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From accounting and economics to biology

Nikolaus Bartzsch and Franz Seitz

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Non-technical summary

The total cash issuance of a central bank consists of domestic transaction and hoarding balances as well as foreign demand. The different shares are not known exactly. Within the euro area, the environment is still more complicated as euro cash issued by one country may migrate to other euro area countries in which it is a perfect substitute. Transaction balances usually are made up of small denominations. The introduction of the new Europa series of banknotes since 2013 offers the opportunity to calculate these transaction balances. We apply the methods to the already circulating €10 and €5 banknote.

At the end of 2014, the Bundesbank had issued a total net amount of just over €24 billion in €10 banknotes. In statistical terms, each resident living in Germany was therefore endowed with around 29 banknotes of this denomination. Owing to the introduction of the new ES 2 series on 23 September 2014, it was possible for the first time to estimate the volume of €10 banknotes that are held for transaction purposes both in Germany and outside the euro area.

The estimation of the volume of €10 banknotes held for domestic transaction purposes is primarily based on the observed return flows of the old series (ES1) of €10 banknotes received by the Bundesbank. The cash balance of €10 banknotes held for domestic transaction purposes was estimated at around €4.0 billion at the time of the introduction of ES 2 (end of August 2014). This means that only 17% of the total (net) amount of €10 banknotes issued by the Bundesbank were used for transaction purposes within Germany. The remaining 83% has either migrated abroad, been hoarded (or got lost). The results of the analysis are also important as a means of explaining the just over €19 billion worth of ES1 €10 banknotes which are still outstanding in the Bundesbank's balance sheet. Given that the cash balance held for domestic transaction purposes has since been almost fully replaced, it is no longer to be expected that ES1 banknotes will flow back to the Bundesbank in any sizeable amounts.

The volume of "German" €10 banknotes – officially stemming from banknote shipments by the Bundesbank – held for transaction purposes outside the euro area was estimated at just over €40 million at the end of May 2015 using the biometric method. It is derived from cumulated shipments of ES2 €10 banknotes up to the end of May 2015 and the value of the ES1 and ES2 €10 notes deposited in May 2015 at the shipment branches. In terms of the Bundesbank's cumulated net issues of €10 banknotes in the amount of around €24 billion at the end of 2014, the estimated cash balance held for transaction purposes outside the euro area accounts for just 2%.

Additionally we have estimated the volume of transaction balances of "German" €5 notes in Germany and in non-euro-area countries in the same way by making use of the introduction of the new ES2 €5 banknotes on 2 May 2013. As in the case of €10 notes, the share of domestic transaction balances in the total volume of circulation of €5 notes is about one-fifth. However, the share of cumulated net shipments in total circulation is much higher for the €10 notes and mainly consists of hoardings while the shares of hoardings and transaction balances in the cumulated net shipments of €5 notes are almost equal. These differences show that in contrast to the €10 note the €5 note is not a typical "foreign demand banknote".

JEL-Classification: C49, E41, E58

Keywords: euro banknotes, biometric method, foreign demand, transaction balances

1 Introduction

The total cash issuance by a central bank consists of domestic transaction and hoarding balances as well as amounts hoarded and used for transactions abroad. The different shares are not known exactly. Within the euro area, the environment is still more complicated as issues of one country may migrate to other euro area countries in which they are perfect substitutes. Transaction balances usually are made up of small denominations. The introduction of the new Europa series of banknotes (ES 2) since 2013 offers the opportunity to calculate these transaction balances. We apply the methods to the already circulating €10 and €5 banknote.

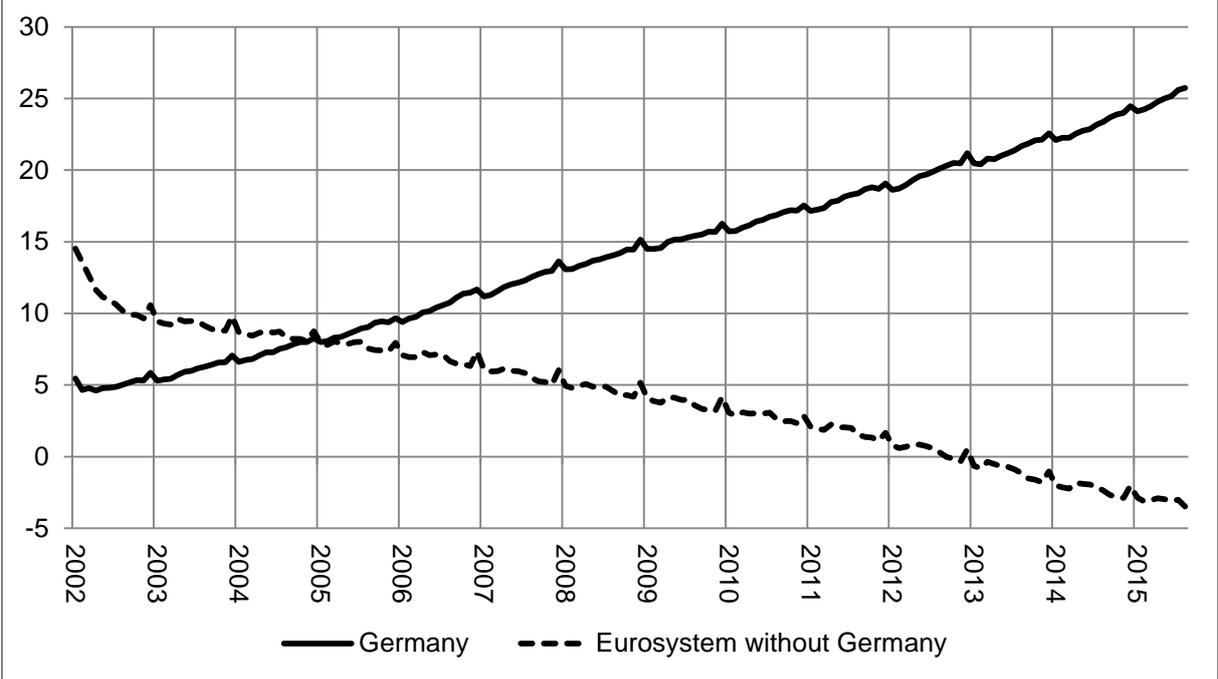
At the end of 2014, the Bundesbank had issued a total net amount of €24 billion €10 banknotes ("German" €10 notes). In statistical terms, each resident living in Germany was therefore endowed with 29 banknotes of this denomination. Even though cash is still the most commonly used means of payment at the point of sale in Germany, the total number of issued banknotes still seems very high. Presumably, only part of this amount is actually used for payment purposes in Germany (known as the "domestic transaction balance"). The rest may either have been lost, hoarded in Germany or may be in use abroad for transaction and hoarding purposes.

The fact that it is not possible to equate the cumulated net issues of a euro-area country with the national volume of cash in circulation in that country also becomes evident when making international comparisons (Figure 1). The Bundesbank's cumulated net issues of €10 notes have been steadily increasing since 2002. The Bundesbank therefore issues more €10 banknotes than it receives through inpayments. Conversely, the cumulated net issues of the (entity of) other Eurosystem member countries are steadily declining; in these countries, more banknotes are paid in than are paid out. A significant share of "German" banknotes therefore flows out of Germany. In the past few years, these cross-border flows were in fact so substantial that the cumulated net issues of the other Eurosystem countries have been negative since the beginning of 2013. The total volume of banknotes issued by the Bundesbank since 2002 would, in fact, be more than sufficient to fully cover the *entire* demand for €10 banknotes (both in Germany and abroad). The Bundesbank is therefore making a sizeable contribution to the supply of cash in the Eurosystem and also to the seigniorage revenues of the other central banks.

This raises the question as to how high the volume of €10 banknotes that are in active circulation in Germany actually is. According to our estimates, the value of the total domestic transaction balance has remained fairly constant since 2008 at around €35 billion.¹ This equates to just under 10% of the Bundesbank's cumulated net issues at the end of 2014. Calculations for individual denominations are much more difficult as, depending on the face value, banknotes are not all equally suitable for transaction purposes or as a store of value and are also subject to varying degrees of demand from other countries.

In the following, the transaction balances of €10 banknotes are examined in greater detail both in Germany (section 2) as well as outside the euro area (section 3) with the help of data obtained during the introduction of the new ES2 series.² The results are summarised in section 4 together with those for the transaction balances of the €5 banknotes.

Figure 1: Cumulated net issuance of €10 banknotes (€billion)



Source: Currency Information System (CIS) II.

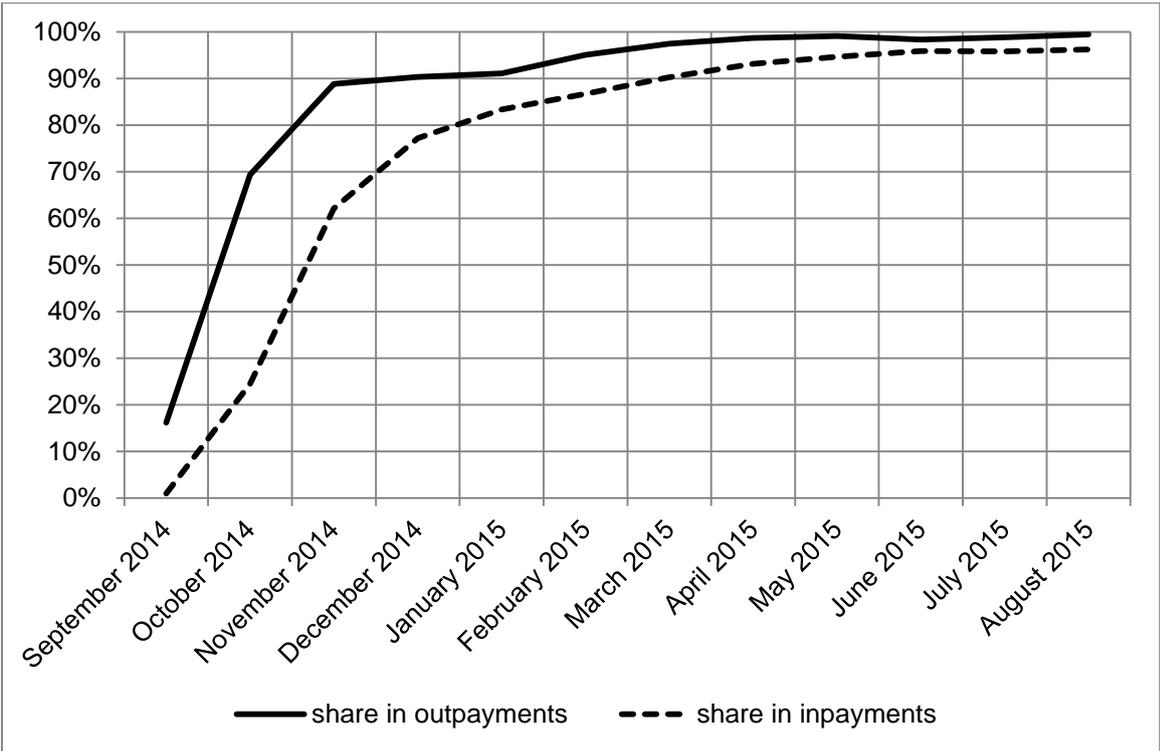
¹ This is an update of the estimate in section 3.3 of Bartzsch, Rösl & Seitz (2011a).
² The new Europa series of banknotes is the second euro banknote series. To date the ES2 series has been introduced for the following denominations: €5 banknote (on 2 May 2013), € 10 banknote (on 23 September 2014) and € 20 banknote (on 25 November 2015). The core design of the banknotes has not changed. However, the new series has been evolved to include additional security features to further improve counterfeit protection.

2 The volume of €10 banknotes held for transaction purposes in Germany

2.1 Replacement of the old ES1 banknotes

The Bundesbank has been putting the new ES2 €10 banknotes into circulation in Germany since 23 September 2014. To begin with, figure 2 shows the share of the new ES2 banknotes in relation to the Bundesbank's gross monthly outpayments. Since April 2015, this share has stood at roughly 99%. Accordingly, ES1 €10 banknotes have accounted for a share of around 1% of gross outpayments since then. Only remaining stocks of ES1 €10 banknotes are paid out again. ES1 €10 banknotes that flow back to the Bundesbank are filtered out during processing and destroyed.

Figure 2: €10 ES2 banknotes as a share of the Deutsche Bundesbank's gross inpayments and outpayments



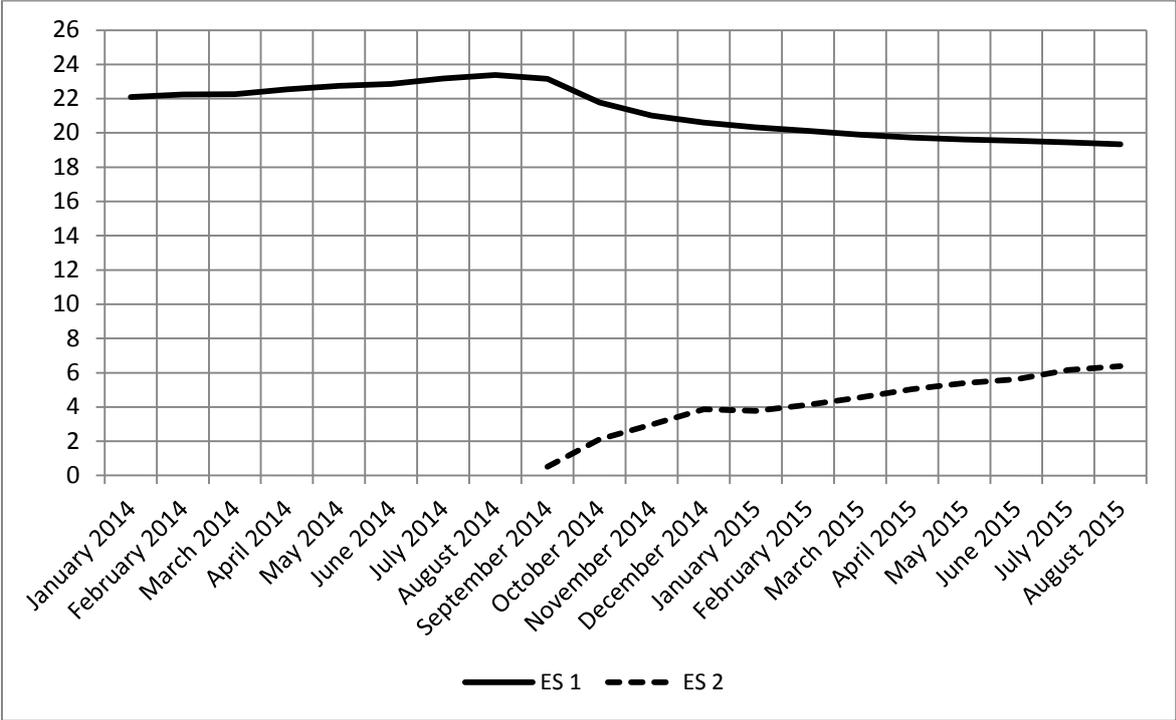
Source: CIS II.

Figure 2 also shows the share that is accounted for by the new ES2 notes in relation to the Bundesbank's gross monthly inpayments. Inpayments made at the Bundesbank can be assumed to be a representative sample of the banknotes in active circulation in Germany (domestic transaction balances). These inpayment data therefore provide information about the extent to which the ES1 €10 banknotes have already been replaced with ES2 banknotes. Since May 2015, the new series has

accounted for a share of around 95% of the gross inpayments at the Bundesbank. This means that the share of ES2 banknotes held for domestic transaction purposes was roughly the same as the share of these banknotes that was paid out since then (99%). During the period following the launch of the ES2 banknotes at the end of September 2014 up until May 2015, the volume of €10 banknotes held for transaction purposes in Germany therefore appears to have been almost completely replaced.

In order to determine how many €10 banknotes are in active circulation in Germany, we calculate how many banknotes flowed back to the Bundesbank between the end of August 2014 and May 2015. Given that Germany is a net exporter of €10 banknotes (see Figure 1), only a small amount of foreign banknotes end up in Germany. The return flows to the Bundesbank are therefore primarily banknotes from the domestic cash cycle. By adding up these return flows over time, these data can be used to estimate the domestic transaction balance. The sum of the return flows can be determined using the Bundesbank's cumulated net issues. Figure 3 shows the development of the Bundesbank's cumulated net issues, with separate curves for the old and the new series of €10 banknotes. Between the end of August 2014 and May 2015, the cumulated net issues of ES1 banknotes declined from €23.4 billion to €19.6 billion. During this period, the Bundesbank therefore withdrew a net amount of around €3.8 billion old ES1 banknotes from circulation and replaced them with ES2 notes. If it is also taken into consideration that, owing to the parallel issuance of ES1 and ES2 banknotes, (according to the inpayments with the Bundesbank) around 5% of domestic circulation is still accounted for by ES1 notes that have not yet been replaced by ES2 notes, the calculated €3.8 billion makes up around 95% of the domestic transaction balance. Based on this calculation, the domestic transaction balance contains around €4.0 billion ($= €3.8/0.95$) worth of €10 banknotes.

Figure 3: Cumulated net issuance of €10 banknotes by the Deutsche Bundesbank (€ billion)



Source: CIS II.

2.2 Implications

The cash balance of €10 banknotes held for domestic transaction purposes of around €4.0 billion at the end of August 2014 equals 17% of the total amount of €10 banknotes issued by the Bundesbank. This corresponds to the active circulation of €10 banknotes in Germany. Each resident living in Germany accounted for approximately five such €10 banknotes, and not 29 banknotes as estimated on the basis of the net issues.³

These calculations are largely in line with our estimates on the share of the total domestic transaction balance accounted for by banknotes in relation to the Bundesbank's cumulated net issues, which stands at just under 10%. By comparison,

³ It should be noted that the five "German" (issued by the Bundesbank) €10 notes in the transaction balance accounted for by each resident living in Germany on average also include the cash holdings of credit institutions and the volume of change held by retailers. According to an update of the estimate in Deutsche Bundesbank (2009, page 49), the domestic cash transaction balance had a value of €34 billion in 2014. €13 billion of this amount was accounted for by households, just over €19 billion by the cash holdings of credit institutions and only just under €2 billion by the volume of change held by retailers; the latter can therefore be disregarded. The cash holdings of credit institutions, on the other hand, arise almost exclusively from domestic transactions. They can therefore be interpreted as an external component of the transaction balance of domestic households, see Section 2.2.2c) in Bartzsch, Rösl & Seitz (2011b). When considering the domestic cash transaction balance, coin holdings can be disregarded as they only account for an estimated value of around €2 billion. See Altmann & Bartzsch (2014).

the estimated share of the total amount of cash held for transaction purposes that is accounted for by the €10 banknote (approximately 17%) seems quite plausible given that the €10 note is a denomination typically used for payments.

Furthermore, the analysis clearly shows that it is not possible to equate the Bundesbank's cumulated net issues with the volume of cash in active circulation in Germany, ie the volume of cash held for domestic transaction purposes. This should be borne in mind, especially when assessing the level of market penetration of the new banknote series. The cumulated net issues could, for instance, lead one to assume that just over €19 billion in ES1 banknotes are still in active circulation in Germany, whereas in actual fact, these banknotes were taken out of the German cash cycle quite some time ago. A large share of these notes has migrated abroad and has been paid in at other central banks or will at some stage be paid in at these central banks (see Figure 1). A further share may have been permanently hoarded or lost. It is therefore better to use the inpayment flows at the Bundesbank when assessing the level of market penetration of the new series, with the new series accounting for a share of 96% in autumn 2015. Whether the approach outlined in this paper could also be used to calculate the volume of cash held for domestic transaction purposes in other euro-area countries would have to be examined on a case-by-case basis. The calculations are based on the assumption that the domestic demand for euro banknotes is fully met by the Bundesbank's cumulated net issues. This approach is therefore only suitable for countries that are net exporters of the specific denomination under consideration. This assumption is plausible in the case of Germany and the €10 banknote as Germany has, over time, already issued more than 100% of the current aggregate demand for €10 banknotes (see Figure 1). This assumption is not true of other countries, however.

3 Volume of "German" €10 banknotes held for transaction purposes outside the euro area

In section 2, the domestic transaction balance of "German" €10 notes was derived from the decline in the number of ES1 banknotes after the introduction of the ES2 series. The so-called biometric method is another way to make use of the introduction of the ES2 series. This method allows to estimate the transaction balances of "German" €10 euro notes outside the euro area with the help of official shipments of banknotes.

3.1 The biometric method

The early 1990s saw the launch of a new series of US dollar banknotes featuring a security thread. Back then, Richard Porter and Ruth Judson, two economists at the Federal Reserve Board, took advantage of this opportunity to estimate the volume of \$50 and \$100 notes in circulation abroad using different methods.⁴ The introduction of the ES2 €10 notes can similarly be used to gauge the volume of "German" €10 banknotes outside the euro area. To this end, use was made of a "biometric" method, originally devised by the Danish biologist Carl Petersen that has also already been applied to the dollar market.⁵ Biologists are often confronted with the problem of not knowing the size of the total population N (eg the number of fish in a lake). By marking newly added fish of population size M and taking a random sample from the lake some time later it is, however, possible to produce a ratio estimator. This allows a conclusion to be drawn concerning the size of the population N . Measuring the volume of cash in circulation presents a similar problem inasmuch as the volumes circulating in Germany and abroad are not known.⁶

The biometric method can be used to estimate the volume of "German" €10 banknotes held for transaction purposes outside the euro area, the intrinsic assumption being that these notes are in free and random circulation.⁷ Therefore, we can only capture the volume in circulation of "German" €10 notes held for transaction purposes - these are actually in circulation in non-euro-area countries - and not those being hoarded in these locations. The term "hoarded banknotes" refers to notes that return to central bank branches at a much slower pace than notes in circulation in the narrower sense. This definition encompasses not just notes used as a long-term or temporary store of value but also notes that have gone astray or been destroyed.⁸ If, as presumed, the notes are circulating in an unhindered and random

⁴ See Porter & Judson (1995), page 893; Porter & Judson (1996), section 3.2; U.S. Treasury Department (2006), section 4.2.2; Judson (2012), section IV.B.

⁵ See, e.g., Porter & Judson (1996).

⁶ However, it has been shown that Germany is a net exporter of euro banknotes both to other euro-area countries and to non-euro-area countries (see Bartzsch, Rösl & Seitz (2011a;b).

⁷ Since Germany is a member state of the European monetary union, the term "abroad" refers to two categories of country: other euro-area countries and non-euro-area countries. In this context, the biometric method therefore takes a different approach to that deployed by Porter and Judson for the United States.

⁸ Banknotes paid in to the Bundesbank via shipments stem either from the volume of cash held for transaction purposes or from temporary hoarding. The problem is that it is not possible to visibly discern *whether a given note belongs to the former or latter category.*

fashion, the share of marked banknotes in the random sample matches the share of marked banknotes among the population as a whole.

$$\frac{M}{N} = \frac{m}{n} \quad (1).$$

M denotes the collective value of all marked notes (ES2 €10 banknotes). n represents the value of all €10 notes belonging to the random sample while m denotes the value of all marked €10 notes included in that sample. Solving (1) for N , the value of all "German" €10 notes held in non-euro-area countries for transaction purposes, we get

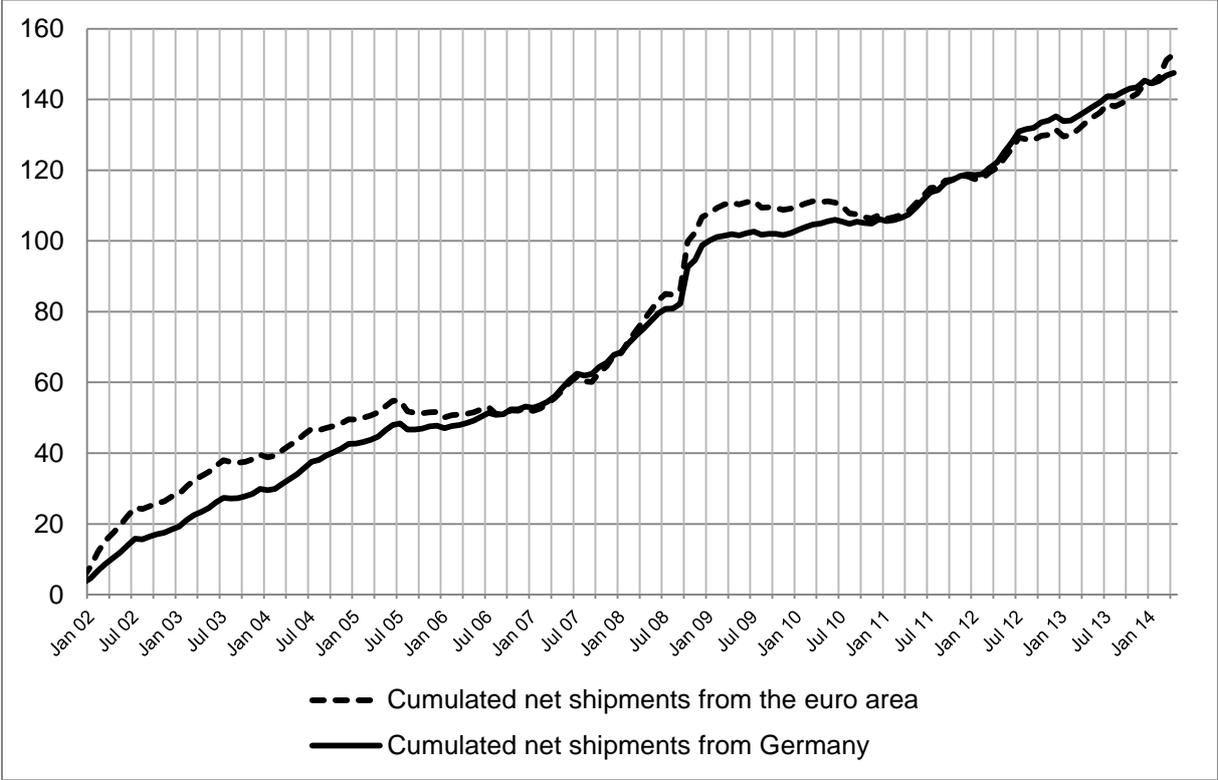
$$N = \frac{n}{m} M \quad (2).$$

Variables n , m and M on the right-hand side of (2) are derived from official "shipments". This term refers to all €10 banknotes paid in to branches of the Bundesbank in the context of official deliveries of banknotes to countries outside the euro area (shipments).⁹ In other words, the random samples n and m are only taken from branches handling shipments (branch category 1). The implicit assumption we make is that banknotes in these random samples (forming part of shipments) were brought into circulation by the *Bundesbank* and not by other Eurosystem central banks. This assumption can be justified by the fact that the vast majority of shipments occurring within the Eurosystem are handled by the Bundesbank (see figure 4). Moreover, since the beginning of 2013, more than 100% of all €10 notes issued by the Eurosystem have emanated from the Bundesbank. Branch category 1 thus comprises branches that strive to satisfy not just the demand coming from within Germany itself but also from other euro-area countries and non-euro-area countries alike. In order of importance, these are first and foremost the Bundesbank's branches in Frankfurt and Mainz, followed by its branches in Freiburg *and* Villingen-Schwenningen (which "replaced" the Lörrach office), with Berlin and Munich in third place.¹⁰

⁹ The shipments are processed by wholesale banks active in the international wholesale banknote market. The inpayments stemming from these shipments correspond to the random sample of fish from a lake mentioned above.

¹⁰ The Lörrach office, which occupied an important position in the international wholesale banknote market in terms of the Swiss banking system's logistical links with the euro cash cycle, was closed on 30 September 2012.

Figure 4: Cumulated net shipments of euro banknotes from Germany and the euro area (€billion)



Sources: Deutsche Bundesbank and ECB.

Variable n denotes the value of all €10 notes (ES1 and ES2) paid in to the above branches in May 2015 from countries outside the euro area. Variable m stands for the value of all ES2 €10 notes included in this volume. Drawing of the random sample was held off until May 2015 in order to give the €10 notes from the old and new series enough time to achieve a good mix. Inpayment flows at the Bundesbank have been used to assess the level of market penetration of the new series, with the new series accounting for a share of around 95% since May 2015. Apart from via shipments, "German" euro notes are mainly transported abroad to non-euro-area countries either as a result of travel or as remittances.¹¹ These channels are captured only partly by the biometric method.¹² In any case, N from equation (2)

¹¹ At the end of 2014, "German" euro notes worth an estimated €261 billion were to be found in circulation outside the euro area. Of this amount, €156 billion stemmed from shipments, with €105 billion arising from foreign travel. These figures represent an extrapolation of the estimate made by Bartzsch, Rösl & Seitz (2011a, section 3.1). No data is available on the denominational break down regarding "German" euro notes exported through travel.

¹² The inpayments at the Bundesbank arising from shipments also include notes which were originally exported from Germany to non-euro-area countries through travel or remittances.

relates only to that share of the volume of "German" €10 notes held for transaction purposes in non-euro-area countries that is attributable to shipments.

Value M denoting the volume of ES2 €10 notes brought into circulation by category 1 branches between 23 September 2014 and 30 May 2015 and destined for non-euro-area countries comes to €363 million.¹³ The sum total n comprising all €10 notes (ES1 and ES2) paid in to category 1 branches in May 2015 as shipments from non-euro-area countries amounts to around €29 million. Value m denoting the volume of ES2 €10 notes included in n totals just over €19 million.¹⁴ Therefore, N , which constitutes the volume of "German" €10 notes held for transaction purposes outside the euro area, has an estimated value of just over €540 million at the end of May 2015. This estimate represents a lower limit for the volumes of euro cash held for transaction purposes in these countries as no consideration is given to banknotes leaving the country on account of travel abroad or remittances (cash taken or sent by migrants back to their home countries). Viewed in relation to the total volume of "German" €10 banknotes in circulation, which amounted to €24.5 billion at the end of 2014, the estimated cash balance held for transaction purposes outside the euro area accounts for no more than just over 2% of the whole. At first glance this would appear to be a very low figure. But this result was to be expected for a number of reasons. First, a large share of "German" €10 banknotes is to be found in other euro-area countries (see Figure 1). Second, euro banknotes kept outside the euro area are primarily being hoarded.¹⁵ The cumulative value of net shipments of "German" €10 banknotes (in countries outside the euro area) as at the end of 2014 was estimated to have reached a level of €6.2 billion, equivalent to one-quarter of the volume of this denomination in circulation. An estimated share of around 9% of these cumulated net shipments (worth €540 million) relate to transactions. The remaining and bigger share, worth €5.7 billion, is hoarded. At the end of 2014, the total cash

¹³ This represents the cumulative value of net outward payments from Germany to countries outside the euro area (ie the sum total of all outward payments less all inpayments) in the context of the official shipments described above.

¹⁴ According to the ECB (2011) national central banks are obliged to supply monthly data on the importing and exporting of euro notes to and from non-euro-area countries. These figures are meant to be broken down according to denomination using the most accurate estimates available. To this end, the Bundesbank makes use of its cash management system, which records shipment banknotes according to denomination, also differentiating between types ES1 and ES2. Inpayments (imports) data broken down by denomination have only been available since January 2013. For the period between 2002 and 2012 it was, however, possible to derive estimates of cumulative net shipments according to denomination using inpayment shares (in value terms) from the year 2013.

¹⁵ See section 3.4 in Bartzsch, Rösl & Seitz (2011a).

balance of "German" €10 banknotes held outside the euro area came to an estimated amount of about €8.5 billion.¹⁶ This means that the difference (8.5 bn. – 6.2 bn.) is brought abroad via other channels than official shipments.

How plausible are these estimates? In order to investigate on this question, we use a number of tests to quality-check the results.

Hypothesis 1: " N should not be larger than the total volume of shipments of €10 notes effected by the Bundesbank since the introduction of euro cash."

N is part of the total volume of shipments. Therefore, it may not exceed the latter. With respect to shipments, only data on the cumulative outpayments are broken down by denomination. Inpayments data have only been broken down by denomination since January 2013. Assuming that the proportion of €10 notes among inpayments arising from shipments in 2013 can also be applied to the period between 2002 and 2012, the estimated (net) cumulative value of shipments of €10 notes effected by the Bundesbank is found to stand at around €6.2 billion at the end of 2014. This figure lies well above the estimated value of N of €540 million.

Hypothesis 2: " N should be lower than transaction balances of €10 notes held in Germany, which is replenished by domestic branches engaged in typical domestic activities."

This hypothesis rests on the notion that €10 notes held in non-euro-area countries are seldom put to use, unlike holdings of such notes in Germany. To put this hypothesis to test, we analyse the following large branches engaged in typical domestic transactions and defined here as branch category 2: Hamburg, Stuttgart, Leipzig and Cologne. Choosing large branches for branch category 2 reduces the risk of distortion by individual customers. M_2 , the value of ES2 €10 notes brought into circulation by category 2 branches between 23 September 2014 and 30 May 2015 amounts to around €478 million. Variable n_2 representing the value of all ES1 and ES2 €10 notes paid in to category 2 branches in May 2015 amounts to around €564 million. Meanwhile, variable m_2 denoting the volume of ES2 €10 notes included in n_2 totals around €538 million.

¹⁶ According to an estimate based on the seasonal method, the volume of "German" €10 notes held outside the euro area rose linearly from just under €2 billion in 2002 to €6 billion in 2009, see section 2.2.2a) in Bartzsch, Rösl & Seitz (2011b). Extrapolating this figure to the end of 2014 yields €8.5 billion.

$$N_2 = \frac{n_2}{m_2} M_2 \quad (2').$$

In (2'), N_2 , which constitutes the volume of €10 notes held for transaction purposes in Germany and originally issued by category 2 branches, has an estimated value of about €500 million. This figure lies below the estimated value for N of €540 million, though only marginally. The latter is therefore compatible with hypothesis 2.

Hypothesis 3: "N should be low"

This hypothesis also works on the assumption that €10 notes held in non-euro-area countries are seldom used for transaction purposes. Presumably, most euro notes in these countries are being hoarded.¹⁷ At the end of 2014, N (€540 million) made up just 2.2% of the total volume of "German" €10 notes in circulation (€24.5 billion).¹⁸ Similarly, when compared with the (estimated) volume of €10 notes held *in Germany* for transaction purposes amounting to €4.0 billion (see section 2), N accounts for a modest share (around 14%) of the total figure. The estimated value of N is thus also compatible with hypothesis 3.

4 Summary and conclusions

Table 1 provides an overview of the key estimates and in addition the corresponding results for the transaction balances of the €5 banknotes. The latter have been derived in the same way by making use of the introduction of the new ES2 €5 banknotes on 2 May 2013.

The volume of "German" €10 notes arising from shipments and held outside the euro area for transaction purposes accounts for an estimated value of around €0.5 billion (as at the end of May 2015). Therefore, of the cumulated net shipments (with an estimated value of about €6.2 billion as at the end of 2014) and hence of the total volume of "German" €10 notes being held outside the euro area (estimated total of around €8.5 billion at the end of 2014) the vast majority of notes are being hoarded.

The (total) volume of "German" €10 notes in circulation amounting to €24.5 billion, combined with the estimated value of €10 notes held for transaction purposes in Germany amounting to €4.0 billion and the estimated value of the total volume of

¹⁷ See section 3.4 of Bartzsch, Rösl & Seitz (2011a).

¹⁸ At the end of 2014, (cumulative net) shipments of "German" €10 notes (with an estimated value of €6.2 billion) accounted for one quarter of the total volume of "German" €10 notes in circulation.

"German" €10 notes held outside the euro area amounting to €8.5 billion leave a residual value of €12.0 billion. This figure represents half of the cumulated net issues of "German" €10 notes. It comprises all notes hoarded in Germany as well as stocks of notes (hoarded or held for transaction purposes) in other euro area countries. The lion's share of this is presumably to be found in other euro-area countries where the demand for €10 notes is completely provided by the Bundesbank.

Table 1: Components of the volume of "German" €10 and €5 notes in circulation (€ billion)

	€10 note ¹⁾	€5 note ²⁾
Total volume in circulation (cumulated net issues)	24.5	8.5
Banknotes held for transaction purposes in Germany	4.0	1.8
Total volume of banknotes kept outside the euro area	8.5	-
<i>of which</i> (cumulated net) shipments	6.2	0.56
<i>of which</i> notes held for transaction purposes	0.5	0.24
<i>of which</i> hoarded	5.7	0.32
Remaining volume ³⁾	12.0	6.1

Sources: Deutsche Bundesbank and authors' own estimates.

Notes: 1) Volume of banknotes held in Germany for transaction purposes as at the end of August 2014; banknotes held for such purpose outside the euro area arising from shipments as at the end of May 2015. All other specified data relate to the end of 2014. 2) Volume of banknotes held in Germany for transaction purposes as at 1 May 2013; banknotes held for such purpose outside the euro area arising from shipments as at the end of January 2014. All other specified data relate to the end of 2013. The total volume of banknote balances outside the euro area could not be estimated with the seasonal method, see Bartzsch, Rösl & Seitz (2011b), section 2.2.2.a) 3) Hoarded in Germany or hoarded/held for transaction purposes in other euro-area countries or – only for €5 note – hoardings/transaction balances outside the euro area which are not related to shipments.

As in the case of €10 notes, the share of domestic transaction balances in the total volume of circulation (cumulated net issues) of €5 notes is about one-fifth. However, the share of cumulated net shipments in total circulation is much higher for the €10 notes and mainly consists of hoardings while the shares of hoardings and transaction balances in the cumulated net shipments of €5 notes are almost equal. These differences show that in contrast to the €10 note the €5 note is not a typical "foreign demand banknote".

After the remaining ES2 denominations of €20 and above have been brought into circulation and have stirred with the ES1 series, the volume of "German" banknotes held for transaction purposes in Germany and in non-euro-area countries can also be calculated for these denominations using the method presented in this paper.

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