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Altmann, Markus and Bartzsch, Nikolaus

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Markus Altmann and Nikolaus Bartzsch

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Markus Altmann and Nikolaus Bartzsch

Markus Altmann
Deutsche Bundesbank
Financial Stability Department /
Zentralbereich Finanzstabilität
Wilhelm-Epstein-Str. 14
D-60431 Frankfurt/M.
e-mail: markus.altmann@bundesbank.de

Nikolaus Bartzsch
Deutsche Bundesbank
Cash Department /
Zentralbereich Bargeld
Wilhelm-Epstein-Str. 14
D-60431 Frankfurt/M.
e-mail: nikolaus.bartzsch@bundesbank.de

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Abstract

According to estimates using the seasonal method, the volume of euro coins held for transaction purposes in Germany in 2011 stood at €2.3 billion; this corresponds to around 36% of the total volume of German (ie issued by the Deutsche Bundesbank) euro coins in circulation. 76% of the total volume of coins held for transaction purposes was accounted for by €1 and €2 coins. Only in the case of €2 coins has the cash stock held for transaction purposes made a significant contribution to the growth in the volume of coins in circulation in recent years. Therefore, structural models are the most suitable method of determining the demand for this denomination. Given the overall weakness in the growth of the cash held for transaction purposes, coin processing costs have, all other things being equal, risen less sharply than the volume of coins in circulation. Small denomination coins (1 and 2 cent coins) account for comparatively low shares of the coins held for transaction purposes (less than 30%). This is because they are hoarded to a greater extent in order to lighten one's wallet or purse, or are lost. This could be used as an argument for applying a rounding rule (to nearest five cents). It is presumed that abroad German euro coins are, on balance, only held outside the euro area. There they are being hoarded on a permanent basis. Due to the inadequate data availability, the cash balance held for domestic transactions by sector cannot be fully recorded. Estimates for 2011 put them at between €0.7 billion and €1.0 billion. Households and credit institutions accounted for the largest share.

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1 Introduction

Since the introduction of the euro banknotes and coins, there has been a marked upward trend in the demand for German-issued euro coins.[1] At the start of 2002 there were only €3.8 billion worth of coins in circulation (11.1 billion coins); however, by the end of 2012, this figure had risen steadily to €6.8 billion (29.6 billion coins).[2] In statistical terms, this worked out most recently at 368 coins with a value of €85 euro for each person living in Germany. The growth in 1 and 2 cent coins is particularly pronounced. On average, each German citizen is in possession of 187 coins of these denominations. The coins in circulation are used for the following purposes: firstly, the (domestic) transaction balance for purchases; secondly, (domestic) hoarding; and thirdly, foreign demand. Coins may be hoarded permanently or temporarily. Based on the broad definition that is applied here, this not only comprises classical hoarding as a store of value and the regular setting aside of coins to be used as small change, eg for vending machines (temporary hoarding), they also include seepage losses in the form of collections, as well as coins that are lost or damaged (permanent hoarding). Up to now, there has not been any in-depth study conducted into dividing the euro coins that have been issued in Germany ("German" euro coin circulation or the circulation of "German" euro coins) into the different purposes of use. However, it is clear from the figures indicated that the rise in the number of German coins in circulation cannot be explained simply by an increase in the amount of cash held by individuals for transaction purposes. This is all the more the case given that the reduction in cash payments made by households does not exactly suggest dynamic growth in the balance of coins held for domestic transactions.[3] In this paper, we will seek to estimate the level of these transaction cash balances and how they progress over time. The remainder of the total volume of coins in circulation is consequently accounted for by the domestic hoarding balances and German euro coins circulating outside the country (foreign demand).

The determination of the level of the transaction balance of euro coins in Germany is of interest for the following reasons. Firstly, it is of relevance to seigniorage. Responsibility for minting euro coins lies with the national governments of the euro-

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[1] In this context, the volume of (German-issued) euro coins is the imputed value of euro coins paid out by the Deutsche Bundesbank less those paid in (cumulative net issuance). Euro regular issue coins comprise all the coins in the denominations from 1 cent to €2, including €2 commemorative coins (such as the Federal States series). All of these coins are legal tender throughout the entire euro area. €10 coins and euro gold coins (€20, €100 and €200 euro) count purely as collectors' coins and not as regular-issue coins.
[2] During this period, the volume of coins issued by the euro area rose from €12.3 billion (38.1 billion coins) to €23.7 billion (102.0 billion coins).
[3] For information about the decline in the cash payment share, refer to Deutsche Bundesbank (2012, p 36).

area countries. The total value of all the coins to be brought into circulation every year has to be approved by the ECB Governing Council. In Germany, coins are issued by the Deutsche Bundesbank in consultation with the European Central Bank. While the German Federal government is responsible for the minting of coins, it is the Deutsche Bundesbank that puts the coins into circulation by purchasing them from the Federal government at their face value. The difference between the face value and the minting costs is the money creation profit (seigniorage). Unlike in the case of banknotes, the seigniorage generated from the issuance of coins is collected directly by the Federal government.[4] Consequently, the issuance of coins contributes towards the funding of the state budget.[5] If the overall demand for coins is broken down into the categories "transaction balance", "hoarding" and "foreign demand", the sources of seigniorage can be determined from the coins in circulation. If the share accounted for by permanent hoarding and (net) foreign demand is high, this is favourable for the state budget. These "inactive" coin balances generally do not flow back to the central bank. The seigniorage associated with these coins is therefore permanently ascribed to the state budget.

As described in Deutsche Bundesbank (2013, p 40), the costs for the production of one and two cent coins (known as small denomination coins) are close to or even higher than their nominal value. A money creation loss occurs in this case. If there are any further rises in the cost of raw materials, it could become uneconomical to produce these coins, and they could become used for purposes other than those intended. In addition, not inconsiderable costs arise in the banking industry and in the retail trade sector for the counting, preparation (eg rolling) and transportation of these coins.[6] If only a small share of the small denomination coins in circulation were used for transaction purposes, this would be an argument in favour of restricting their use, for example, by applying a rounding rule. So far, two of the euro-area member states have introduced a rounding rule, Finland and the Netherlands, in order to make payment transactions more efficient; see Deutsche Bundesbank (2013). The payment amount is rounded up or down to the nearest five cents at the checkout. The findings of a survey conducted by the Deutsche Bundesbank on payment behaviour indicate that the German public is currently not especially concerned about the introduction of a rounding rule (Deutsche Bundesbank, 2012). However, no clear trend can be derived from the

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[4] The seigniorage resulting from the issuance of banknotes is distributed between the central banks of the individual member states according to their ECB capital share. The seigniorage is distributed among the governments following deduction of any expense items.

[5] According to the Treaty establishing the EU, the stock of euro coins held by the central bank, which has already been credited to the government, may not exceed 10% of the national volume of euro coins in circulation.

[6] At the end of 2011, small denomination coins accounted for a 50% share of the German euro coins in circulation in terms of pieces or volume.

responses. According to a study conducted by the European Commission, 39% of the respondents in Germany indicated in 2011 that they had particular difficulty using 1 cent coins. This figure was even as high as 55% in the case of 2 cent coins. Therefore, these surveys do not provide a uniform picture of the attitude of the general public towards small denomination coins. An important consideration in this regard is the question regarding the degree to which small denomination coins are used at all when making a payment. This question will be answered on the basis of the transaction balance shares estimated in this study.

The division of coins in circulation into their components is also a significant factor in terms of the costs of processing coins. These costs are incurred by domestic cash handlers, principally through the balance of coins held for (domestic) transactions or through the active circulation of coins. An increase in the number of German euro coins in circulation only leads to higher cash (processing) costs if it is attributable to a rise in the transaction balance.

Ultimately, the determination of the transaction balance is also significant for forecasting coin circulation. The Deutsche Bundesbank forecasts the change in circulation for each denomination every January and September as part of its coin requirement planning for the Federal Ministry of Finance, see Deutsche Bundesbank (2013). Time series models from the RegARIMA class are used for this.[7] Forecasts using structural models which map the individual motives of the demand for cash, such as transactions and hoarding, can essentially be used as an alternative. However, it is difficult to find suitable variables for this. The transaction motive can be more or less recorded using a proxy variable for consumption which is paid for using coins ("cash consumption"). It is much more difficult to find an opportunity cost variable for the hoarding motive. Structural models are all the more suitable for forecasting, the greater the dynamics of the coins in circulation are driven by the transaction balance.

Existing scientific studies on the purposes of cash have been primarily concerned with cash as a whole or with banknotes. Sumner (1990), for example, conducted a study into the transaction balances and hoarding balances of US dollars. He compared the seasonal fluctuations in the cash in circulation and retail sales figures in order to estimate the transaction balances. According to his study, the transaction balance accounted for 38% of the US currency in circulation in 1980. Bartzsch, Rösl and Seitz (2011a, 2011b) studied the breakdown of euro banknotes brought into circulation by the Deutsche

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[7] RegARIMA or ARIMAX models are ARIMA models with an exogenous input. The input can be both deterministic (eg dummy variables) or stochastic and exogenous.

Bundesbank ("German" euro banknotes) into transaction balance, foreign demand[8] and hoarding. The transaction balance of banknotes can only explain a small proportion (10% to 15%) of German euro banknotes in circulation. Foreign demand accounts for the greatest share at almost 70%. According to studies conducted by the Federal Reserve Board, between 60% and 70% of US currency is held abroad (United States Treasury Department 2006).[9]

Unlike cash (banknotes and coins), few studies have been conducted into the usage of coins. Glanville (1970) put forward estimates for the rates at which coins are lost in the United Kingdom. The coins included in these estimates had either been lost, damaged, permanently collected and were in circulation abroad. The wastage rates were determined using the "vintage method". Consequently, they correspond to the constant annual rate at which the active circulation of coins of a certain age has to shrink in order to maintain the proportion of those coins in a random sample. The derived wastage rates were between 0.7% and 3.7%, depending on the random sample, the denomination of the coin and the date on which the coins were first issued. Similarly, Goldin (1985) estimated the annual rate at which Israeli pound coins, issued between 1960 and 1979, were lost. To this end, he took a random sample of coins at the end of 1981. Their distribution in terms of their date of issue (imprinted on the coin) was compared with the corresponding distribution of the coins issued in the period indicated. The fewer older coins that were found in the sample, the greater the number of coins that had been lost of the denomination in question. On balance, the loss rates for the small denomination coins were rather high (40% in the case of the smallest denomination). In the case of large denominations, however, the annual loss rates were in single digit percentages. Applying the same method for the Netherlands and Germany respectively, Bos (1994) and the Deutsche Bundesbank (2003) also concluded that the loss rates for large coin denominations are much lower than those for small denomination coins. Deutsche Bundesbank (2003) also contains a model calculation, based on household surveys, into the hoarding of euro coins by individuals between the years 2002 and 2004. Furthermore, a seasonal method was applied to estimate the cash balance held in DM coins for domestic transactions for the period from 1970 to 2001. This was estimated at DM 6.2 billion at the end of the 1990s, which corresponds to 53% of all the coins in circulation.

The studies on euro coins are primarily concerned with the mixing of national coins (coins with a national reverse side) in each of the member states. As the reverse sides of

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[8] Foreign demand covers German euro banknotes in circulation, both within the (other) euro-area countries and outside the euro area.
[9] However, the figures quoted in the literature fluctuate between 20% and 70% (Feige 2009).

the euro coins are different in each country, surveys and random samples can be used to determine the proportion of domestic and foreign coins present in the domestic coins in circulation. In this regard, Seitz, Stoyan and Tödter (2012) estimated that, extrapolating the existing growth rate of coins in circulation in the likeliest variant, €1 coins with a German reverse will drop to a share of around 50% of all the €1 coins in circulation in Germany in the long term (from around 75% in 2008). However, no conclusions can be inferred from this about the circulation of "German" euro coins (in the sense of cumulated net issuance by the Deutsche Bundesbank).

The paper is structured as follows. Chapter 2 contains a general description of direct and indirect approaches to estimating the cash balance held in euro coins for domestic transactions. In chapter 3 we will estimate the cash balance held in euro coins for domestic transactions both for each individual denomination, as well as for the overall (value of all denominations in) circulation. The shares of the circulation of each denomination (by value) are calculated in section 3.2, and the transaction balances are calculated in euro in section 3.3. We assess the quality of these estimates in chapter 4 on the basis of observations made during the introduction of euro cash. Chapter 5 contains estimates of the level of transaction balances of euro coins by sector among consumers, credit institutions, retailers and vending machine operators. Finally, we will assess in chapter 6 to what degree conclusions can be inferred about domestic hoarding of and foreign demand for German euro coins on the basis of the estimates for the cash balance held for domestic transactions. The results are summarised in chapter 7.

2 Direct and indirect approaches to recording the cash balance held in euro coins for domestic transactions

In the case of direct approaches, attempts are made to a greater or lesser degree to identify the cash balance held in euro coins for domestic transactions directly. Among other things, surveys on the payment and cash-withdrawal behaviour of households, as well as cash balance notifications from credit institutions are used. See also the estimate of sector-specific transaction balances in chapter 5.

Indirect approaches, on the one hand, are those which make use of information from special, one-off events, such as the introduction of euro cash; see also chapter 4.[10] Another type of indirect approach, on the other hand, makes use of the fact that the cash balance held in euro coins for domestic transactions exhibits different characteristics to

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[10] An overview of the direct and indirect approaches is provided by Feige (1997, p 168 ff) in connection with the estimate of foreign demand for US currency.

the other components of the German euro coins in circulation. As the Deutsche Bundesbank satisfies any demand for cash, these characteristics reflect the demand behaviour for cash. The problem can be formulated more precisely as shown below (Feige 1997, p 184). Estimates are to be determined for the shares β_1 and β_2 of two sub-populations C_1 and C_2, which together give rise to the total population C. X_1 and X_2 denote the observed and recorded characteristics belonging to C_1 and C_2 in the sub-populations. The average attribute X is then derived as the weighted average of the two characteristics, whereby the weights are the unknown shares β_1 and β_2.

(1) $$X = \beta_1 X_1 + \beta_2 X_2$$

As $\beta_1 = 1 - \beta_2$, the shares can be estimated from the characteristics that are observed and measured:

(2)
$$\beta_1 = \frac{X - X_2}{X_1 - X_2}$$

$$\beta_2 = \frac{X_1 - X}{X_1 - X_2}.$$

A meaningful solution to this problem exists if the characteristics of the two parts X_1 and X_2 differ ($X_1 \neq X_2$), and the calculated shares are between zero and one. Applied to the question of determining the level of the cash balance held in German euro coins for domestic transactions, the characteristics of the German euro coins that are hoarded in Germany or that exist abroad (X^a) must differ sufficiently from those of the German euro coins that are used for domestic transactions (X^d) to enable the share to be identified in the monitoring of overall behaviour.[11] Possible examples of characteristics or of differentiating features are age,[12] quality, speed of circulation or the seasonal

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[11] In this paper, "German" (euro) coins or "German" (euro) coins in circulation always means the coins brought into circulation by the Deutsche Bundesbank. They are not only euro coins with a German reverse side. Coins paid out again may also be coins with a foreign reverse side (from one of the other euro-area countries) that had been paid in previously to the Deutsche Bundesbank. The Bundesbank issues coins on behalf of the Federal Ministry of Finance (BMF) in its capacity as a "fiscal agent". The BMF decides which coins are produced and in what quantities. The circulation of German euro coins (including the cash balances of the credit institutions), which is also referred to here as "German" euro coins in circulation, corresponds to the cumulated net issuance, ie the balance arising from the cumulated difference between the monthly outpayments from and inpayments to the Deutsche Bundesbank. See also footnote 1.

[12] Coins have a lifespan of between 20 to 30 years.

structure of the coins. The share of the German euro coins in circulation accounted for by the cash balance held for domestic transactions is then determined

(3) $$\beta^d = \frac{X - X^a}{X^d - X^a}$$

and for the corresponding share attributable to domestic hoarding and foreign demand

(3') $$1 - \beta^d = \frac{X^d - X}{X^d - X^a} \, .$$

In chapter 3 we determine β^d with the aid of the different seasonal structures of X^a and X^d.

3   Seasonal method

In the following, the transaction balance of euro coins in Germany as a whole and by denomination is estimated using an indirect approach, ie applying what is known as the seasonal method. Section 3.1 contains a description of the seasonal method, and the formulas for calculating the transaction balance are derived from this. It is used in section 3.2 to estimate the transaction balance (by denomination) as a share of the circulation (by denomination). The corresponding absolute values of the transaction balances (in € million) are set out in section 3.3.

3.1   Deriving the calculation formulas

The aim of the seasonal method is to filter out information about the transaction balance from the "seasonal structure of the coins in circulation" characteristic. This idea originally came from Sumner (1990), who applied this approach to determine domestic hoarding balances for US currency. However, since then, this approach has also been adopted for several currencies to investigate the domestic and foreign component (Porter and Judson, 1996, p 889 ff; Seitz, 1995, section 2.2; Fischer, Köhler and Seitz, 2004, section 5.1; Bartzsch et al, 2011b, subsection 2.2.2). The fundamental assumption of this approach is that the transaction balance has a more pronounced seasonal structure than coins in circulation as a whole. The latter ultimately also includes hoarding balances and foreign demand. Both have little to do with seasonal developments domestically (in Germany). Chapter 6 shows that foreign demand for German euro coins principally consists of coins which foreign tourists take outside the

euro area and which are hoarded there permanently owing to the difficulties involved in exchanging them. As described in Deutsche Bundesbank (2003, p 161), there is already a greater assumption about the invariance of the domestic coin hoard. One cannot rule out the possibility that this hoard will increase at a greater rate than usual because of the rise in transactions at the end of the year. This applies, for example, if individual households regularly empty small change out of their wallets and hoard it temporarily. However, the resulting seasonal fluctuations in the *balance* of the domestic coin hoard may be considerably lower than in the inflow and outflow. Nevertheless, this would lead to a certain under-estimation of the coins held for transaction purposes. At any rate, we assume that the cash balances held for domestic transactions and the remaining components of the circulation of German euro coins (domestic hoarding and foreign demand) differ from one another in the seasonal figure, and that the overall circulation shows a dampened seasonal factor.

The underlying seasonal model assumes that the time series for the circulation of German euro coins comprises three parts: a trend component T_t, a seasonal term S_t and an irregular component.[13] They should be linked together on a multiplicative basis (multiplicative seasonal model). Attributing the irregular component to the trend for simplicity and allowing for the fact that some of the coins are found in domestic hoards or abroad (*a*), this results in (*t* represents the time index, *d* stands for the domestic transaction balance)

(4) $$T_t S_t = T_t^d S_t^d + T_t^a S_t^a.$$

If β_t now encompasses the share of the total trend that is found in the domestic transaction balance T^d and, as a consequence, $(1-\beta_t)$ is the corresponding share of the domestic hoard and of foreign demand, it follows that

(5) $$T_t S_t = \beta_t T_t S_t^d + (1 - \beta_t) T_t S_t^a \ \text{ or}$$

(5') $$S_t = \beta_t S_t^d + (1 - \beta_t) S_t^a.$$

(5') is an application example for the general equation (1) in chapter 2, whereby the seasonal factor takes on the role of the measured characteristic *X*. Assuming that there is

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[13] A cyclical component is not shown separately. This does not alter the results.

a missing season in the domestic hoard and in the foreign demand share, ie $S^a = 1 \ \forall \ t$, (5') can be further simplified to

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

Given the values for the seasonal terms S and S^d, this gives rise to the share of the domestic transaction balance accounted for by German euro coins as an equation for the unknown value β_t

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

The share of the domestic hoard and foreign demand is then, in turn, $(1-\beta_t)$. S_t corresponds to the seasonal figure for the cumulated net issuance of euro coins by the Deutsche Bundesbank and can be determined by applying the normal seasonal adjustment processes (for example, X12-ARIMA, Tramo-Seats). On the other hand, S^d, the season for the domestic transaction balance, is unknown and must be determined on an approximate basis.

However, equation (7) does not always deliver meaningful results. If, for example, there is no seasonal influence during any period, ie $S_t = S_t^d = 1$, β_t tends towards infinite or any value of β_t can be reconciled with the equation (7). Problems may arise, even if the seasonal figure for the (total, value-based) German coins in circulation is not weaker during all the periods than that of the domestic transaction balance.[14] Consequently, this method does not always deliver clear results.

Therefore, further modifications are needed to allow for these eventualities and to enable this method to be implemented. Fairly accurate estimation results can often be obtained only for a certain frequency within a year (see also Porter and Judson, 1995, p 19 f). We therefore take into account the fact that seasonal fluctuations are usually greatest around Christmas owing to domestic transactions. In the case of German coin issues (total circulation), the seasonal high is in December, while there is a seasonal low in January (in this case, this is accordingly a one-month frequency). In order to factor this into the equation, we replace the time index t with m,j, whereby m denotes the mth month and j stands for the jth year. If equation (6) for January is subtracted from the

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[14] If the seasonal figure in the domestic transaction balance is more pronounced than that in the domestic hoards and in foreign demand, the following equation applies to values greater than 100: $S_t < S_t^d$, for values less than 100: $S_t > S_t^d$.

corresponding equation for the preceding December, the domestic transaction balance share β_j reads as

$$(8) \qquad \beta_j = \frac{S_{dec,j} - S_{jan,j+1}}{S_{dec,j}^d - S_{jan,j+1}^d}.$$

In Figure 1, both seasonal factors ($S_{dec,j}$, $S_{jan,j}$) of Germany's total issuance are presented for our observation period (2004 to 2011). 2002 and 2003 were not factored in because the circulation of euro coins was still in a transitional phase during those years following the introduction of euro cash. While data up to the end of 2012 have been used, we were only able to determine transaction balance shares, β_j, up to and including 2011 (see equation (8)).

The next thing to do is to approximately determine the unknown seasonal amplitude of the domestic transaction balance in the denominator of equation (8). This involves taking the seasonal amplitude of a transaction variable *tr* (which is still to be defined more closely), $\Delta S(tr)$, ie the difference between the seasonal high and low of the transaction variable. However, it is not simply a case of replacing the denominator in equation (8) with the seasonal amplitude of the transaction variable. This still has to be multiplied by the transaction or income elasticity in demand for coins in order to convert the "transaction variable" unit into the "(value-based) coins in circulation" unit. We have selected a value of 0.5 for transaction elasticity. This value is derived from the cash management theory for currency which is used for the payment of regular transactions (Baumol 1952).

Consequently, equation (8) becomes[15]

$$(8') \qquad \beta_j = \frac{S_{dec,j} - S_{jan,j+1}}{S_{dec,j}^d - S_{jan,j+1}^d} \approx \frac{S_{dec,j} - S_{jan,j+1}}{0,5 \cdot \Delta S(tr)},$$

whereby $\Delta S(tr)$ is the difference between the seasonal high and low of the transaction variable *tr*.

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[15] Only the part of the coins in circulation required for transaction purposes exhibits a seasonal pattern, which follows the seasonal deflections in transaction volume or, as the transaction variable is only an approximation, comes close to it. It is assumed, on the other hand, that there are no seasonal deflections in the other components of demand which are not required for payment purposes – hoardings (including losses) and foreign demand (see equation (6)). Therefore, the seasonal fluctuations in the entire volume of coins in circulation are dampened all the more so the higher the share of those components is in coins in circulation. See Deutsche Bundesbank (2003, p 157).

Figure 1: Seasonal factors $S_{dec,j}$ and $S_{jan,j}$ for the circulation of German euro coins (by value)
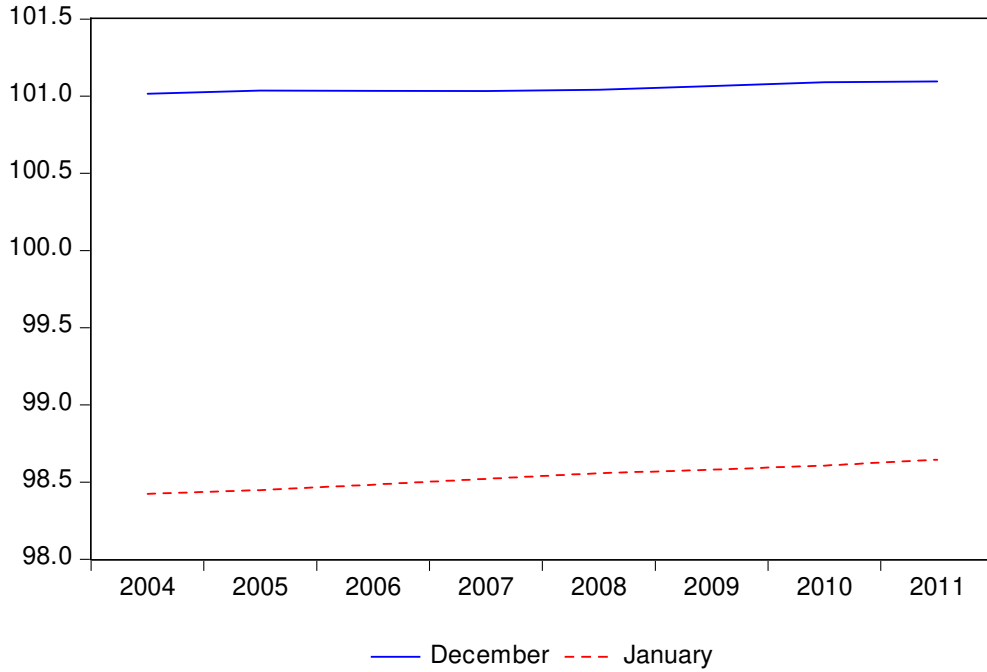
Source: Deutsche Bundesbank

The selected transaction variable should illustrate the demand for coins for transaction purposes insofar as possible. The most suitable option appears to be a proxy variable which is most akin to consumption spending by households paid for using coins. As a rule, cash consumption as a subset of private consumption and retail sales figures can be considered as possible transaction variables tr. These variables are described in greater detail in section 3.2. In the case of cash consumption, we have to switch over to quarterly data (q) and adapt equation (8') accordingly. The seasonal amplitude of the *quarterly* (value-based) circulation of German euro coins (in the numerator) reflects the difference between the seasonal factor for coins in circulation in the second quarter of the year j and the seasonal factor for coins in circulation in the first quarter of the following year $j+1$. The seasonal amplitude of the cash consumption (in the denominator) is equal to the difference between the seasonal factor for cash consumption in the fourth quarter and its seasonal factor in the first quarter of the following year. Consequently, equation (8') becomes[16]

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[16] In accordance with equation (8'), one could expect that the seasonal high in the numerator for equation (8") lies in the fourth quarter. However, it falls in the second quarter for the following reasons. In terms of monthly seasonal factors, those in December are the highest, immediately followed by the seasonal

$$(8'') \qquad \qquad \beta_j \approx \frac{S_{q2,j} - S_{q1,j+1}}{0,5 \cdot \Delta_{q4,j;q1,j+1} S(tr)}.$$

3.2 Domestic transaction balance shares in German euro coins in circulation

In the following, the share of the balance of coins in circulation held for domestic transactions, β_j, in accordance with equations (8'') or (8'), is determined both for the entire (value-based) circulation (total for all denominations) of German euro coins (ie those issued by the Deutsche Bundesbank) as well as for the (value-based) circulation of same, by denomination.[17] As previously mentioned, real cash consumption and real retail sales are possible transaction variables. As the quality of data available for private consumption is much better, we will present the results for this scenario first of all. At the end, we will take a brief look at the results arising when retail sales figures are used.

The cash consumption has to be determined from the components of real private consumption which are normally (also) paid for with coins. To this end, we first adopted the definition contained in Seitz and Setzer (2009) for cash consumption. According to that definition, cash consumption consists of the following private consumption components in Germany: 1) accommodation and hospitality services, 2) clothing and footwear, 3) leisure, entertainment and culture, 4) food and beverages, as well as 5) other purposes, such as body care and personal articles. This definition of real cash consumption is designated below as "real cash consumption within broad boundaries" because it is based on the transaction-related demand for banknotes and not primarily on the demand for coins. Therefore, we have defined "real cash consumption within narrow boundaries" as an alternative transaction variable, which should be more akin to consumption paid for with coins. "Cash consumption within narrow boundaries"

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factors in June and May, which is attributable to public holidays and to the start of the holiday period. Furthermore, the seasonal factors in November are low.

[17] As chapter 6 shows, Germany is a net exporter of euro coins. This means that the entire domestic demand for coins is met by the Deutsche Bundesbank (in the net assessment, ie when assessing the cross-border *net flows* of euro coins). In addition, the Bundesbank also meets part of the demand for coins abroad. Therefore, the *domestic balances of German euro coins* (transaction balance and hoardings) correspond *in the net assessment* to the entire *domestic balances of euro coins.* The latter include euro coins which were brought into circulation by the Deutsche Bundesbank (German euro coins) and euro coins issued by other Eurosystem central banks (foreign euro coins).

consists of the following private consumption components: 1) "Food and alcoholic beverages" and 2) "Alcoholic beverages and tobacco products"[18]

The share of the total coins in circulation accounted for by the domestic transaction balance, β_j, is determined using equation (8") for both the broad and narrow definitions of real cash consumption.[19] Both time series are shown in Figure 2. Based on the calculation formula, the transaction balance shares can only be calculated up to and including 2011, even though the database covers 2002 to 2012. The years 2002 and 2003 were not taken into consideration on account of the distortions to coin circulation following the introduction of euro cash. It is apparent that both series are close together at the start (2004) and end (2011) of the period. The maximum gap occurs in 2007 and amounts to five percentage points. Consequently, the results of the two transaction variables turn out similar, in any event. This is important because it is difficult to say which of them best reflects true coin consumption. Cash consumption within broad boundaries probably encompasses components which are only paid for to a limited extent with coins, if at all. On the other hand, cash consumption within narrow boundaries may not include all the components of private consumption that are paid for with coins. For this reason we calculate the (definitive) share of the transaction balance as an (unweighted) average of the two transaction balance shares arising from cash consumption within broad boundaries and that within narrow boundaries. In the following, we refer to this for the sake of simplicity as the transaction balance share, arising from the "average" real <u>c</u>ash <u>c</u>onsumption (*cc*). The resulting share of the entire circulation of German euro coins accounted for by the transaction balance is also shown in Figure 2. The lowest level in the period under analysis was 2011, at almost 36%. The maximum occurred in 2006 and 2007 at almost 41%. The declining trend since 2008 could be attributable to the drop in the share of cash payments made in retail outlets. In addition, the share of coins in circulation accounted for by the transaction balance automatically reduces over time due to the accrual of coins that are lost or that are collected permanently. However, this argument principally applies to "older" coins in circulation.

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[18] Other components that may possibly (also) be paid for with coins were not taken into consideration owing to an absence of available data. On the one hand, it entails components which are not published for the entire period under consideration here, ie 2004-2012, but rather only for 2002-2009: 1) newspapers and magazines, 2) stationery products and drawing materials, as well as 3) hairdressing services and other body care services. On the other hand, the following components were not taken into consideration because they are only available as annual series and not as quarterly series: 1) leisure and cultural services, as well as 2) catering services.

[19] In the case of cash consumption within broad boundaries, the seasonal high only occurs in the fourth quarter from 2004 to 2008 inclusive. It occurs in the third quarter in the years after that. The shares of the transaction balance, β_j, that follow from equation (8") are similar for those two seasonal highs.

The shares of all the cash in circulation accounted for by domestic transaction balances with the (average) cash consumption as a transaction variable in accordance with equation (8") were alternatively also calculated with *combined seasonal and calendar factors* of (average) cash consumption instead of only with seasonal factors.[20] We rejected this variant due to inexplicable large deflections ("peaks") in the transaction balance shares.

A further calculation variant is to use real retail sales figures as a transaction variable (*tr*) instead of real cash consumption. For the purposes of this monthly series, the shares of all the German euro coins in circulation (by value) accounted for by domestic transaction balances, β_j, were calculated in accordance with equation (8'). There are also narrow and broad boundaries here once again.[21] The shares for the transaction balance lie within a range of between 15% and 19%. A low value such as this can only be expected with older issues of coins in circulation, but not with euro coins in circulation as they are still very young.[22]

Bartzsch et al (2011a, 2011b) have shown that euro banknotes issued in Germany account for a 10% - 15% share of the (domestic) transaction balance, while the foreign demand share is about 65%. As we will show in chapter 6, German euro coins (in the sense of *net* issuance) are in circulation to a much lesser degree abroad, on the other hand. By the same token, one would expect that German euro coins would account for a significantly greater share of the (domestic) transaction balance than German euro banknotes. For this reason and due to the inferior quality of the data on retail sales, we have favoured the estimates that are based on cash consumption.

Applying the seasonal method, the percentage shares accounted for by the domestic transaction balance can also be estimated for the individual coin denominations. The share of the domestic transaction balance (by denomination) refers here to the circulation *of the denomination in question* and not to the *overall circulation* (by value) (collective circulation of all denominations). In the case of small denominations (1 cent, 2 cents and 5 cents), the seasonal high occurs in the third quarter and not in the second

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[20] There is no calendar dimension to the German euro coins in circulation, and thus, they do not have any combined seasonal and calendar factors either.

[21] Real retail sales figures excluding trade in vehicles, as reported in the official retail sales statistics, were selected as real retail sales figures within broad boundaries. The retail sales figures within narrow boundaries consist of retail trade with various types of products, most notably food and luxury foodstuffs, beverages and tobacco products (all sales locations). The real retail sales figures within both boundaries experience a seasonal high in December and a seasonal low in February.

[22] In chapter 4, the share of the (older) DM coins in circulation accounted for by the transaction balance in 2000 was estimated at just under 15% with the introduction of euro cash.

quarter as happens with all coins in circulation.[23] Once again, the (average) real c̲ash c̲onsumption (*cc*) is taken as a transaction variable. By adapting equation (8") accordingly, the following formula is created for calculating the domestic transaction balance shares for small denomination coins

(9)
$$\beta_j \approx \frac{S_{q3,j} - S_{q1,j+1}}{0,5 \cdot \Delta_{q4,j;q1,j+1} S(cc)}.$$

Figure 2: Percentage share of (all) the German euro coins in circulation (by value) accounted for by the domestic transaction balance
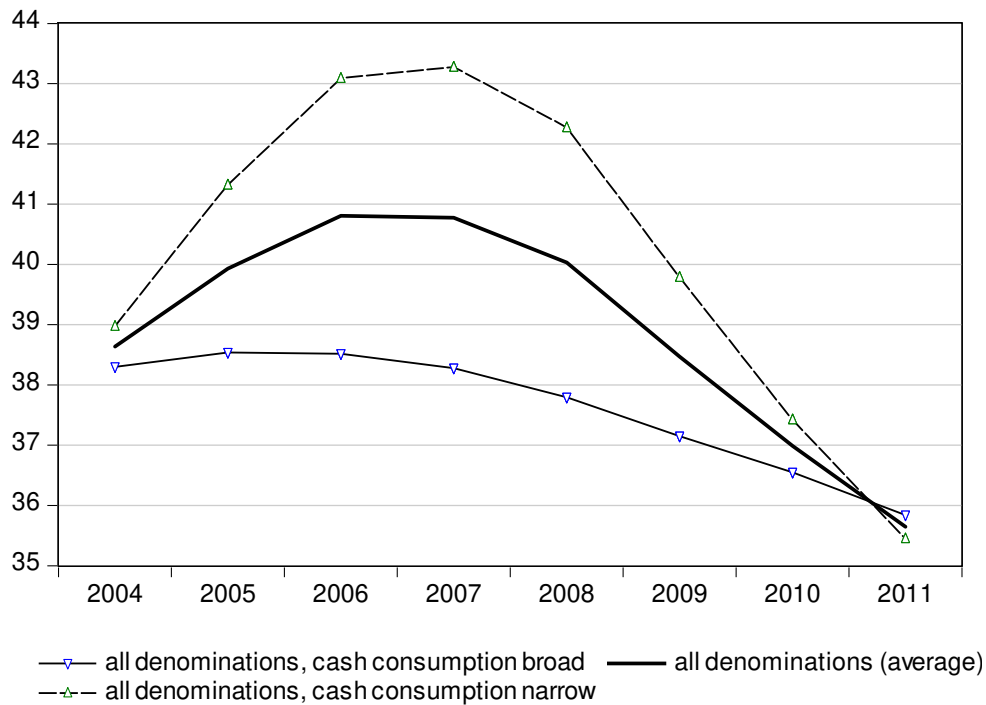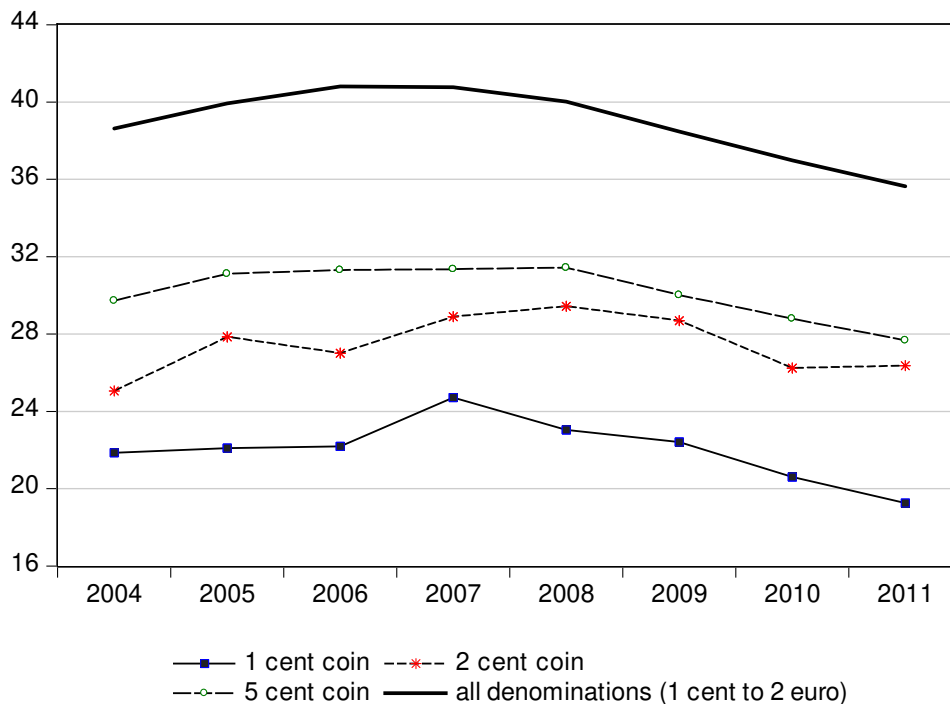

Source: Deutsche Bundesbank and authors' own calculations

The resulting domestic transaction balance shares are shown in Figure 3. By way of comparison, the share of all the German euro coins in circulation accounted for by the domestic transaction balance from Figure 2 is also shown.

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[23] The seasonal high for all coin denominations apart from the €2 coin occurs in the third quarter. This could be attributable to the holiday period. The seasonal high for the €2 coin, however, is in the second quarter. Given the large weighting of €2 coins in the circulation of all German euro coins by value (about 50% at the end of 2011), the seasonal high for all the coins in circulation (by value) is also in the second quarter.

Figure 3: Percentage share of the German euro coins in circulation (by value) accounted for by the domestic transaction balance in the case of small denomination coins

Source: Deutsche Bundesbank and authors' own calculations

The shares of domestic transaction balances of small denomination coins is between about 20% and 30%, well below the share of all the German euro coins in circulation (by value) accounted for by the domestic transaction balance. That can be explained by the fact that small denomination coins are presumably hoarded to a greater extent in order to lighten one's wallet or purse. At any rate, almost 30% of the respondents agreed with the following statement in Deutsche Bundesbank (2012, p 26): "I rarely pay with small change and generally put it aside."[24] Furthermore, people cannot pay with small change at vending machines.[25] Furthermore, lost coins are likely to play a relatively large role in the case of small denomination coins (Deutsche Bundesbank, 2003, p 142). They account for a correspondingly low share of the transaction balance. The latter rises as the size of the denomination increase. As with total circulation, small denominations have tended to account for decreasing shares of the domestic transaction balance in recent years.

The transaction balance shares are particularly low among small denomination coins (1 cent and 2 cent coins). Therefore, these coins are used relatively infrequently to pay for goods and services. The majority of them are likely to be hoarded in order to lighten

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[24] For information about the motives for retaining coins, see also Deutsche Bundesbank (2003, p 141).
[25] The coin balances in vending machines are estimated in chapter 5.

one's wallet or purse or are lost.[26] Given the current discussion on small denomination coins, this could be regarded as an argument in favour of introducing a rounding rule at the checkout (to the nearest five cents).

Domestic transaction balance shares by denomination, ie relative to the circulation (by value) of the respective denomination, β_j, are also determined for medium denominations (10 cent, 20 cent and 50 cent) from equation (9). The domestic transaction balance shares for medium denomination coins are above those for total circulation (see Figure 4). The shares of the domestic transaction balance for 20 cent and 50 cent denominations are particularly high. They were 46% and 51% respectively in 2011. The two denominations can be classed as typical transaction denominations. Unlike small denomination coins, people rarely hoard medium denomination coins in order to lighten their wallet or purse. Given their low face value, they are also not as good as a store of value as large denomination coins (€1 and €2 coins). Just like small denomination coins, the domestic transaction balance shares of medium denomination coins have fallen in recent years, and it rises as the denomination size increases.

Figure 4: Percentage share of the German euro coins in circulation (by value) accounted for by the domestic transaction balance in the case of medium denomination coins
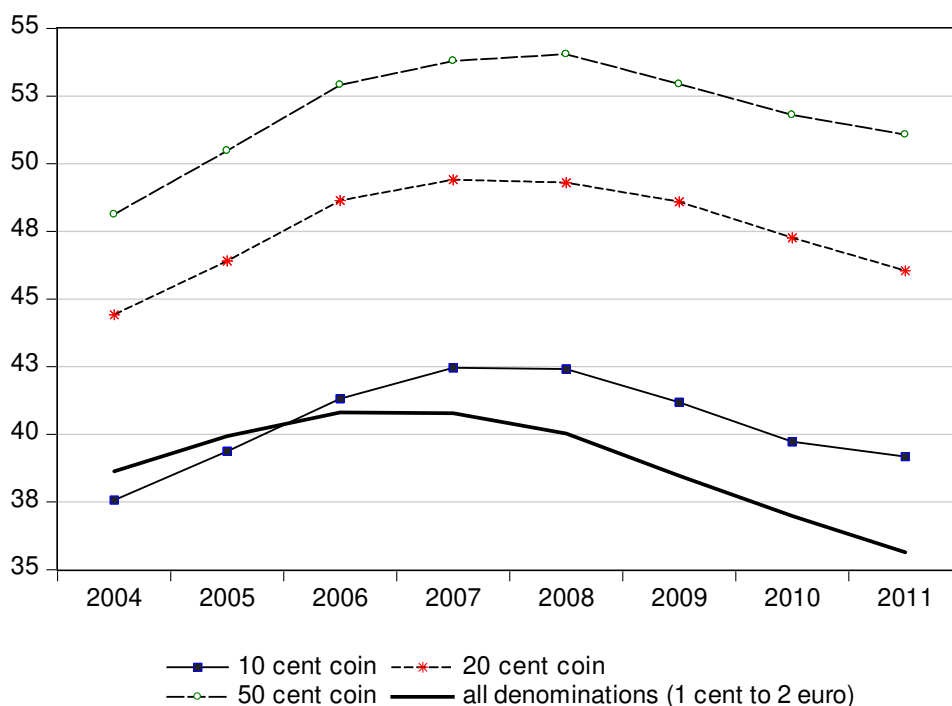
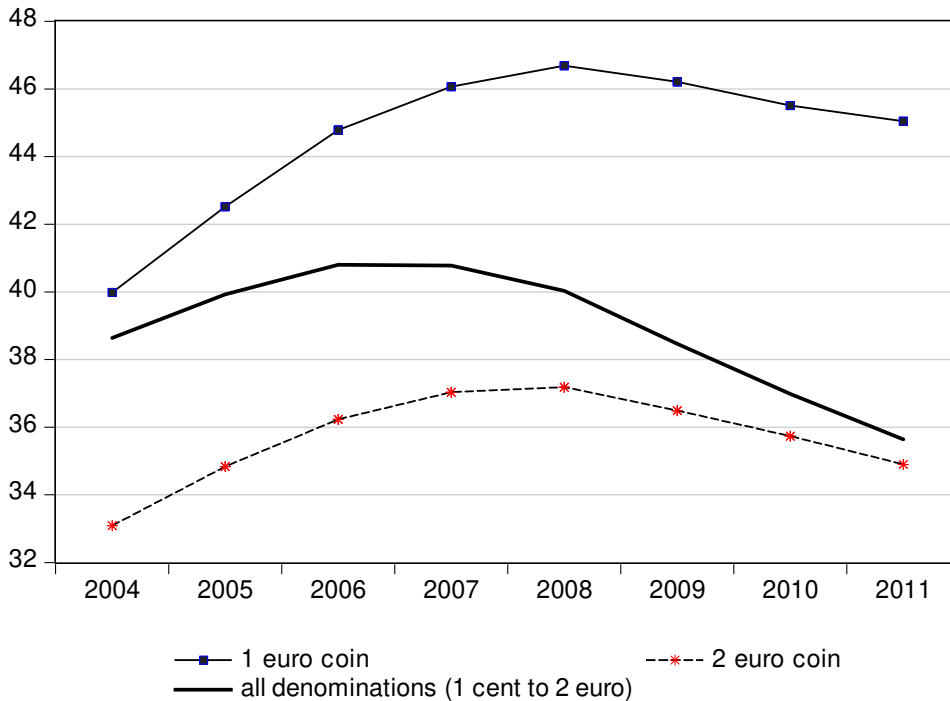*Source*: Deutsche Bundesbank and authors' own calculations

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[26] This hypothesis for small denomination DM coins is confirmed in Deutsche Bundesbank (2013, p 38).

In the case of large denomination coins (€1 and €2), only the percentage domestic transaction balance share for the €1 coin is calculated according to equation (9).

The seasonal high for the circulation of the German €2 coin is not in the third quarter, but rather in the second quarter. Therefore, the following equation applies for the domestic transaction balance share in the circulation of the €2 coin, β_j, (see also equation (8"))

$$(10) \qquad \beta_j \approx \frac{S_{q2,j} - S_{q1,j+1}}{0,5 \cdot \Delta_{q4,j;q1,j+1} S(cc)}.$$

Figure 5: Percentage share of the German euro coins in circulation (by value) accounted for by the domestic transaction balance in the case of large denomination coins

Legend:
- ▪ 1 euro coin
- --*-- 2 euro coin
- —— all denominations (1 cent to 2 euro)

Source: Deutsche Bundesbank and authors' own calculations

The corresponding transaction balance shares are shown in Figure 5. In the case of the €1 coin, this clearly exceeds the corresponding share of the total circulation (by value). However, this lies below the shares for 20 cent and 50 cent coins, which are "typical" transaction denominations. This could be due to the fact that €1 coins are more suitable as a store of value because of their comparatively high face value and are, thus, hoarded to a greater extent. This assumption is supported by the domestic transaction balance shares in the circulation of the €2 coin, which, over the entire period under consideration, are lower than the shares for the domestic transaction balance in the total (value of) coins in circulation. Because of its high face value, the €2 coin is particularly good for hoarding to be used as a store of value. However, it is also in demand as a

collectible object in the form of commemorative €2 coins, including the Federal States series.

3.3 Balances of German euro coins held for domestic transaction purposes

In section 3.2, the *percentage shares* for the domestic transaction balance of the German (value of) coins in circulation are determined by denomination and for the total circulation. The associated domestic transaction *balances* (in € million) are calculated by multiplying these shares by the denomination-specific or total circulation of German euro coins (by value).

The share of the total circulation of German euro coins attributable to the domestic transaction balance rose from more than €1.7 billion in 2004 to just over €2.3 billion in 2011. During the same period, the total value of German coins in circulation rose from almost €4.5 billion to just over €6.5 billion (Figure 6). Consequently, around 30% of this rise is attributable to the domestic transaction balance.

Figure 6: Domestic transaction balance and total value of German euro coins in circulation (in € million)
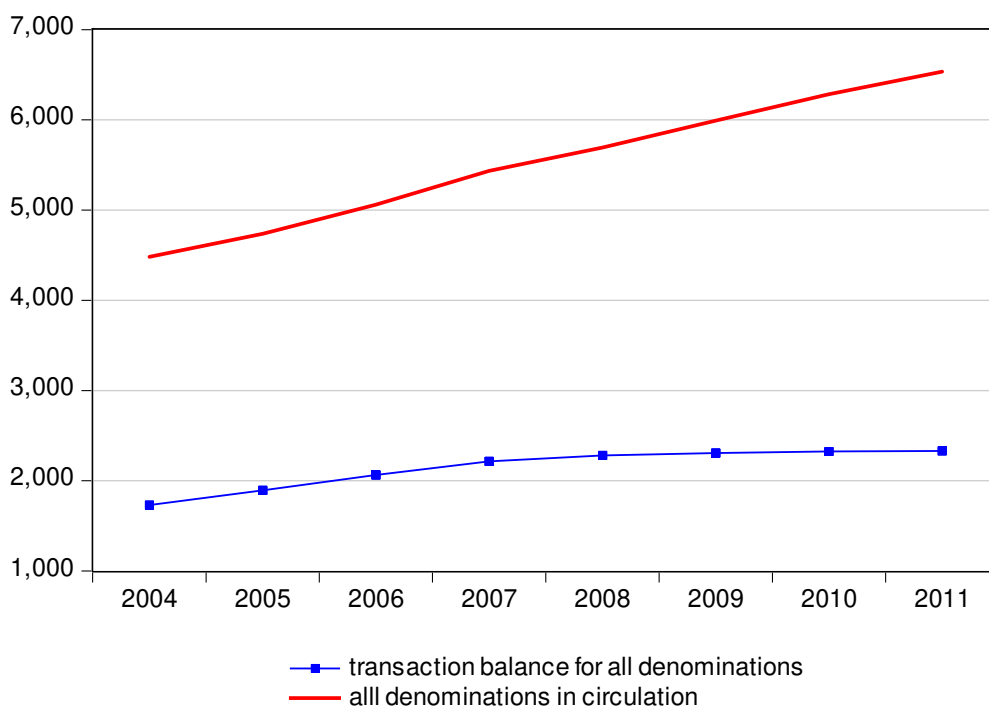
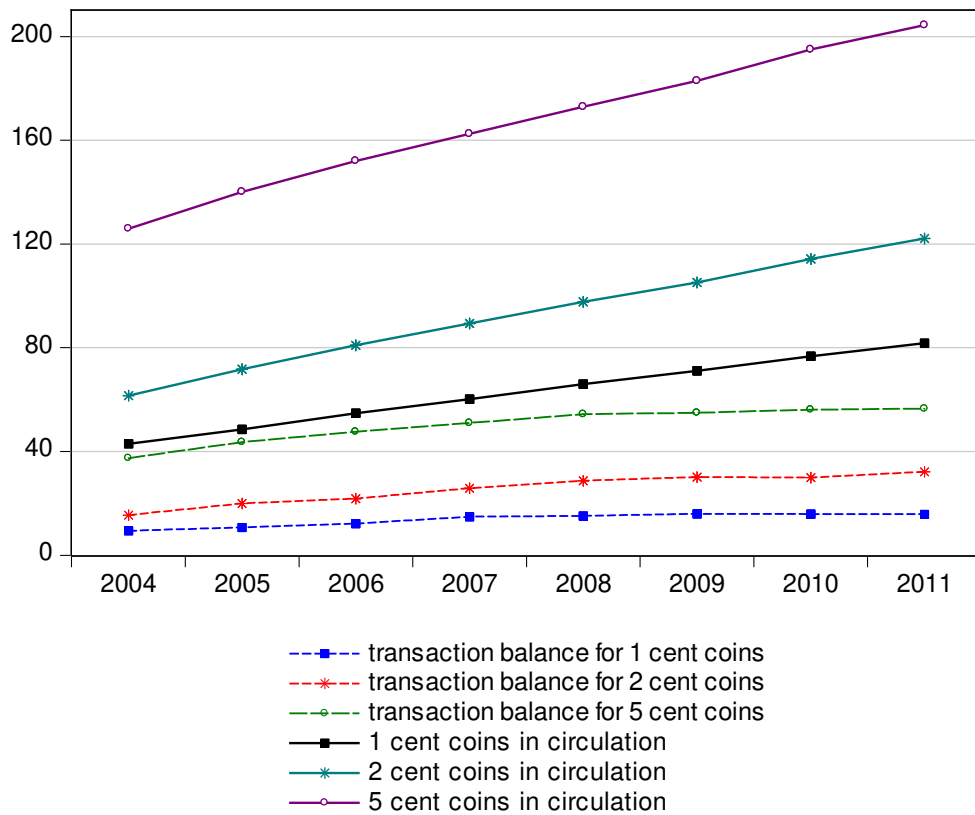*Source*: Deutsche Bundesbank and authors' own calculations

However, while the total volume of coins in circulation has grown markedly with a linear trend during the period under review, the time series for the domestic transaction balance has flattened out noticeably since 2008 and barely makes any contribution towards the growth of the total circulation. The share of the total value of German euro coins in circulation accounted for by the domestic transaction balance has therefore dropped since 2008 (Figure 2).

The transaction balances for small denominations are shown together with the respective circulations in Figure 7. The higher the denomination, the greater the (domestic) transaction balance. Reflecting the low value of the circulation of these denominations, the transaction balances are quite low at under €60 million. While the shares accounted for by the transaction balance in the circulation by denomination have been on the decline since 2008 (Figure 3), transaction balances have stagnated during this same period. Therefore, the downward trend in transaction balance shares is more than offset by the strong upward trend in circulation (by denomination).

The dynamic development in the circulation of small denomination coins is consequently not attributable to the domestic transaction motive because the corresponding transaction balances have remained more or less constant for a number of years. Domestic and foreign hoards are rather more likely to have played a part in this.[27] As described in chapter 1, structural models are therefore less suitable for estimating or forecasting the circulation of small German euro coins. To this end, one would have to identify a suitable opportunity cost variable for the hoarding motive, which is very difficult. By contrast, the transaction motive can be depicted via real cash consumption, as has been defined in section 3.2 as a transaction variable for calculating the transaction balance shares.

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[27] Refer to the comments in chapter 6 on the role played by foreign demand.
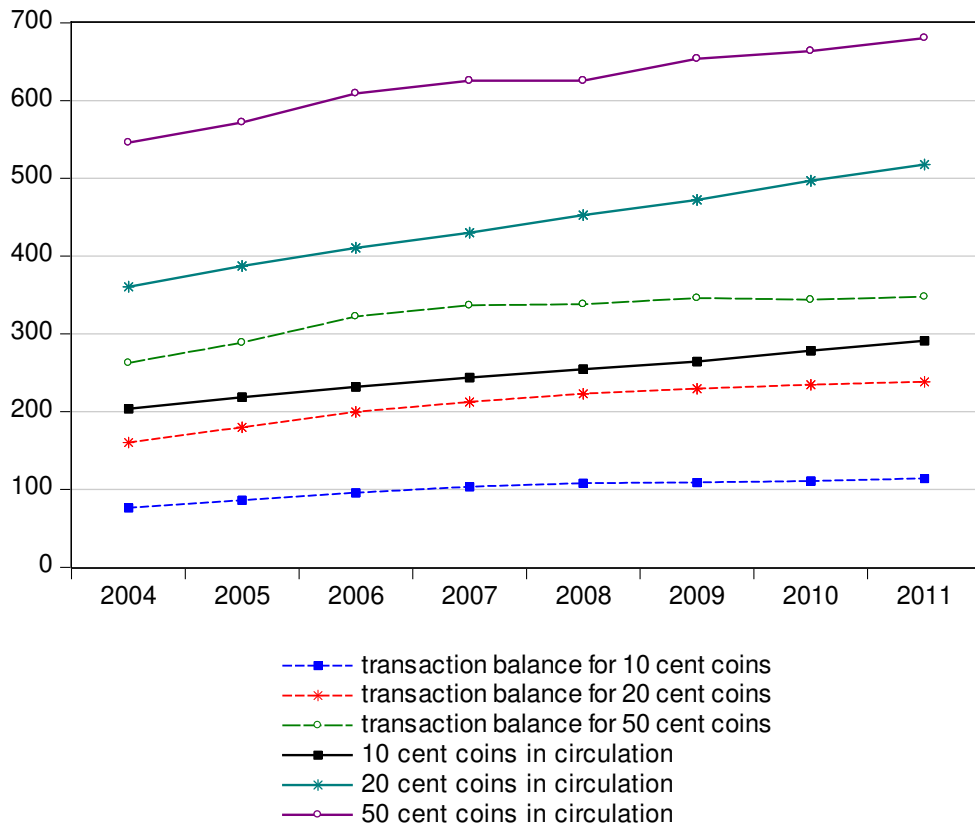
Figure 7: Domestic transaction balance and German euro coins in circulation in the case of small denomination coins (in € million)

Source: Deutsche Bundesbank and authors' own calculations

Figure 8 shows the domestic transaction balances and circulations of medium–denomination coins. Transaction balances rise again as the size of the denomination increases and they have been stagnating since 2008. Since then, they have stood at between €100 million and €350 million, which is significantly higher than in the case of small denomination coins. As with the latter, the declining transaction balance shares in medium denomination coins (see Figure 4) have been more than compensated for by the rise in circulation (by denomination). Once again with medium denomination coins, the growth in circulation is not attributable to the domestic transaction motive, but rather to hoarding at home and abroad. Therefore, time series models are likely to be more suitable than structural models for estimating and forecasting the circulation of medium denomination German euro coins.

Figure 8: Domestic transaction balance and German euro coins in circulation in the case of medium denomination coins (in € million)

legend:
- --■-- transaction balance for 10 cent coins
- --✳-- transaction balance for 20 cent coins
- --○-- transaction balance for 50 cent coins
- ──■── 10 cent coins in circulation
- ──✳── 20 cent coins in circulation
- ──○── 50 cent coins in circulation

Source: Deutsche Bundesbank and authors' own calculations

The domestic transaction balances and circulation of the two large coin denominations are shown in Figure 9. The most recent transaction balances of just over €600 million for the €1 coin and just over €1.1 billion for the €2 coin are well above those of small and medium denominations, as one would expected. As with the latter, the declining transaction balance shares in large denominations (see Figure 5) are more than offset by the growth in circulation (by denomination). While the transaction balance for €1 coins, as well as for small and medium denominations, has been stagnating since 2008, the transaction balance for €2 coins has been rising markedly since 2004. This is due to the strong growth in the circulation of €2 coins. The share of the circulation (by value) for this denomination in the circulation of all coin denominations had risen from just over 44% at the end of 2004 to just under 50% by the end of 2011. The circulation of German euro coins (by value) is clearly dominated by the two large denominations. During the period under observation, they consistently accounted for a share of about 70% of the entire (value of the) coins in circulation.[28] During the same period, the two

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[28] Within the euro area, the share of the total circulation of coins (by value) accounted for by the two large denominations consistently stood at around 69%.

large denominations' share in the transaction balance of all German euro coins rose from 65% to 76%.

As with small and medium denominations, the transaction balance for €1 coins also makes no contribution towards the growth in the circulation of that denomination. This is different in the case of the €2 coin. Here, the rise in the transaction balance from 2004 to 2011 amounts to almost 38% of the corresponding rise in the circulation of that denomination, in any event. Therefore, structural models for estimating or forecasting the circulation of coins are still likely to be the most suitable for the €2 coin.

Following the reasoning set out in chapter 1, cash handling companies primarily incur costs for the processing of coins through the transaction balance, ie through coins which are "actively" in circulation.

Figure 9: Domestic transaction balance and German euro coins in circulation in the case of large denomination coins (in € million)
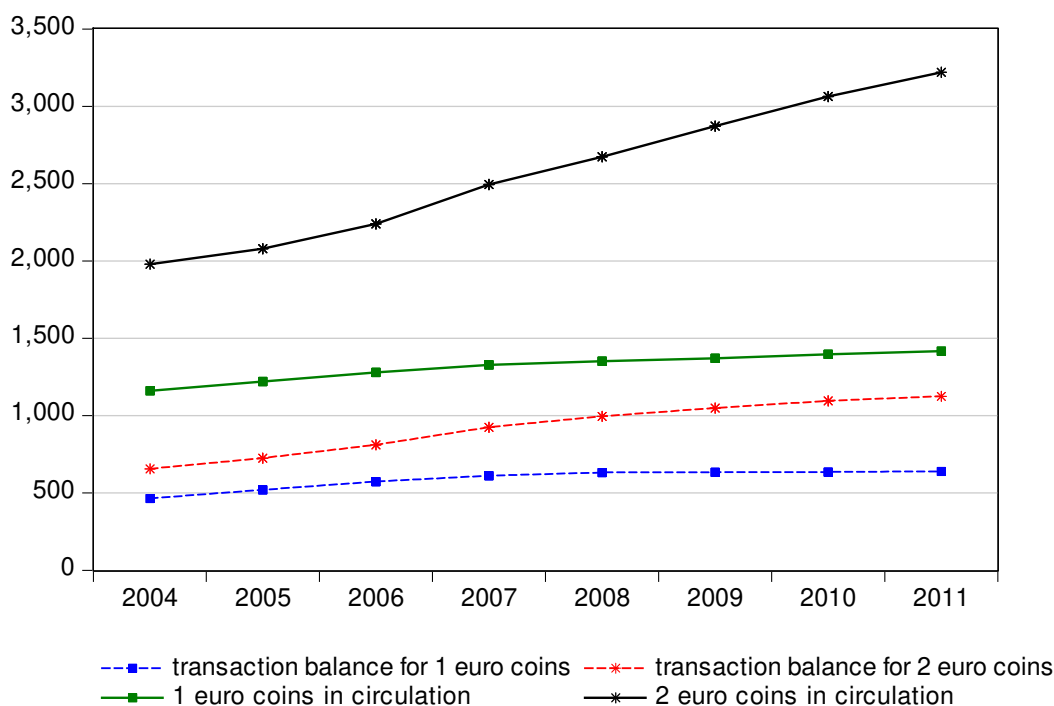

Source: Deutsche Bundesbank and authors' own calculations

Therefore, the rise in coins in circulation (by volume) in recent years, has, all other things being equal, not been accompanied by a corresponding rise in cash-handling costs for coins. The €2 coin is the only denomination in which the transaction balance has risen in recent years. However, it accounts for a very low share of the German euro coins in circulation by volume (6% in 2011).

Finally, the (total) domestic transaction balance for German euro coins, calculated via the total (value of) coins in circulation, from Figure 6 is compared with the sum of the

domestic transaction balances by denomination (see Figure 7, Figure 8 and Figure 9). Both time series should be at levels and at a chronology which are as close as possible to one another, so as to ensure that the estimates which are derived using the seasonal method are inherently conclusive.[29] As Figure 10 shows, this is also the case.

Figure 10: Domestic transaction balance of German euro coins (in € million): Total circulation versus denominations

- -□- total transaction balances for the individual denominations
- -■- transaction balance (calculated for all coins in circulation)
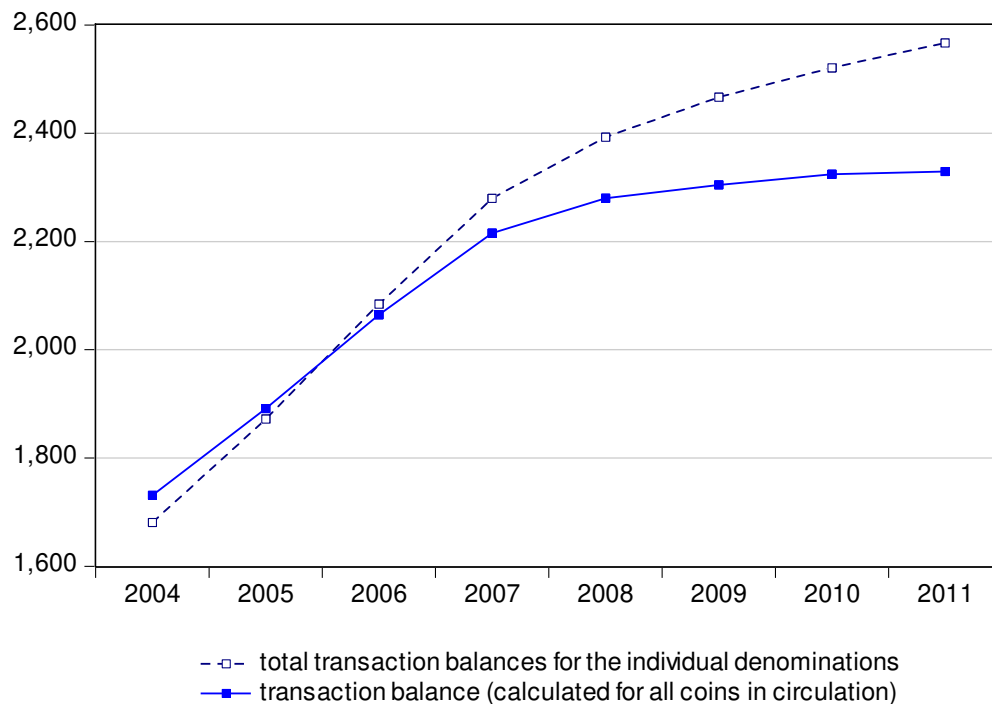
Source: Authors' own calculations

Since 2008, both series have diverged and by 2011 there was already a difference between them of about €240 million. However, in relation to the entire value of German euro coins in circulation, this difference only amounts to 3.6 percentage points. The (total) domestic transaction balance for German euro coins, calculated via the total domestic transaction balances by denomination, (just under €2.6 billion) accounted for more than a 39% share of the German euro coins in circulation in 2011. The share of the domestic transaction balance, determined via the total (value of) German coins in circulation (just over €2.3 billion) amounted to just under 36% in the same year (see Figure 2).

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[29] Differences may arise, among other things, through problems in seasonal adjustments to the *individual denominations*. The seasonal adjustment to the entire circulation of coins (total for all the denominations) is easier.

4　Findings from the introduction of euro cash

The quality of the estimates of the domestic transaction balance of euro coins in chapter 3 can also be verified with the support of data on the circulation of D-Mark coins. To this end, the individual components of the circulation of D-Mark coins are determined with reference to Deutsche Bundesbank (2009a, pp 55-58) using information from the introduction of euro cash. While there was a peak of DM 12.1 billion worth of coins in circulation in December 2000, this value had dropped to DM 8.7 billion by the end of 2001.[30] This decline of DM 3.4 billion was caused by the winding up of temporary hoarding balances. Coins which were not required for transaction purposes were paid into the central bank in what was known as a "dormant coins campaign".[31] This is most likely to have been coins hoarded in money boxes. However, coins are not only hoarded temporarily, they are also withdrawn from the coin cycle on a permanent basis. On the one hand, coins are collected and, on the other hand, they are lost. The balance of D-Mark coins still outstanding can be used as an approximate value for gauging the level of coins permanently taken out of circulation. Ten years after the currency conversion, the lion's share of the D-Mark coins which have not yet been returned to the Deutsche Bundesbank can be considered to be irretrievably lost or to have been transferred into collection balances permanently. For example, there was only DM 27 million worth of coins exchanged into euro during 2012. By the end of 2012, the volume of outstanding D-Mark coins stood at around DM 6.9 billion. Having determined the level of temporary hoarding balances and the volume of coins permanently withdrawn from circulation, this left a domestic transaction balance of DM 1.8 billion in 2000.[32] This corresponds to a share of almost 15% of the (total) circulation of DM coins in that year.[33] The share of temporary hoarding balances was 28%.[34] 57% of the circulation of DM coins in the year 2000 was made up of permanent hoards, ie seepage losses in the form of lost and collected coins.[35] In a similar study, the Deutsche Bundesbank (2013, p

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[30] Deutsche Bundesbank (2009a, pp 55-58) not only looks at the coins in circulation under consideration here; it also takes DM 10 and DM 5 collectors' coins into account. Therefore, the circulation reported there (DM 16 billion by the end of 2000 and DM 12.5 billion by the end of 2001) is higher than here.

[31] The "dormant coins campaign" was intended to prompt consumers to exchange DM coins which had not been used for payments, ie hoarded coins, via the commercial banks or via the Deutsche Bundesbank. This meant that the exchange of DM coins into euro was extended over a longer period of time.

[32] According to estimates, the level of the temporary hoarding balances in 2000 corresponds to DM 3.4 billion (= DM 12.1 billion - DM 8.7 billion). The value of the DM coins permanently withdrawn from circulation is estimated to be DM 6.9 billion. Consequently, the cash balance held in DM coins for domestic transactions was estimated to be DM 1.8 billion at the end of 2000 (= DM 12.1 billion - DM 3.4 billion - DM 6.9 billion).

[33] 1.8/12.1 * 100 = 14.9%.

[34] 3.4/12.1*100% = 28.1%.

[35] 6.9/12.1 * 100% = 57%.

38) also reached the conclusion that the majority of DM coins had not been used for payment transaction purposes.

These estimates for components of DM coins in circulation are plausible as this represented "older" coins in circulation prior to the introduction of euro cash. By contrast, the share of cash held for transaction purposes should be significantly greater in the case of coins that were recently put into circulation.[36] This is also the case with the share of German euro coins in circulation accounted for by cash held for transaction purposes, estimated in section 3.2. This stood at just under 36% in 2011. Thus, the estimates presented here for shares of DM coins in circulation and German euro coins in circulation held for transactions tally well.[37]

Another possible way of estimating the share of cash held for transaction purposes in German euro coins in circulation is to extrapolate the share of DM cash held for transaction purposes. This method dates back to Seitz (2007) who determined that 25% of the total volume of cash in circulation was accounted for by cash held for transaction purposes in 2000, which corresponded to a domestic balance of cash for transactions of €35 billion (converted).[38] If this value is extrapolated with the growth rates for nominal consumption spending by households within the country, this works out at a balance of €43.7 billion of euro cash held in Germany for transactions in 2011. In order to estimate the balances of euro coins held in 2011 for domestic transactions, this value is multiplied by the (value-related) share of coins in cash in one's wallet, as indicated by the second wave of the survey, conducted by the Deutsche Bundesbank, on payment behaviour (Deutsche Bundesbank, 2012, p 22). According to this, the balance of euro coins held for domestic transactions in 2011 was estimated at €2.5 billion. The domestic transaction balance thus equates to a 38.3% share of the value of the German euro coins in circulation. Both values are very similar to the €2.3 billion or 35.6% derived using the seasonal method in chapter 3.

In addition, the estimates for the domestic transaction balance can also be confirmed over time. Based on the extrapolation according to Seitz (2007), €40.8 billion of euro

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[36] This is due to the fact that the balance of cash held for transaction purposes is built up very quickly when a new currency is introduced. The situation with regard to lost coins is very different. The annual rates of loss reveal a balance of lost coins, which grows steadily over time.

[37] The share of DM coins in circulation held for transaction purposes, estimated at 53% at the end of the 1990s in Deutsche Bundesbank (2003, subsection 4.3.2), which applies a seasonal approach, cannot be confirmed, however, and appears to be clearly overstated. This is presumably due to the fact that private consumption, which is selected as the transaction variable, is not a precise means of recording consumption spending by private households using coins.

[38] A further variant for deriving the initial transaction balance can be found in Bartzsch et al (2011b, subsection 2.2.6). This method leads to a similar value for the extrapolated balance of euro cash held for domestic transactions.

cash was held in Germany in 2008 for transactions. Multiplying this by the share of cash in one's wallet in 2008 (Deutsche Bundesbank, 2009b, p 40), this equates to just over €2.3 billion of euro coins being held for domestic transactions, which corresponds to 40.7% of German euro coins that are in circulation being used for transactions. These values are almost identical to the figures for cash held for domestic transactions estimated in chapter 3 for 2008 (a balance of almost €2.3 billion and a share of 40.0%). In addition, both estimates suggest a slight rise in the balance of coins held for transaction purposes between 2008 and 2011.

Overall, the estimates for the balance of German euro coins held for domestic transaction purposes according to chapter 3 (seasonal method) are clearly confirmed by information from the introduction of euro cash.

5 Cash balance held in euro coins for domestic transactions by sector

The transaction balance of coins comprises all coins that are used for payment. In addition to the balance of coins in the wallets of households (consumers), this also includes the balance of change at checkouts in shops, the balance of coins in entertainment and vending machines, as well as the balance of coins held by credit institutions. While households use coins for conducting payment transactions, shops use coins as change. The balances in machines are fed by sales income and are disbursed again in part as change. In general, sales income exceeds the amount disbursed again as change; consequently, the coins in the machines have to be emptied regularly. Credit institutions hold coins for withdrawal by retailers and households. In addition, coins are paid in at credit institutions by machine operators and households.[39] The credit institutions dispose of their surplus coins at the Deutsche Bundesbank and also obtain coins from there. In the following we will try to use direct approaches to estimate the balances on euro coins held for (domestic) transactions by sector.

The Deutsche Bundesbank conducted a survey of the payment behaviour of residents in Germany between 2008 and 2011, see Deutsche Bundesbank (2009b, 2012). It ascertained how much cash people had in their wallet during the recording period. In 2008, the survey respondents carried an average of €118 in their wallet, €6.70 of which was accounted for by coins. By contrast, there was a slight decline in the amount of cash carried in their wallet in 2011. They carried an average of €103, €5.90 of which in coins. The cash in people's wallets is generally used for making payments. Therefore, it

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[39] Retail traders, on the other hand, are likely to be a source of net demand for coins. They require this as change.

can be allocated completely to the transaction balance. If the average balance of coins is now extrapolated for the total German population, this gives a transaction balance of around €440 million worth of euro coins carried by households for the year 2008, and a sum of approximately €410 million for the year 2011.

The coins held by other users (sectors) for transaction purposes can also be estimated by applying direct approaches. However, this entails assumptions of greater or lesser reliability. While we know the average cash balance held by credit institutions in Germany, we do not know how it is split between banknotes and coins. However, this split can be calculated approximately by referring to the inpayment and outpayment data for credit institutions with the Deutsche Bundesbank.[40] To this end, the share of coins in the total inpayments made by credit institutions to the Deutsche Bundesbank within one year is transferred to the average cash balance held. Alternatively, the calculation can also be done with the outpayment data. The results of this estimate for the final two years of the study period are shown in Table 1 and Table 2.[41] While the cash balance of coins in accordance with the calculation based on outpayments was up in 2012, compared with the previous year, the calculation based on inpayments shows a decline. It is difficult to tell which result is more plausible. At any rate, the change in the institutional framework conditions for coins (standard containers, account management of cash-in-transit companies) have had an impact on the demand for coins (Deutsche Bundesbank 2013).[42]

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[40] Some of the coins held by private individuals can be found in piggy banks or elsewhere at home and are, therefore, to be assigned to the hoarding motive. Since these hoarded coins are also paid into credit institutions, they should, strictly speaking, be excluded from the coin transaction balance of the credit institutions. However, the information required for this is not available.

[41] The calculation of the cash balances of the credit institutions is based on an average calculation over a period of one year. Owing to changes in the Bundesbank's range of services (standard containers, account management of cash-in-transit companies), there is only limited comparability between the data from prior to 2011 and the figures shown here. For more information on the changed institutional framework see also Deutsche Bundesbank (2013).

[42] Between the beginning of January and the end of April 2011, cash handlers built up working volumes of coins. These were required as part of the preparations for private coin recycling in order for the cash handlers to be able to balance out the supplied and demanded quantities of coins, including inpayments and outpayments not meeting the filling requirements of a standard container. During this period, the volume of coins in circulation was higher than would normally be expected. It was not until May 2011 that private coin recycling started to take off on a sizeable scale. Since then, growth in the volume of coins in circulation has been significantly slower.

Table 1: Cash balance of coins held by credit institutions (in € million) - outpayments

	2011	2012
Outpayments by credit institutions in notes	442,816	444,882
Outpayments by credit institutions in coins	3,554	4,113
Cash balance for credit institutions	15,110	15,650
Cash balance in coins held by credit institutions	**120**	**143**

Source: Deutsche Bundesbank and authors' own calculations

Table 2: Cash balance of coins held by credit institutions (in € million) - inpayments

	2011	2012
Inpayments by credit institutions in notes	274,831	268,028
Inpayments by credit institutions in coins	2,952	2,678
Cash balance for credit institutions	15,110	15,650
Cash balance in coins held by credit institutions	**161**	**155**

Source: Deutsche Bundesbank and authors' own calculations

The degree to which the calculation shown is justified depends on various factors. It assumes that credit institutions only pay cash into the Deutsche Bundesbank that they had in their balance beforehand. However, distortions arise if the credit institutions collect coins or banknotes directly from retailers and then pay them straight into the Bundesbank afterwards. Precisely the same thing happens on the outpayment side. Cash which is paid out to credit institutions must not be passed on directly to other market participants. In addition, the calculation is influenced by the aforementioned changes in the Bundesbank's range of services. For example, the abolition of coin money accounts for cash-in-transit companies resulted in cashless processing of cash transactions being shifted to credit institutions, even though the operational business is still operated by the cash-in-transit companies. Unfortunately, there are no findings available about the level of the coin balances held by the cash-in-transit companies.[43] The introduction of the standard container for coin transactions also had an impact on the coin balances of credit institutions. On the one hand, this causes a rise in the coin balance held by credit institutions because larger quantities of coins are required in order to make inpayments free of charge to the Deutsche Bundesbank. Furthermore, larger quantities of coins have

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[43] As the number of cash centres operated by cash-in-transit companies is unknown, a rough estimate cannot be made either.

to be procured on the outpayment side by the Deutsche Bundesbank than are actually required. On the other hand, the standard container encourages the recycling of coins outside the Deutsche Bundesbank and can thus contribute towards a reduction in cash balances at credit institutions as a result of the increased speed of circulation of the coins.

On balance, this estimation process leads to a rough approximation value of the coin balances held by credit institutions for transaction purposes. In order to assess the robustness of the estimate, we will also calculate the coin balance held by credit institutions using an alternative method.

For this purpose, the average coin balance is determined on the basis of the number of credit institutions in Germany and on the basis of the quantity of coins in each denomination required to fill a standard container. Since the standard container is the sole packaging unit for inpayments and outpayments that is still accepted free of charge by the Bundesbank, credit institutions have an incentive to hold correspondingly large cash balances. Consequently, coin balances are accrued on the inpayment side until the quantity of coins required to fill a standard container is reached. On the outpayment side, coins amounting to the volume required to fill a standard container are obtained from the Deutsche Bundesbank. Based on the storage approach proposed by Baumol (1952) and Tobin (1956), we assume that these two types of coin balances are accrued at a consistent rate. Based on this assumption, every credit institution holds half a standard container of coins in every denomination, on average. In the next step, the number of credit institutions in Germany will be determined. The bank statistics published by the Deutsche Bundesbank encompass both the number of institutions, as well as the number of branches, each divided in terms of banking groups. This allows institutions which, as a result of their business model, do not handle cash (such as building and loan associations, securities trading banks, etc) to be excluded. Therefore the analysis relates to big banks, savings banks, as well as cooperative banks. However, the decision still has to be taken on whether to base the assessment on the number of credit institutions or on the number of branches. In the area of savings banks and cooperative banks, we use the number of institutions because the size of the individual institutions is not likely to necessitate multiple standard containers having to be kept in any one particular denomination. The situation is different in the case of big banks. According to the banking statistics, each big bank had an average of 2,000 branches in 2011. It is highly likely that each institution holds more than half a standard container. If one were to apply the assumption that savings banks and cooperative banks each hold half a standard container per institution and per 20 branches (on average) to the big banks, this would work out at 400 places where half a standard container is held in each

denomination for around 8,000 branches of the four big banks in Germany. As shown in Table 3, based on this calculation method, credit institutions held around €290 million in coins on average in 2012.

Table 3: Cash balance of coins held by credit institutions (in € million) – standard containers (2012)

Denomination	Quantity required to fill a standard container (in € thousand)	Savings banks (institutions)	Cooperative banks (institutions)	Big banks (estimate)	**Total for credit institutions**
€2	150	32	82	26	140
€1	75	16	41	13	70
50 cent	40	8	22	7	37
20 cent	20	4	11	4	19
10 cent	15	3	8	3	14
5 cent	7.5	2	4	1	7
2 cent	4.0	1	2	1	4
1 cent	2.5	1	1	0	2
all	314	66	171	55	**292**

Source: Authors' own calculations

This value is about twice as high as the values determined on the basis of the cash balances, as well as inpayments and outpayments of coins at the Deutsche Bundesbank. Similar to the calculation conducted on the basis of cash balances, the calculation based upon the quantity required to fill standard containers is also subject to a certain number of assumptions. Depending on the size of the institution, deviations in terms of the quantity of standard containers held are conceivable in the case of savings banks and cooperative banks. Whereas large institutions may have to keep more than half a standard container in each denomination on account of the scale of their business, small institutions can cooperate with one another to seek a cost-efficient way of holding coins. In the absence of any data material on this, we assume that the two effects have a compensating impact on average. We are also unable to tell from the data whether there actually is half a standard container held in each denomination for every 20 branches of big banks. If half a standard container is held in each denomination for every 10 branches (corresponding to savings bank) of a big bank, the coin balance held by credit institutions rises to approximately €350 million. If this figure were to rise to 30 branches (corresponding to cooperative banks), the value of the coins held would drop to €270 million. If credit institutions were not to use the standard container as a medium

for inpayments and outpayments of coins to and from the Deutsche Bundesbank, this would reduce the quantity of coins held on average by credit institutions.[44] According to data from the Deutsche Bundesbank, more than 95% of outpayments and around 80% of inpayments of coins are now processed using the standard container. This justifies the reference to the filling quantity of a standard container.

A further portion of the transaction balance of coins is found in the cash registers of commercial enterprises. Commercial enterprises require coins to give them as change. The Deutsche Bundesbank commissioned the EHI Retail Institute to conduct a study to investigate the impact that a rounding rule would have on the coin demand of retailers, see Deutsche Bundesbank (2013). To this end, the coin demand of commercial enterprises was estimated. According to an interview with an expert, commercial enterprises are generally supplied with coins twice a week. Assuming that the stock of coins is reduced consistently, the level of the change balance is calculated from the need for coins for three days of sales activity divided by two. Based on sales figures and cash payment shares, these change requirements can be extrapolated across all commercial enterprises in Germany.[45] This presupposes that the need for coins in the individual sectors is in proportion to the share of cash payments and to sales figures. Based on this, commercial enterprises in Germany hold around €130 million worth of coins in their cash registers on average.

In addition to commercial enterprises that require coins as change, there are also enterprises in which coins are used as the primary method of payment. These include, first and foremost, vending machine operators (travel tickets, car park tickets, cigarettes). The coin balances which are accumulated in vending machines as a result are allocated in full to the transaction balance. In order to determine the coin balance held in vending machines, recourse has to be taken to an ancillary calculation. An approximate value for the daily turnover of cash at vending machines in Germany can be calculated on the basis of sales figures from the Association of the German Amusement and Vending Machine Industry (VDAI) and from the share of cash payments conducted at vending machines according to the Deutsche Bundesbank (2012, p 54). If an assumption is now made about the frequency at which vending machines are emptied, this works out at an average coin balance of between €30 million and €100 million. See also Table 4.

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[44] A fee of €25 per transaction is levied for inpayments and outpayments which are not compliant with standard containers.

[45] The data collected by the EHI does not cover all commercial sectors. It does not include pharmacies, mail order trade, filling stations (although filling station shops are included) and car sales. Pharmacies are the only locations where coins are likely to be used to any significant extent. On balance, the sectors which are not considered are negligible and do not have an adverse impact on the estimate.

Table 4: Coin balance in vending machines (in € million) - vending machine turnover

	2011	2012
Total turnover (excluding car park and travel ticket vending machines)	8,855	9,300
Cash share (Deutsche Bundesbank 2012)	80.4%	80.4%
Turnover in cash	7,119	7,477
Turnover in cash per day	20	20
Coin balance if emptied every day	**29**	**31**
Coin balance if emptied every seven days	**68**	**72**
Coin balance if emptied every ten days	**98**	**102**

Sources: Deutsche Bundesbank, Association of the German Amusement and Vending Machine Industry (VDAI), authors' own calculations

Unfortunately, the data from the vending machine industry do not include all vending machine sales transactions. The data do not include sales at car park ticket machines, phone boxes and travel ticket machines. Consequently, the values shown here are likely to be lower limits. Moreover, a distinction cannot be made between banknote and coin payments on the basis of the cash payment share. The turnover in coins is presumably lower than the cash turnover shown here. In addition, vending machines give out coins again as change, which means that the coin balance in the vending machines is reduced. All in all there is no information available about the precise level of the different influences.

In summary, the amount of the (domestic) transaction balance of coins in 2011 was estimated at between €660 million and €1,010 million. The single biggest value was the coin balances in the wallets or purses of households at around €410 million. This is followed by credit institutions, commercial enterprises and vending machine operators. See also Table 5.

The total for the (domestic) transaction balances (by sector) is thus well below the 2011 cash balance held for domestic transactions estimated using indirect approaches in chapters 3 and 4 at around €2.3 billion and around €2.5 billion respectively. Due to the inadequate data situation, the transaction balance determined using direct approaches cannot be fully recorded. There is a frequent observation that the estimates of cash

components made using direct approaches are lower than those determined using indirect approaches. This is true, for example, of the foreign demand for US currency (Feige, 2009, section 2) or of the hoarding of euro banknotes in Germany (Bartzsch et al, 2011a, section 3.3 in conjunction with Bartzsch et al, 2011b, section 2.2.2).

Table 5: Overview of estimated results (in € million)

	2011	2012
Coin balance in one's wallet or purse	410	-
Cash balance in coins held by credit institutions	120-370	140-350
Change balance in coins held by commercial enterprises	130	130
Coin balance in vending machines	30-100	30-100
Total	690-1,010	-

Source: Authors' own calculations

6   Foreign demand and hoarding of German euro coins

The purposes of coin usage are generally broken down into the following three categories: transaction balance, hoarding and foreign demand. The foreign share of D-Mark coins in circulation is unlikely to have played a major role, see Deutsche Bundesbank (2003, p 161). Little is known to date about the hoarding of and foreign demand for euro coins issued in Germany ("German euro coins"). While Seitz et al (2012) conducted a study into the mixing of €1 coins in Germany, ie the share of €1 coins with a foreign reverse side among all the €1 coins in circulation in Germany, it still tells us nothing about the net circulation of German euro coins abroad. The cross-border movement of euro coins, known as coin migration, is also investigated in Deutsche Bundesbank (2013). To this end, the Bundesbank took a sample of 2,000 coins (20 cent to €2 coins) at each of 30 different branches and sorted them according to their country of origin based on the reverse side of the coins. In 2012, some 37% of the coins in circulation in Germany (by units) originated from other euro-area member states. In order to obtain a complete picture of coin migration, not only is it useful to know about the origins of the coins migrating into Germany, it is also helpful to find out about the whereabouts of the coins flowing out of the country. However, no such information is available to date owing to a lack of comparable up-to-date data about the

distribution of coins abroad.[46] Similarly, there is a lack of information about the *net* inflows and outflows of coins in circulation between euro-area member states based on which the foreign demand for German euro coins, ie euro coins brought into circulation by the Bundesbank, could be estimated.[47]

However, based on the approach set out in Bartzsch et al (2011a), an international comparison of the cumulated net issuance of coins can at least provide an initial indication about differences in net flows within the euro area. Only the Netherlands is having a negative circulation of €1 coins. It does not have a negative circulation in reality; this is purely the result of the way in which inpayments and outpayments are offset at the central bank. In other words, the volume of inpayments of €1 coins at the Dutch central bank regularly exceeds the volume of outpayments of €1 coins. This is possible as a result of the inflow of €1 coins from other euro-area member states. In a further step, the shares in terms of pieces of the total circulation of euro coins accounted for by national coins in circulation can be compared with the ECB capital shares of those countries. A country's ECB capital share is calculated on the basis of its population and its economic output and, thus, upon important factors for determining the transaction balance of cash in that country. While the coins in circulation in some countries deviate from the calculated value based on the ECB capital share, the deviations are by far not as pronounced as in the case of euro banknotes, for which Bartzsch et al (2011a) ascertained that there was (also) a significant migration within the euro area. Table 6 shows the values for Germany and the countries with the most striking differences.

The cross-border flows of banknotes can be explained for Germany on the basis of its integration into international currency dealings and by tourism (including business travel) (Bartzsch et al 2011a, section 3.1). As the "global leader in travel", with its large population and a correspondingly large volume of tourism, Germany has an above-average circulation of banknotes, while the cumulated net issues of banknotes in countries neighbouring Germany and in popular holiday destinations are negative in some cases. By contrast, tourism does not appear to lead to any significant cross-border net flows of coins within the euro area. Firstly, the German share of the entire volume of euro coins in circulation only deviates slightly from its ECB capital share. Secondly,

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[46] In Seitz et al (2012), the return flows of (€1) coins to Germany are also taken into account in the model calculation.

[47] Information of this nature is available for euro banknotes, ie firstly, net shipments from Germany to countries outside the euro area and, secondly, information from a survey about the cash that Germans take with them when they travel abroad, which was collected within the framework of the balance of payments statistics. Bartzsch et al (2011a, section 3.1) use this information to estimate the circulation of German-issued euro banknotes abroad.

an inconsistent picture emerges of deviations in coins in circulation from the ECB capital share in popular travel destinations and in countries neighbouring Germany. When one considers the individual denominations, the deviations appear to correlate with national differences in terms of use. All in all, there are no significant imbalances in currency flows *within the euro area*, even though deviations from the value corresponding to the ECB capital share are observed in some countries.

Table 6: Shares by piece of national coins in circulation and ECB capital shares (September 2012)

Reference variable: Quantity	Germany	France	Spain	Italy	Netherlands	Austria	Luxembourg	Ireland
€2 euro	34%	14%	10%	15%	1%	6%	1%	3%
€1 euro	22%	8%	25%	24%	0%	6%	1%	2%
50 cent	26%	11%	13%	21%	4%	4%	1%	3%
20 cent	28%	13%	13%	16%	3%	5%	1%	4%
10 cent	24%	15%	18%	15%	4%	6%	1%	5%
5 cent	26%	15%	19%	12%	6%	4%	1%	5%
2 cent	31%	19%	15%	11%	2%	6%	1%	5%
1 cent	33%	18%	17%	11%	2%	6%	0%	5%
All denominations	**29.0%**	**15.9%**	**16.7%**	**13.6%**	**2.8%**	**5.6%**	**0.7%**	**4.4%**
Share of the capital	**27.1%**	**20.3%**	**11.9%**	**17.9%**	**5.7%**	**2.8%**	**0.3%**	**1.6%**

Source: ECB

German euro coins make their way into countries *outside the euro area* via three channels: first, via the euro coins taken by German tourists and business travellers to holiday areas (such as Turkey) for transaction purposes; second, through countries outside the euro area which have introduced the euro unilaterally as legal tender and, third, via tourists and business travellers from outside the euro area who take euro coins back to their home countries following a trip to the euro area. In the case of the first channel, we assume, as with coin migration within the euro area, that households and business travellers take just as many coins with them to countries outside the euro area as they take from these countries back to Germany. Consequently, there is no (net) export of German euro coins. The second channel concerns Kosovo and Montenegro. Euro coins are in circulation in these countries for transaction and hoarding purposes. However, the balances concerned can be disregarded as the countries are so small. The third channel is the most important of the three. It concerns tourists from countries

outside the euro area who take euro coins back home with them, where, unlike in the case of euro banknotes, they cannot generally be exchanged and therefore end up being hoarded. A large share of these coins never return to the euro area and can therefore be regarded as being permanently hoarded, see Bos (1994). This form of "waste" is probably more significant because Germany attracts visitors from all around the world.[48]

Consequently, the *active* volume of German euro coins circulating outside of Germany *(excluding permanent hoarding)* probably plays only a minor role. Therefore, the difference between the German euro coins in circulation (by denomination and by overall value) and cash balance held in German euro coins for domestic transactions determined in section 3.3 is likely to consist principally of domestic hoards and permanent hoards outside the euro area. The division into these two types of hoards and the composition of the domestic hoards (temporary and permanent hoards, collector holdings and lost coins) lies outside the scope of this study and merits future research.

7   Summary, conclusions

According to our estimates conducted using indirect methods (seasonal approach, introduction of euro cash), the transaction balance of euro coins in Germany rose from just over €1.7 billion in 2004 to around €2.3 billion in 2011. During the same period, the circulation of euro coins issued by the Deutsche Bundesbank ("German" euro coins in circulation) rose from just under €4.5 billion to just over €6.5 billion. Consequently, 30% of this rise is attributable to the cash balance held for domestic transaction purposes. However, while the total volume of German euro coins in circulation has grown steadily and markedly during the period under review, the time series for domestic balances has flattened out noticeably since 2008 and barely makes any contribution towards the growth of the volume of German euro coins in circulation. The share of the (overall) volume of German euro coins (by value) accounted for by the cash balance held for domestic transactions has therefore dropped since 2008 and stood at just under 36% in 2011. The declining trend in recent years could be due to the diminishing proportion of cash payments in retail trade. In addition, the share of coins in circulation accounted for by the transaction balance drops automatically due to the accrual of lost and collected coins over time. This is also indicated by the (domestic) transaction balance share of D-Mark coins, estimated by us using data on the introduction of euro cash, of just under 15% in 2000.

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[48] With 28.4 million visitors, Germany was one of the ten most popular travel destinations in the world in 2011 (German Travel Association (DRV) 2012, p 7).

The cash balance held in small denominations (1 cent to 5 cents) for domestic transaction purposes was very low with less than €60 million in 2011 in each case. This is in line with the low circulation of these denominations by value. The largest cash balances held for domestic transactions were accounted for by the €1 coin (€600 million of late) and the €2 coin (at just over €1.1 billion). The €2 coin is the only denomination in which the cash balance held for domestic transaction purposes is still rising significantly, unlike the other denominations which have been stagnating since 2008. The circulation of German euro coins (by value) is clearly dominated by the two large denominations. During the period under assessment, they consistently accounted for a share of about 70% of the entire coins in circulation. During the same period, their share of the transaction balance (by value) of all German euro coins rose from 65% in 2004 to 76% in 2011.

The shares of the cash balance held for domestic transactions of the German euro coins in circulation (by denomination and by value) was 20% to 30% for small denomination coins in 2011, which is well below the transaction balance share for the total circulation (by value) (36%). This may be explained by the fact that small coins are hoarded to a greater extent in order to lighten wallets and purses, or are lost. Furthermore, they cannot be used for making payments at vending machines. The shares of the cash balance held for domestic transaction purposes for 20 cent or 50 cent coins are above average (46% and 51% respectively in 2011). These two denominations can be classed as typical transaction denominations. Unlike small denomination coins, people rarely hoard them in order to lighten their wallet or purse. Given their low face value, they are also not as suitable as large denominations to be used as a store of value.

Using surveys and statistics (direct methods), we have also estimated the (domestic) transaction balances by sector. Due to the inadequate data situation, the cash balance held for domestic transaction purposes cannot be fully recorded with this approach. Consequently, the total cash balances held for domestic transactions by sector were estimated at between €0.7 billion and €1.0 billion in 2011. The single largest value was the coin balances in the wallets and purses of households at around €0.4 billion. This was followed by credit institutions, commercial enterprises and vending machine operators.

Looking at the foreign perspective, there are only likely to be significant quantities of German euro coins (on balance) outside the euro area. Tourists from those countries take euro coins back home with them from their travels, where, unlike in the case of euro banknotes, they cannot generally be exchanged and therefore end up being placed in money boxes. A large share of these coins never return to the euro area and can

therefore be regarded as being permanently hoarded. Active foreign demand for German euro coins (excluding permanent hoarding) presumably plays only a minor role, however.

The estimates mentioned suggest that the following conclusions may apply. Firstly, the low transaction balance share for small denomination coins (1 cent and 2 cent coins) can be used as an argument for applying a rounding rule at the checkout (to the nearest 5 cents). Small denomination coins are used relatively infrequently to pay for goods and services. The majority are likely to be hoarded in order to lighten one's wallet, or are permanently lost. In addition, as the prices of raw materials rise, there is a risk that production costs will exceed the face value of small denomination coins. Furthermore, given their large quantities in the banking industry and in the retail trade, considerable costs are incurred as a result of the counting, processing and transport of small denomination coins.[49]

Secondly, with the exception of the €2 denomination, the rise in coins in circulation by denomination in recent years, has, all other things being equal, not increased in line with a corresponding rise in cash-handling costs. The latter are primarily incurred by cash handling companies through the transaction balance (coins which are in active circulation). With the exception of the largest denomination, this has been more or less constant for all denominations since 2008.

Thirdly, our results are of interest for the estimation of demand for coins or for forecasting the coins in circulation. The demand for coins essentially depends on a transaction variable (for the transaction motive) and on an opportunity cost variable (for the hoarding motive to be used as a store of value). The cash consumption defined in chapter 3 can be used as one such transaction variable in structural models. It is more difficult to find a suitable proxy variable for opportunity costs. Structural models for demand for German €2 coins are the most suitable. This is the only denomination in which the transaction balance makes a significant contribution towards the growth of the (entire) circulation. Hoarding balances play a greater role in other denominations. Time series models appear to be more suitable here.

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[49] At the end of 2012, 1 cent and 2 cent coins accounted for 50% of the total volume of German euro coins in circulation.

List of references

Bartzsch, N, G Rösl and F Seitz (2011a), Foreign demand for euro banknotes issued in Germany: estimation using direct approaches, Discussion Paper, Series 1, 20/2011, Deutsche Bundesbank.

Bartzsch, N, G Rösl and F Seitz (2011b), Foreign demand for euro banknotes issued in Germany: estimation using indirect approaches, Discussion Paper, Series 1, 21/2011, Deutsche Bundesbank.

Baumol, W J (1952), The transactions demand for cash: an inventory theoretic approach, Quarterly Journal of Economics, 66 (4), pp 545-556.

Bos, J W D (1994), The demand for coins in the Netherlands, DNB Quarterly Bulletin, June, pp 67-90.

Deutsche Bundesbank (2003), Münzgeldentwicklung in Deutschland – Eine empirische Studie über den Münzgeld- und Banknotenumlauf in der Bundesrepublik Deutschland mit einer Prognose der Münzgeldnachfrage bis 2007, March.

Deutsche Bundesbank (2009a), The development and determinants of euro currency in circulation in Germany, June, pp 45-58.

Deutsche Bundesbank (2009b), Payment behaviour in Germany. An empirical study of the selection and utilisation of payment instruments in the Federal Republic of Germany, June.

Deutsche Bundesbank (2012), Payment behaviour in Germany in 2011 – An empirical study of the utilisation of cash and cashless payment instruments, October.

Deutsche Bundesbank (2013), Current and projected development of coin circulation in Germany, Monthly Report, January, pp 29-41.

Deutscher ReiseVerband (2012), Fakten und Zahlen zum deutschen Reisemarkt 2011 – Eine Übersicht zusammengestellt vom Deutschen ReiseVerband (DRV), March.

Feige, E L (1997), Revised estimates of the underground economy: implications for US currency held abroad, Discussion Paper 13805, MPRA.

Feige, E L (2009), New estimates of overseas U.S. currency holdings, the underground economy and the "tax gap", Discussion Paper 19564, MPRA.

Fischer, B, P Köhler and F Seitz (2004), The demand for euro area currencies: Past, present and future, Working Paper 330, European Central Bank, April.

Glanville, R G de (1970), The number of coins in circulation in the United Kingdom, Studies in Official Statistics, Research Series 2, Central Statistical Office.

Goldin, E (1985), Statistical analysis of coins lost in circulation, Journal of Business & Economic Statistics, 3 (1), pp 36-42.

Porter, R D and R Judson (1995), The location of U.S. currency: How much is abroad?, Board of Governors of the Federal Reserve System, October.

Porter, R D and R Judson (1996), The location of U.S. currency: How much is abroad?, Federal Reserve Bulletin, 82 (10), pp 883-903.

Seitz, F (1995), Der DM-Umlauf im Ausland, Discussion Paper 1/95, Volkswirtschaftliche Forschungsgruppe der Deutschen Bundesbank, May.

Seitz, F (2007), A simple way to capture transaction balances, Economics Letters, 95, pp 230-233.

Seitz, F and R Setzer (2009), The demand for German banknotes: structural modelling and forecasting, discussion paper, mimeo, April.

Seitz, F, D Stoyan and K-H Tödter (2012), Coin migration and seigniorage within the euro area, Jahrbücher für Nationalökonomie und Statistik, 232 (1), pp 84-92.

Sumner, S B (1990), The transactions and hoarding demand for currency, Quarterly Review of Economics and Business, 30 (1), pp 75-89.

Tobin, J (1956), The interest-elasticity of transactions demand for cash, Review of Economics and Statistics, 38 (3), pp 241-247.

United States Treasury Department (2006), The use and counterfeiting of United States currency abroad, Part 3, September.

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