For a more detailed description of the seasonal method, see the box on page 36. This section presents three methods which can be used to gauge as reliable a picture as possible of the seasonal component of the euro banknotes held in Germany. The first method comprises selecting a reference country, the second uses a transaction variable and the third analyses banks' cash balances. As these methods are based on different assumptions concerning what share of foreign and domestic demand is recorded, the foreign share calculated also differs depending on the method used.

*Method 1: reference country*

An ideal reference country mirrors Germany's use of banknotes with the exception of foreign demand. This is likely to be true of France which, for instance, has a similar standard of living to Germany and, as a fellow euro-area country, the same banknote denominations. Furthermore, given the fact that official net shipments of euro banknotes

to non-euro-area countries consist almost exclusively of German issues, it may be assumed that, on balance, only very few euro banknotes issued by France find their way to non-euro-area countries. With the exception of demand for euro banknotes from non-euro-area countries, France's use of banknotes is likely to be very similar to that in Germany. As a result, the seasonal method using France as a reference country can give a good idea of the volume of Bundesbank-issued euro banknotes that are in circulation outside the euro area.

Using this method, it is estimated that German euro banknotes to a value of around €160 billion were circulating in non-euro-area countries at the end of 2009. These estimates are not implausible insofar as throughout the reporting period they are higher than the official cumulated German net shipments to non-euro-area countries, which represent a lower bound of circulation outside Germany in this region chiefly due to the fact that they do not include foreign travel. For more information, see the chart on page 37.

Another possible approach is to approximate the domestic seasonal component of the euro banknotes held in Germany using the seasonal variation of a transaction variable. This approach is based on private consumption expenditure in Germany. The domestic hoarding of cash is captured by estimating the domestic income elasticity of demand

*Method 2: transaction variable*

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<sup>9</sup> However, small denominations used in foreign travel are likely to be subject to seasonal influences, especially within the euro area. Yet this is likely to be fairly insignificant in relation to the total volume of banknotes circulating outside Germany.

## Seasonal method

The underlying seasonal model assumes that the time series of German banknote issuance consists of three terms: a trend component  $T_t$ , a seasonal term  $S_t$  and an irregular or noise component. These are multiplicatively interlinked (multiplicative seasonal model). Attributing the noise term to the trend term for simplicity and including a term for the share of outstanding banknotes held abroad gives the following equation,

$$(1) \quad T_t S_t = T_t^d S_t^d + T_t^a S_t^a,$$

where  $t$  represents the time index, and  $d$  and  $a$  stand for domestic and foreign variables, respectively. Let  $\beta_t$  denote the fraction of the overall trend held domestically and, consequently,  $(1 - \beta_t)$  the share held abroad:

$$(2) \quad S_t = \beta_t S_t^d + (1 - \beta_t) S_t^a.$$

Assuming that the foreign share does not vary seasonally, ie  $S^a = 1$  for all  $t$ , equation (2) can be further simplified to

$$(3) \quad S_t = \beta_t S_t^d + (1 - \beta_t).$$

With given values for the seasonal terms  $S$  and  $S^d$ , an equation is produced containing an unknown value,  $\beta_t$ , which denotes the share of banknotes held domestically:

$$(4) \quad \beta_t = \frac{S_t - 1}{S_t^d - 1}.$$

$S_t$  is the seasonal component of total German cumulated net banknote issuance and can be calculated using the customary seasonal adjustment methods (eg X12-ARIMA, Tramo/Seats). By contrast,  $S^d$ , the seasonal term for the share of banknotes circulating in Germany, is unknown and must be estimated. However, equation (4) does not always produce meaningful results. If, for example, in any given period there is no seasonal influence, ie  $S_t = S_t^d = 1$ , any value of  $\beta_t$  is consistent with equation (4). It is thus impossible

to uniquely identify  $\beta_t$ . Even if the seasonality of all outstanding banknotes is not lower than that of the banknotes held domestically in all periods, problems can still occur. This method thus produces plausible results for some but not all periods.

Therefore, further adjustments have to be made to allow for these factors and enable this method to be applied. Meaningful estimation results can often only be generated for certain frequencies of a year.<sup>1</sup> For example, in the case of German banknote issues, the seasonal high is in December, while the seasonal low is in February. This means there is a two-month frequency. In order to factor this into equation (4), the time index  $t$  in equation (3) is replaced by  $m, j$ , where  $m$  represents the  $m^{\text{th}}$  month and  $j$  stands for the  $j^{\text{th}}$  year. If equation (3) for February is subtracted from the corresponding equation for the preceding December, the domestic share  $\beta_j$  is produced as follows

$$(5) \quad \beta_j = \frac{S_{dec,j} - S_{feb,j+1}}{S_{dec,j}^d - S_{feb,j+1}^d}.$$

The seasonal component of the stock of euro banknotes held in Germany,  $S^d$ , in equation (5) is unknown and must be estimated. Here it is estimated using the seasonal term of banknotes in circulation in a reference country, the seasonal component of a transactions variable as well as the seasonal term of banks' cash holdings. In the second case, the amount of cash being hoarded domestically can also be determined by taking into account the domestic income elasticity (transactions elasticity) of the demand for banknotes,  $\eta$ . Equation (5) can then be rewritten as

$$(6) \quad \beta_j = \frac{S_{dec,j} - S_{feb,j+1}}{S_{dec,j}^d - S_{feb,j+1}^d} = \frac{S_{dec,j} - S_{feb,j+1}}{\eta \cdot \Delta S(tr)},$$

where  $\Delta S(tr)$  stands for the difference between the seasonal high and the seasonal low of the transactions variable.

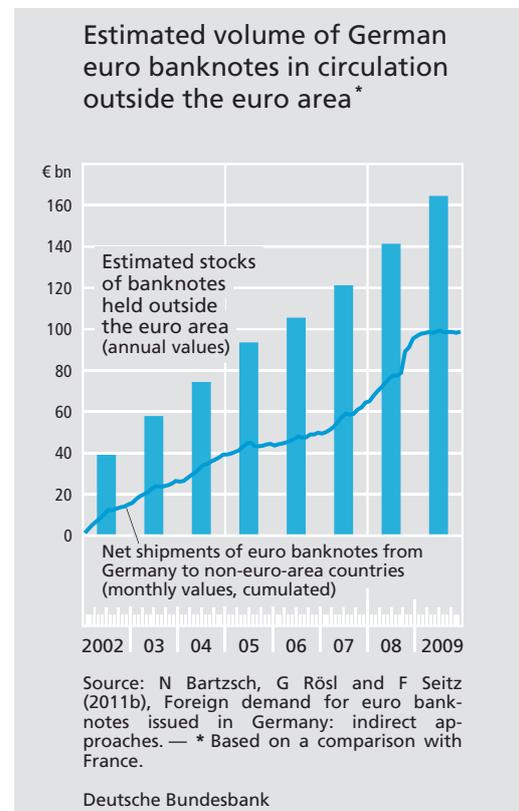
<sup>1</sup> See Federal Reserve System, The Location of U.S. Currency: How Much is Abroad?, Bulletin, October 1996, p 883 ff.

for banknotes. This then enables the total volume of Bundesbank-issued euro banknotes held outside Germany (both inside and outside the euro area) to be derived. This volume has been increasing since 2002 and amounted to approximately €250 billion at the end of 2009 (see the chart on page 38).

After taking into account the results from the method using France as a reference country, the cumulated net export of euro banknotes from Germany to other euro-area countries (cumulated domestic migration) thus amounts to €90 billion.

*Method 3:  
banks' cash  
balances*

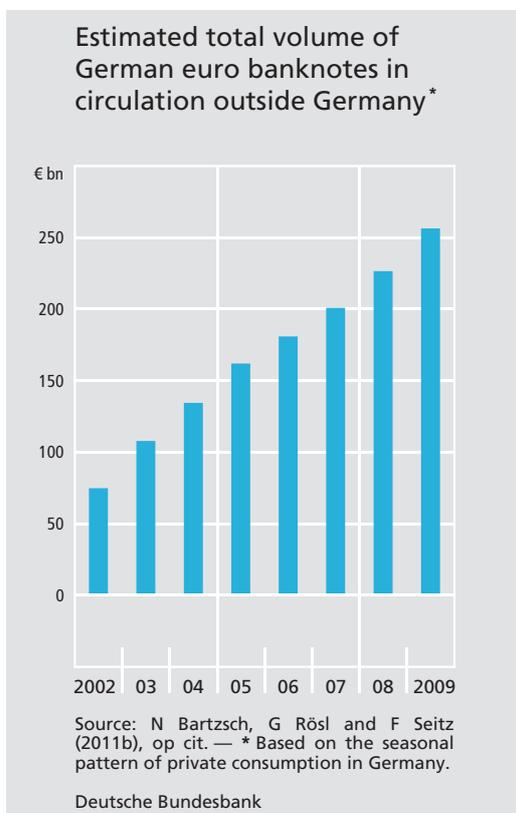
The third method of determining the seasonal component of the Bundesbank-issued euro banknotes in circulation in Germany uses the seasonal structure of cash balances held by banks in Germany. As these cash balances incur opportunity costs, they are kept to a minimum and result almost exclusively from regular domestic transactions. Domestic hoarding and foreign demand have virtually no impact on banks' cash balances. This approach is used to determine the sum of total foreign demand for German euro banknotes and the stock being hoarded in Germany, which is estimated to amount to €290 billion. This leaves an estimated residual of just under €60 billion for transaction demand from households and enterprises in Germany. After deducting the estimated €250 billion for total circulation outside Germany that was derived using the "transaction variable" method, this means that euro banknotes to the value of approximately €40 billion were being hoarded in Germany at the end of 2009.



### Indirect approach 2: estimating a banknote demand function

Another way of estimating circulation outside Germany indirectly is to determine a function for purely domestic demand for Bundesbank-issued banknotes. France is once again selected as the reference country as it is comparable with Germany in terms of domestic demand for banknotes. Again it is assumed that banknotes issued in France have little or no circulation outside the euro area, and that the domestic migration of banknotes issued by the French and German central banks within the euro area is similar. However, the banknote demand function does not include any variables that capture this domestic migration within the euro area. Germany's total circulation beyond its borders can thus be

*Total foreign demand estimated at €240 billion*



calculated as the difference between the Bundesbank's cumulated net issuance of euro banknotes and Germany's domestic circulation estimated using the banknote demand function for France. According to this estimate, total circulation outside Germany has been rising continuously since 2002. At the end of 2009, the outstanding volume of Bundesbank-issued banknotes outside Germany is put at between €210 billion and €270 billion, with the point estimate at €240 billion.

#### Indirect approach 3: information from the introduction of euro cash

The size of domestic transaction balances, and thus also the sum of foreign demand for and domestic hoarding of Bundesbank-issued

euro banknotes, can be estimated using the growth in the volume of banknotes in circulation in Germany around the time euro cash was introduced. At the end of 2001, €77 billion of D-Mark banknotes were still in circulation. After the first nine days of 2002, roughly 90% of domestic cash payments were already being made in euro.<sup>10</sup> The bulk of transaction balances therefore appear to have been converted by this time. The remaining D-Mark banknotes to the value of €47 billion that were still outstanding on 9 January 2002, less 10% that was still in use for cash payments in D-Mark (€9 billion), are consequently assignable to domestic hoarding and foreign demand. This results in a transaction balance of €38 billion in Germany at the start of 2002. If this amount is extrapolated with the growth rate for nominal private consumption to the end of 2009, this yields a domestic transaction balance of around €40 billion. Thus at the end of 2009, foreign demand and domestic hoarding together amounted to roughly €310 billion.

#### Indirect approach 4: implications from the financial crisis

This method tests the robustness of the estimate for domestic hoarding derived in the first indirect method. In the wake of the sub-prime crisis, the American investment bank Lehman Brothers was forced to file for bankruptcy in September 2008. This greatly unsettled the financial markets and triggered a flight to safe and liquid assets, including cash.

*Hoarding in Germany and non-euro-area countries ...*

<sup>10</sup> See Deutsche Bundesbank, Zum Stand der Euro-Bargeldeinführung in Deutschland, press release of 11 January 2002 (in German only).

Summary of estimation results \*

Year-end level, various approaches

Item	Net shipments and foreign travel	Circulation outside Germany as residual	Seasonal methods	Banknote demand function	Introduction of euro cash	Financial crisis
	2009	2008	2009	2009	2009	2009
	€ bn					
Cumulated net issuance of euro banknotes in Germany	350	330	350	350	350	350
Total volume of German euro banknotes in circulation outside Germany	220	280 (UL)	250	240 (210 LL, 270 UL)	310 (UL)	–
Volume of German euro banknotes in circulation outside the euro area	160	–	160	–	– <sup>1</sup>	110 (LL)
Cumulated net exports of euro banknotes from Germany to other euro-area countries	60	185 (UL)	90	–	–	–
Domestic circulation	130	50 (LL)	100	110 (80 LL, 140 UL)	40 (LL)	–
Transaction balances	–	30	60	–	40	–
Hoarding	–	20 (LL)	40	–	–	110
	Percentage of cumulated net issuance of euro banknotes in Germany					
Cumulated net issuance of euro banknotes in Germany	100	100	100	100	100	100
Total volume of German euro banknotes in circulation outside Germany	65	85 (UL)	70	70 (60 LL, 75 UL)	90 (UL)	–
Volume of German euro banknotes in circulation outside the euro area	45	–	45	–	– <sup>1</sup>	30 (LL)
Cumulated net exports of euro banknotes from Germany to other euro-area countries	15	55 (UL)	25	–	–	–
Domestic circulation	35	15 (LL)	30	30 (25 LL, 40 UL)	10 (LL)	–
Transaction balances	–	10	15	–	10	–
Hoarding	–	5 (LL)	10	–	–	30

Sources: N Bartzsch, G Rösl and F Seitz (2011a), Foreign demand for euro banknotes issued in Germany: direct approaches, unpublished, as well as N Bartzsch, G Rösl and F Seitz (2011b), Foreign demand for euro banknotes issued in Germany: indirect approaches, unpublished. These studies are planned for publication as Deutsche Bundesbank

Research Centre discussion papers as part of Series 1 "Economic Studies". — \* Lower limit: LL, upper limit: UL. All values have been rounded to the nearest €5 billion or 5 percentage points. Figures may not add up due to rounding. — <sup>1</sup> Hoarding only.

As a result of the crisis, the net issuance of banknotes in Germany rose by €16 billion in October 2008.<sup>11</sup> Half of this rise is attributable to higher net shipments of euro banknotes to non-euro-area countries. An examination of the gross withdrawals of €500 banknotes (the denomination typically used by hoarders) from the Bundesbank in October 2008 supports this hoarding hypothesis. In that month, withdrawals were almost equally divided between demand from Germany and non-euro-area countries.<sup>12</sup> Hence during the financial crisis, the demand for Bundesbank-issued euro banknotes as a store of value rose just as strongly in Germany as it did in countries outside the euro area. Assuming that residents of both Germany and non-euro-area countries share the same average hoarding behaviour, this implies that there should be virtually no difference in the volume of Bundesbank-issued euro banknotes hoarded in Germany and in non-euro-area countries.

... both at €110 billion end-2009

The stocks of banknotes hoarded outside the euro area can be estimated using the "OeNB euro survey" – a survey that has been conducted by the Austrian central bank semi-annually since autumn 2007. This survey collects data about the volume of cash and savings held in foreign currencies by households in central, east and south-east European countries. This implies that the ratio of German euro banknotes being hoarded to total foreign demand in non-euro-area countries (around €160 billion according to the first indirect method) is around 70%. Thus according to these calculations, the stock of Bundesbank-issued euro banknotes being

hoarded in non-euro-area countries amounted to over €110 billion at the end of 2009. Under the aforementioned assumption that both German and non-euro-area residents exhibit the same average hoarding behaviour, this likewise yields an estimated €110 billion for domestic hoarding. This figure clearly exceeds the estimate of €40 billion derived residually in the first indirect approach.

### Conclusions from the estimation results

Even after cash holdings had been replenished at the end of 2003 following the introduction of euro cash, the volume of German euro banknotes outstanding continued to grow strongly. The estimates presented in this article have demonstrated that this growth was primarily driven by foreign demand. Conversely, the domestic share of the Bundesbank's cumulated net issuance of euro banknotes has declined steadily and has more than halved since 2002.

*Domestic share of demand more than halved since 2002*

The results of all approaches at the current end are summarised in the table on page 39. When interpreting the results, it is important to bear in mind that estimating the volume of banknotes in circulation outside Germany is difficult and subject to major uncertainty.

<sup>11</sup> This figure was calculated from the estimated coefficients of dummy variables for October 2008 in regARIMA models for the cumulated net issuance of each banknote denomination in Germany. According to these calculations, the following denominations increased significantly: €50 banknotes (+€1.9 billion), €100 banknotes (+€3.0 billion), €200 banknotes (+€0.9 billion) and €500 banknotes (+€10.2 billion). In October 2008 the crisis thus caused the circulation of these denominations to increase by €16 billion overall.

<sup>12</sup> See Deutsche Bundesbank (2009), op cit, pp 56-57.

Although the approaches examined here vary greatly and are independent of one another, the resulting estimates for banknotes held outside Germany are rather similar. They are therefore likely to be a close approximation of the actual figures.

*Bundesbank-issued euro banknotes predominantly circulating outside Germany*

The point estimates for the breakdown of the total demand for German euro banknotes at the end of 2009 can be summarised as follows. At 65% to 70%, foreign demand accounted for the lion's share of German banknotes outstanding. Only roughly one-third of the Bundesbank's net issuance of euro banknotes was used in Germany. The majority of banknotes in circulation outside Germany were in non-euro-area countries. All approaches put this figure at 45%. Germany is also a net exporter of euro bank-

notes to other euro-area countries. The cumulated domestic migration of euro banknotes from Germany to other euro-area countries is estimated at between 15% and 25%. Domestic hoarding accounts for between 10% and 30%. At 10% to 15%, the share of Bundesbank-issued euro banknotes estimated as being held for domestic transaction purposes is relatively small. Hence it is important that measures of the central bank's degree of participation in the national cash processing cycle are not based on the total outstanding stock of banknotes but are restricted to that portion held for domestic cash transactions, that is the banknotes that actually circulate in the national cash cycle and return relatively quickly to the central bank for processing.

*Share of domestic transaction balances estimated at only 10% to 15%*