6 April 2017
ETS/2017/091

# Estimation of euro currency in circulation outside the euro area[1]

## 1. Introduction

Recent empirical evidence on currency in circulation has shown a significant inconsistency between total currency in circulation and the estimates of holdings in various statistical domains.[2] Some of the evidence points to the European Central Bank (ECB) estimate of euro currency circulating outside the euro area as a prominent cause of this inconsistency.[3]

In this context, in 2015 and 2016 the European System of Central Banks (ESCB) discussed alternative methods for the estimation of circulation outside the euro area. A new methodology was approved in December 2016 and introduced on 6 April 2017 with the release of quarterly balance of payments (b.o.p.) and international investment position (i.i.p.) statistics for the last quarter of 2016.

The following sections present and explain the new methodology used to estimate euro currency holdings by non-euro area residents.

## 2. New estimation method: lower and upper bounds

Given the large variability in the results of the various estimation methods tested and discussed by the ESCB Statistics Committee (STC) in 2016, it was decided to continue using a linear combination of two methods rather than selecting a single method. Two estimates have been chosen to set boundaries to circulation outside the euro area by establishing a lower limit (an estimate of minimum circulation under certain reasonable assumptions on not observable data) and an upper limit (an estimate of a maximum circulation, also on under certain assumptions).

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[1]  In this note, the terms "euro currency", "euro banknotes" or simply "banknotes" are all synonymous and refer to "euro banknotes and coins"', unless otherwise specified.

[2]  The evidence was gathered during an annual exercise to reconcile the total amount of euro currency in circulation and the sum of estimates of the individual euro area countries' holdings in the context of national financial accounts and the estimated holdings by non-euro area residents compiled for b.o.p./i.i.p. and euro area accounts (see footnote 3).

[3]  Since 2004, circulation outside the euro area has been estimated as a weighted average of two components. The first component (with a weighting of 75%) estimates non-euro area holdings as a fixed percentage (9.39%) of total euro banknotes in circulation. The second estimate (with a weighting of 25%) is based on a fixed proportion (4.16%) of coins to banknotes in circulation.

The specific choice of methods for the estimation of lower and upper bounds takes into consideration their suitability for the purpose as well as whether they make use of information and methods readily and regularly available to statisticians at high frequency. This approach ruled out methods for which it is not possible to guarantee the provision of results on a regular basis, e.g. those modelling the demand for currency or exploiting the information on seasonality.

The proposed lower and upper bounds and the reasoning behind their selection are presented below. **The mean point of the interval is proposed as the point estimate of circulation outside the euro area**.

### a) Lower bound: accumulated shipments of high denomination banknotes

The ECB has collected monthly information on shipments of euro banknotes to/from countries outside the euro-area since the introduction of the euro in 2002, including a breakdown by banknote denomination since 2013. Apart from some recent ad hoc surveys, this information is the only direct data source on cross-border currency flows available in the euro area.

This data set, however, only captures flows via official channels, not currency entering and leaving the euro area by other means, e.g. travel/tourism or other cross-border cash payments.

Equation (1) gives a representation of circulation abroad ($F$) as the accumulation of official exports and imports ($x_t^o, i_t^o$), which are covered by the aforementioned statistics on shipments, and the accumulation of other cross-border flows ($x_t^u, i_t^u$), not covered by said statistics.

$$F = \sum_t x_t^o - \sum_t i_t^o + \sum_t x_t^u - \sum_t i_t^u \tag{1}$$

Net shipments ($\sum_t x_t^o - \sum_t i_t^o$) serve as a lower bound to $F$ if we assume that the unobserved $\sum_t x_t^u - \sum_t i_t^u > 0$ , i.e. that the unofficial channel presents net positive outflows. There are reasons to believe that this is indeed the case. Anecdotal evidence, for example, indicates that euro area travellers or migrant workers take a significant quantity of euro banknotes with them when travelling to non-euro area countries. Therefore, a simple accumulation of recorded net banknote shipments would clearly underestimate total euro banknote holdings by non-residents and establish a lower bound.

Moreover, the observation that the reported net shipments of €50 banknotes is negative (i.e. more €50 banknotes enter the euro area than leave it through official channels) raises the question of whether a better (higher in this case) lower bound for non-residents' holdings of euro banknotes could be established by looking into the banknote denomination structure. The refined banknote shipments method takes this approach and relies on three assumptions:

i. demand for low and high denominations is structurally different; low denominations are mainly used for transaction purposes (and therefore more likely to remain within the euro area), whereas high denominations are mostly used for hoarding purposes;

ii.   high denominations (i.e. €100, €200 and €500 banknotes[4]) are more likely to follow the official migration channel as regards inflows (re-imports), meanings that other channels are more likely to present net positive outflows for these denominations;[5]

iii.  the structure of the external demand by denomination over the past three years is representative of the demand structure for the overall period, i.e. from 2002 to 2016.[6]

The proposed method recognises the fact that there is more certainty about the sign of non-official flows for high denomination banknotes than for low denominations. For the former, a positive sign is expected $[\sum_t x_t^u \gg \sum_t i_t^u$ in (1)] and official net outflows constitute a lower bound. For the latter, no particular sign is expected, and the only reasonable and conservative lower limit for circulation abroad is zero.

As information on shipments by denomination is available only from (reference period) January 2013 onwards, deriving a stock series of high denomination banknotes starting in 2002 required some additional steps. As a first step, the monthly share of each denomination was calculated using the observed series of banknote issuances for the available data since 2013.[7] The share was then categorised between low (€20 and smaller) and high (€100 and higher) denominations (the €50 banknotes were excluded from the analysis owing to their negative sign). Second, these monthly shares were applied to the known totals of euro banknotes exported and imported in order to estimate the shipment of banknotes by denomination for the period 2002-2012 (assumption iii. above). As a final step, the difference between high denomination banknotes exported and imported was calculated and cumulated over time.

High and low denominations were issued in approximately the same proportion. However, the percentage of high denominations exported was significantly larger than that of low denominations. This corroborates the assumption that demand for low denominations originates primarily from within the euro area (assumption i. above) and that foreign demand is primarily for high denomination banknotes.

The proposed estimation method for a lower bound for *total* currency held by non-residents consists of adding the cumulating the net shipments of high denominations since 2003 (estimated as described above) to an estimate of holdings abroad as at end of 2002, taken from the total net shipments of all denominations in that year, on the grounds that in the first year total net banknote shipments would provide a better estimate of foreign holdings. This leads to an estimate of approximately €274 billion for end 2016.

This result is consistent with the empirical estimation mentioned in the ECB's report *"The International role of the euro"*. According to this report, 25% of all euro banknotes issued by the *Eurosystem* are estimated to be in circulation outside the euro area (amounting to €240 billion at the end of 2013[8]).

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[4]   For an extended discussion of the classification of low and high denominations, please see Fischer (2004) and Bartzsch, Rosl and Seitz (2011).

[5]   Anderson, R.G. and Rasche, R.H. (2000), "The Domestic Adjusted Monetary Base", *Federal Reserve Bank of St. Louis Working Paper 2000-002A.*

[6]   This assumption could be questioned for the initial period up to 2004 and for the period 2008-2010: in the first case because of the changeover process; in the second case due to the peak of the financial crisis; and, in the third case, due to the Russian rubble crisis. However, anecdotal evidence shows that this increase would primarily affect high denomination banknotes, which would increase the stock of these banknotes held abroad.

[7]   This estimation process can be improved over time as new observations become available.

[8]   *The international role of the euro* (2014), ECB, Frankfurt am Main, July.

***b) Upper bound: ratio of coins to banknotes***

While the lower bound estimate is based on the observed cross-border flows of banknotes (statistics on official banknote shipments) and additional assumptions on unobserved cross-border flows, the upper bound uses an indirect method, combining observed information on domestic circulation, coin circulation[9] and assumptions on what is not observed, in turn based on an assumption of the maximum possible ratio of coins to banknotes in domestic circulation. With this in mind, an upper bound for circulation abroad ($F^u$) can be constructed as:

$$F^u = B - \frac{C}{r} \qquad (2)$$

where "B" is total banknotes in circulation, "C" coins and "r" the maximum value of the coins-to-banknotes ratio.

The observed coins to total banknotes ratio prevailing in 2002 (4.16%) was chosen as the maximum ratio (*r*), i.e. the actual unobserved ratio is assumed to lie below that level, and the circulation derived from (2) is as a consequence an upper bound for the actual circulation. Note that using the fixed coins-to-banknote ratio estimated for 2002 in (2) implies that the growth of banknote issuances since that year that exceeded the growth of coin issuances is entirely attributed to non-resident holdings, an assumption that may indeed only be justifiable for an upper bound estimate.[10]

To assess the validity of the assumption that the actual ratio is below the one observed in 2002, several aspects of currency demand must be considered, most importantly:

- developments in the use of plastic money as substitutes for both banknotes and coins;
- the relative growth of hoarding in relation to currency demand for transaction purposes;
- the euro banknote and coin denomination structure in relation to legacy currencies;
- the percentage of coins officially in circulation that are in fact lost.

All these aspects should have an impact (partly offsetting each other) on the ratio of coins to resident holdings of banknotes. The increasing use of plastic money should, to some extent, be more relevant as an alternative to banknotes, which would imply an increase in the ratio resulting in a decrease in the use of banknotes for transaction purposes. Hoarding in the euro area should have increased since the financial crisis, particularly because of a decrease in the opportunity costs of holding banknotes. This should have had a downward impact on the ratio. The issuance of €500 banknotes should also have had a negative impact on the ratio. Finally, the ratio might increase over time owing to the amount of coins lost and not used in transactions.

All in all, these effects are assumed to be dominated by the hoarding effect, underpinning the assumption that the actual ratio is below the pre-euro ratio of 4.16%.

This method provides an upper bound estimate of non-residents holdings of euro currency of over €400 billion as at end 2016.[11]

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[9] This is based on the rather uncontroversial assumption that coin circulation abroad is negligible.

[10] Between the end of 2002 and the end of 2015, the issuance of euro banknotes increased by 217% and the issuance of euro coins increased by 110%.
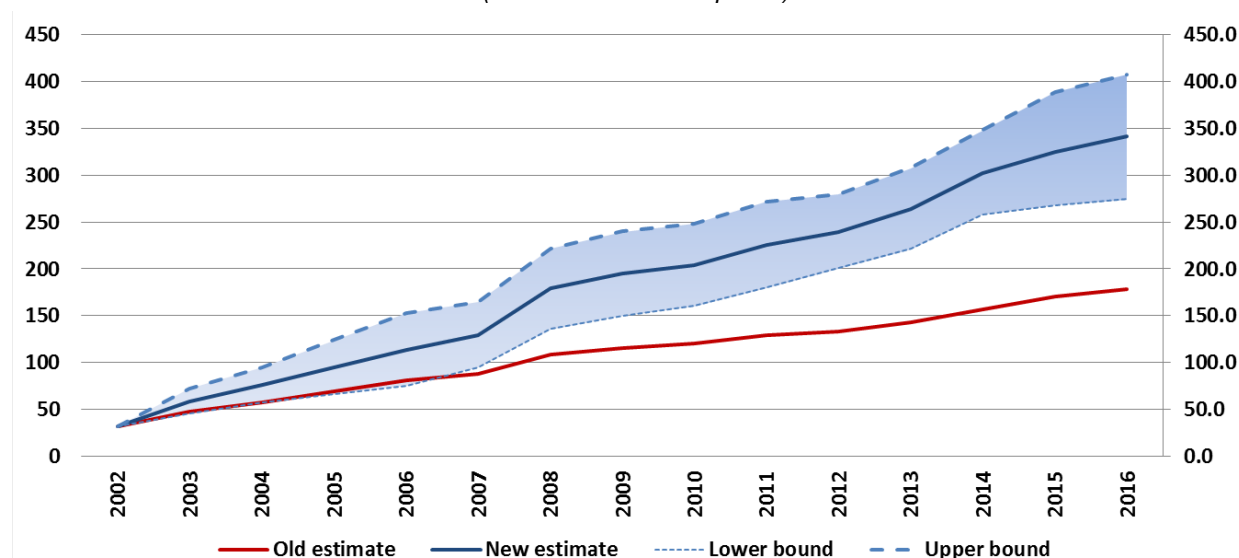
[11] This estimate is derived using cumulated seasonally adjusted coin and banknote data from 2003 onwards. For 2002, the estimate uses banknote shipment data and is therefore equal to the lower bound estimate.

## 3.    The results

By taking the average of the lower and upper bounds, the new method estimates that at the end of 2016 residents outside the euro area held approximately €341 billion in euro banknotes, compared with the €178 billion estimated according to the old method. As can be seen in Chart 1, from an identical estimate at the end of 2002, the difference between the two estimates grows over time and reaches a maximum of €163 billion in December 2016.

The new estimate implies a revision (increase) of the euro area liabilities vis-à-vis non-residents and consequently a reduction in the net i.i.p. The subsequent changes in stocks have also been reflected in the balance of payments as transactions in currency (presented together with deposits in "other investment") liabilities. This change did not impact the current account, thereby having a direct impact in the euro area errors and omissions.

**Chart 1: Holdings of euro banknotes by non-euro area residents**
*(EUR billion at end of period)*



Source: ECB.