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## What can biology tell us about transaction balances?

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### ABSTRACT

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. The introduction of the new Europa series of banknotes in the euro area offers the opportunity to calculate transaction balances with the help of a biometric method. Our results indicate that transaction balances are very low.

### KEYWORDS

Euro banknotes; biometric method; transaction balances

### JEL CLASSIFICATION

E41; E58

### I. 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 euro banknotes (ES2) since 2013 offers the opportunity to calculate transaction balances at home and abroad. We apply one method to the already circulating €10 and €5 banknotes.

Bartzsch and Seitz (2016) derive that the share of domestic transaction balances in the total volume of circulation of these two smallest euro denomination notes is only about 20%. Their calculations are based on return flows of banknotes to the central bank and simple accounting. Usually, these domestic transaction balances are the main focus of interest of papers trying to estimate and analyse the share of cash used for payment purposes (see, e.g., Seitz 2007; Aksoy and Piskorski 2006). However, the euro is also heavily used abroad (Bartzsch, Rösl, and Seitz 2013a, 2013b; ECB, 2015). Therefore, it is interesting to know the euro amounts used for transaction purposes outside the euro area. This is the aim of the

present article. To our knowledge, this has never been done before.

### II. Banknotes held for transaction purposes outside the euro area

The Eurosystem has been putting the new ES2 €5 and €10 banknotes into circulation since May 2013 and September 2014, respectively. After a few months, the share of the new notes has stood at over 95%. ES1 banknotes that flow back to the central banks are filtered out during processing and destroyed. The biometric method is one way to make use of the introduction of the ES2 series to calculate transaction balances.

#### 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 held abroad using, *inter alia*, a biometric method originally devised by the Danish biologist Carl Petersen (Porter and Judson 1996). The introduction of the ES2 notes in combination with official shipments of banknotes can similarly be used to gauge the volume of €5 and €10 banknotes *outside* the euro area.

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Biologists are often confronted with the problem of not knowing the size of the total population  $N$  (e. g. 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 at home and abroad are not known.

In trying to estimate the volume of banknotes held for transaction purposes outside the euro area, we make the intrinsic assumption that these notes are in free and random circulation. Therefore, we can only capture the volume in circulation of 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 a central bank at a much slower pace than notes in circulation in the narrower sense. If the notes are circulating in an unhindered and random 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 banknotes);  $n$  represents the value of all notes belonging to the random sample, while  $m$  denotes the value of all marked notes included in that sample. Solving Equation 1 for  $N$ , the value of all €5 and €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 Equation 2 are derived from official ‘shipments’. This term refers to all banknotes paid in to branches of the Deutsche Bundesbank in the context of official deliveries of banknotes to countries outside the euro

area.<sup>1</sup> 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 1). Moreover, since the beginning of 2013, more than 100% of all €10 and €5 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.<sup>2</sup> 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, with Berlin and Munich in third place.

Variable  $n$  denotes the value of all notes (ES1 and ES2) paid in to the above category 1 branches at a specific month  $t^*$  after their introduction *from countries outside the euro area*. Variable  $m$  stands for the value of all ES2 notes included in this volume. Drawing of the random sample was held off a few months (until  $t^*$ ) in order to give the notes from the old and new series enough time to achieve a good mix. For the €10 note, for example,  $t^*$  is May 2015. Inpayment flows at the Bundesbank have been used to assess the level of market penetration of the new series. 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. These channels are captured only partly by the biometric method.<sup>3</sup>

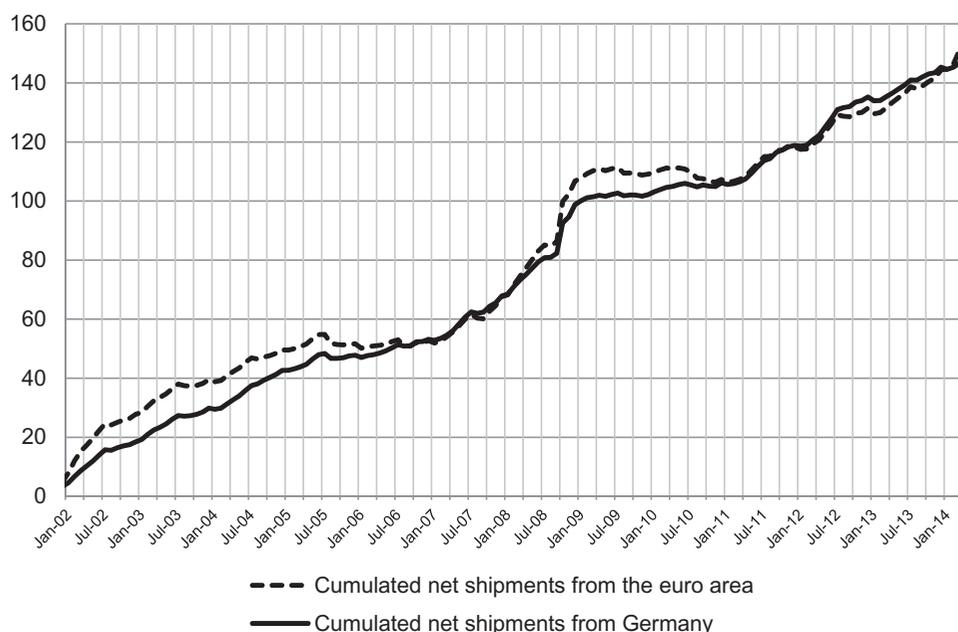
## Results

To exemplify the calculations, we refer to the €10 banknote. In this case,  $M$ , the volume of ES2 notes brought into circulation by category 1 branches until May 2015 and destined for non-euro-area countries

<sup>1</sup>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 earlier.

<sup>2</sup>Since Germany is a member of the euro area, 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.

<sup>3</sup>The inpayments at the Bundesbank arising from shipments also include notes that were originally exported from Germany to non-euro-area countries through travel or remittances.



**Figure 1.** Cumulated net shipments of euro banknotes from Germany and the euro area (€ billion) Source: Deutsche Bundesbank and ECB.

equals €363 million. The sum total  $n$  comprising all notes (ES1 and ES2) paid in to category 1 branches in May 2015 as shipments from non-euro-area countries amounts to €29 million. And  $m$ , the volume of ES2 notes included in  $n$ , totals just over €19 million. Therefore,  $N$ , the volume of ‘German’ notes held for transaction purposes outside the euro area, has an estimated value of just over €540 million at the end of May 2015 (about 9% of shipments). As mentioned earlier, this estimate represents a lower limit for the volumes of euro cash held for transaction purposes in these 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 (Bartzsch, Rösl, and Seitz 2011, Section 3.4). 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. Extrapolating the estimate of the volume of ‘German’ €10 notes held outside the euro area in Bartzsch, Rösl, and Seitz (2013a) to the end of 2014 yields €8.5 billion. This means that the difference is brought abroad via other channels than official shipments.

In the case of the €5 note, transaction balances outside the euro area ( $N$ ) amount to €240 million, constituting around 45% of official shipments. However, the share of cumulated net shipments in total circulation is much higher for the €10 notes and mainly consists of hoardings. These differences show that, in contrast to the €10 note, the €5 note is not a typical ‘foreign demand banknote’.

### III. Summary and conclusions

A biometric method is used to calculate the amounts of euros used for transaction purposes outside the euro area. The method is applied to the two smallest denominations (€5 and €10) for

which a new banknote series has been issued. Bartzsch et al. (2012) present estimates of about 50% of Germany's net issues of banknotes being held outside the euro area. Our results reveal that only between 2% and 3% of the total volume of these denominations are held as transaction balances in these countries. Bartzsch and Seitz (2016) as well as Bartzsch, Rösl, and Seitz (2013a) and Seitz (2007) find that *domestic* transaction balances in Germany amount to about 20%. The rest is hoarded within or outside the euro area or used for transactions in other euro area countries.

After the remaining ES2 denominations of €20 (already introduced at the end of 2015) and above have been brought into circulation and have stirred with the ES1 series, the volume of 'German' banknotes held for transaction purposes in non-euro-area countries can also be calculated for these denominations using the method presented here.

### Disclosure statement

No potential conflict of interest was reported by the authors.

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