A disaggregated analysis of central bank balance sheets: a tale of two currency unions

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Version: May 2017
Preliminary: Do Not Cite, Do Not Distribute

Abstract

Since the start of the Global Financial Crisis, central bank balance sheets have experienced substantial changes due to a variety of non-standard monetary policy measures. This paper analyzes how these measures have percolated to the regional central banks that make up the Eurosystem and the Federal Reserve System. To this end, we construct a new annual harmonized database comprising disaggregated balance sheet data for the Eurosystem and collect existing disaggregated data from the Federal Reserve System. We employ a variety of indicators to measure potential asymmetries in the development of regional central bank balance sheets within the euro area and the US. We observe strong uniformity in the configuration of regional balance sheets within the Federal Reserve System. In contrast, regional balance sheets within the Eurosystem show substantial asymmetries, especially during the European sovereign debt crisis.

Keywords: Central bank balance sheets, disaggregate data, monetary policy

JEL Classification: E40, E42, E50, E52, E58, F45

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1. Introduction

Since the start of the Global Financial Crisis, the European Central Bank (ECB) has employed a variety of non-standard monetary policy measures that have had an impact on the size and composition of the Eurosystem’s balance sheet. As a result, the use of the balance sheet has evolved from a passive approach in which liquidity provision was determined primarily by the need of financial counterparties, to a more active balance sheet management to pursue the twin goals of monetary and financial stability. The ECB’s balance sheet has thus become essential to the understanding of monetary policy transmission in the EMU (Bindseil, 2004; ECB, 2015; Rule, 2015).

A growing literature discusses the effectiveness of quantitative and qualitative easing, policies that affect respectively the size and the composition of central bank balance sheets. While this debate initially focused on the union-wide effects of balance sheet policies, more recently interest has increased in the differential regional effects of such policies, especially across the euro area (Peersman, 2011; Praet, 2012; Ciccarelli et al, 2013; Reis, 2015). In the debate on TARGET, Sinn (2011) and Whelan (2014) have pointed out that ECB policy can have differential effects on the balance sheets of the national central banks. This raises the issue of the uniformity of monetary policy and its transmission inside the monetary union. A priori, substantial divergences in the size and composition of regional central bank balance sheets seem hard to reconcile with the notion of a uniform union-wide monetary policy. On the other hand, when regions are hit by idiosyncratic shocks to financial and monetary stability, differential monetary policy effects may help or even be needed to maintain the integrity of the union.

A precondition to investigate such issues is the availability of disaggregated data. Until now, a complete and harmonized dataset of the disaggregated balance sheet of the Eurosystem was unavailable. This has hampered research into the differential regional effects of non-standard monetary policy operations across the euro area. The first contribution of this paper is to present a harmonized annual dataset for the disaggregated balance sheets of the national central banks that participate in the Eurosystem. The data have been collected from the annual reports of the national central banks and reconciled with the balance sheet of the Eurosystem. We will devote substantial space to explain the reconciliation of the data and to present the dataset.
We use this dataset for a regional analysis of central bank balance sheet composition across the euro area during the period 1999-2015. To this end, we employ two distinct methodologies. First, we apply the taxonomy of Pattipeilohy (2016) to document and compare developments in regional central bank balance sheet composition. Second, we apply metrics from the credit cycle literature (Mink, Jacobs & De Haan, 2012) to capture heterogeneity in regional central bank balance sheet composition over time. Throughout this paper, we perform an identical analysis on the disaggregated balance sheet of the Federal Reserve System. This allows us to compare the two currency unions.

Our results show that the composition of regional central bank balance sheets differs substantially across the euro area, in particular from 2009 onwards. In 2007 and 2008, national central banks experienced a convergence in balance sheet composition as the initial crisis response of the ECB was fairly evenly distributed among member states. In contrast, from 2009 we document a substantial divergence in balance sheet compositions due to the diverse policy challenges across the regions. During this period, central bank liquidity flowed primarily to financially distressed (peripheral) countries with limited access to financial markets. We observe more uniformity in the developments of balance sheets across the districts of the Federal Reserve System.

The remainder of this paper is organized as follows. The next section briefly reviews the literature. Section 3 presents our harmonized database. Section 4 describes the developments in central bank balance sheet composition following the taxonomy of Pattipeilohy (2016). Section 5 applies credit cycle metrics to empirically assess the heterogeneity in regional central bank balance sheet composition over time. We conclude and provide suggestions for future research in section 6.

2. Literature Review

A large literature has developed on the use of non-standard monetary policies by central banks. Borio and Dsityat (2010), Reichlin et al (2010), Porta (2011), Bowdler and Radia (2012) and Fawley and Neely (2013) provide overviews. A seminal theoretical contribution to this literature is Curdia and Woodford (2011). This paper investigates portfolio re-balancing effects of central bank balance sheet polices in an extended New-Keynesian setting. In addition to the conventional interest-rate channel, Curdia and Woodford (2011) distinguish a reserve-supply policy (i.e. the supply of central bank reserves to financial institutions) from a credit policy (i.e. the substitution of central-bank lending for private lending). Although neither of the two is a
perfect substitute for interest rate policy, they find that credit policy is most likely to improve welfare when financial markets are substantially distorted. Gertler and Karadi (2011) corroborate this finding with a DSGE model and add that credit policy can even be beneficial to welfare when nominal interest rates have not hit the lower bound yet. Earlier contributions to the theoretical literature are of Bernanke, Reinhart and Sack (2004), Adrian and Shin (2008), and Gertler and Kiyotaki (2010). A more recent contribution has been made by Hörmann and Schabert (2015).

Empirical research on the implications of non-standard monetary policy for the configuration of central bank balance sheets is scarce, as such policies were rarely used prior to the Global Financial Crisis. A notable exception is the case of Japan. With the zero lower bound binding from the 1990s, the Bank of Japan resorted to balance sheet policies well before other central banks. Ugai (2006), Shiratsuka (2010), and Ueda (2013) assess the balance sheet policies of the Bank of Japan and their implications for the configuration of the balance sheet. Fisher (2009), Cross, Fisher and Weeken (2010) and Rule (2015) contribute to this literature by analysing the balance sheet of the Bank of England.

More recent studies on the composition of central bank balance sheets are Van den End and Pattipeilohy (2015) and Pattipeilohy (2016). Van den End and Pattipeilohy (2015) present empirical metrics to gauge the impact of changes in the size and composition of central bank balance sheets on inflation expectations in the UK, US, Japan and the euro area. They report very different policy outcomes across these regions. Pattipeilohy (2016) develops a comprehensive framework to compare developments in the composition of central bank balance sheets across regions and over time. To assess the convergence or divergence in central bank balance sheet composition, Pattipeilohy (2016) analyses 14 advanced countries and 20 emerging countries over the period 2001-2015. The set of advanced countries includes the euro area, but does not provide an analysis of internal developments within the Eurosystem. Jobst and Ugolini (2014) note that the lack of a harmonized database and the absence of uniform accounting standards hampers the analysis of the composition of central bank balance sheets inside the euro area.

A related subset of the literature discusses the TARGET cross-border settlements system that is used inside the Eurosystem (Reis, 2015). Sinn (2011) interprets the TARGET imbalances as proof of a hidden bailout in the euro area, with e.g. the Bundesbank financing weaker countries in the periphery. In contrast, Whelan (2014) argues that the large intra-Eurosystem accounts have been a crucial by-product of the common monetary policy. Other contributions to the
TARGET literature are Sinn and Wollmershäuser (2012), Cour-Thimann and Winkler (2013) and Auer (2014). Cour-Thimann (2013) adds a comparison with the US, and shows that inter-regional transfers are of less significance in the US compared to the euro area.

While existing studies analyse the responses of central banks to the crisis, including the distinction between quantitative and credit easing policies, they do not provide information on changes in the size and composition of regional central bank balance sheets. The present paper adds to the literature by providing detailed insights into the development of the disaggregated balance sheets of the Eurosystem and the Federal Reserve System.

3. Data

To understand how the ECB’s policy percolates to the balance sheets of the national central banks, we need a breakdown of the Eurosystem’s balance sheet by country. Until recently, these data have not been made available from a single source on a harmonized basis. As of August 2016, the ECB publishes a disaggregated balance sheet on its website. However, historical data have not been made available by the ECB. In its central bank survey, the IMF presents components of the monetary base which contains balance sheet items. A major limitation of this source is that it comprises only a small selection of balance sheet items. To overcome these data issues, we have assembled data from the annual reports provided by national central banks for the period 1999-2015 and reconciled them using a uniform format. The dataset comprises 19 national central banks and the ECB, together forming the Eurosystem. For comparison, we collected a breakdown of the Fed’s balance sheet by district. These data are published on the website of the Federal Reserve System for all 12 districts from 2002 onwards.

A key step in the analysis of regional central bank balance sheets is to construct a database which confines all entries to a uniform classification. Most convenient for this task is to use the balance sheets of the Eurosystem and the Federal Reserve System. As the breakdown of the Fed’s balance sheet is already confined to a uniform standard a further restructuring is deemed redundant, while it is required for the Eurosystem. The balance sheet of the Eurosystem would suit well as a standard for the financial statements of the national central banks (NCBs).

Table 1 displays the schematic balance sheet of the Eurosystem. The Eurosystem balance sheet is in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks (ESCB)\(^5\). This document includes all rules and regulations concerning the standardized accounting procedures for the NCBs and the ECB, in forming the financial statement of the Eurosystem. Unfortunately, the annual reports are not subject to these standardized accounting procedures. Instead, they are contingent on national accounting guidelines, with substantial differences between member states.

[Insert Table 1]

The diversity in reporting by national central banks warrants a careful process of harmonization. To save space, a full justification of our dataset, with extensive details on each reconciliation, is reported in Appendix A. Graphical illustration of the dataset is provided in Appendix B. One example of reconciliation is, among many others, the recording of emergency liquidity assistance (ELA) by the Central Bank and Financial Services Authority of Ireland. In 2009 and 2010, Ireland received large amounts of ELA to provide liquidity assistance to credit institutions in an attempt to alleviate elevated pressures on credit markets, respectively €11.5 billion and €49.5 billion. In terms of balance sheet representation, these ELA amounts have been recorded under item 11.6 of table 1, i.e. “Sundry items”. However, to achieve harmonization across all national central banks we transferred the emergency liquidity assistance to item 6, i.e. “Other claims on euro area credit institutions denominated in euro”. This adjustment is also in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks (ESCB). For all other reconciliations we refer to Appendix A.

A snapshot of the data can already provide valuable information on the redistributive effects of unified monetary policy on the balance sheets of national central banks. Figure 1 displays the configuration of the asset-side of the balance sheet for the Eurosystem, offset against the disaggregated balance sheets for the ECB, Germany (core) and Greece (peripheral). Figure 2 does the same for the liability-side. To save space, both figures display only a selection of

regions in the dataset. The complete graphical representation of the data can be found in Appendix B. While the balance sheet seems fairly evenly distributed for the Eurosystem along its holdings, this is not the case for the regional central bank balance sheets.

A distinct difference can be observed in the composition of regional central bank balance sheets, most notably between Germany and Greece. Essentially, the difference between Germany and Greece is a reflection of the asymmetries between core and peripheral countries in the euro area. For example, from the start of the crisis the assets of the central bank of Greece comprises for the most part credit provision to domestic institutions in relation to monetary policy operations (i.e. items 5 and 6 of Table 1). These headings primarily consist of Longer-Term Refinancing Operations (LTROs) and Emergency Liquidity Assistance (ELA) as part of the enhanced liquidity support from the ECB to financially distressed (peripheral) countries (Trichet, 2009). The intra-eurosystem liabilities show that the enhanced liquidity support of the ECB has been made possible by the redistribution of central bank money across the euro area. As stressed by Whelan (2014), in absence of this channel peripheral countries would have undoubtedly been worse off as funds were hard to obtain elsewhere.

In stark contrast stands the Federal Reserve System. Figures 3 and 4 display the relative distribution of assets and liabilities on the balance sheet of the consolidated Federal Reserve System, offset against three of its largest districts: Boston, New York, and Richmond. Unlike the Eurosystem, the Fed’s liquidity operations were aimed at alleviating pressure on credit markets evenly across its districts and prevent disorderly asymmetric adjustments within financial sectors. The liquidity operations mainly consisted of large purchases of Mortgage-Backed Securities (MBS) and Treasury notes and bonds. The relative uniformity in balance sheet configuration may be explained by the introduction of the Depository Institutions Deregulation and Monetary Control Act of 1980 (Monetary Control Act) and the Interbank
Settlements Accounts (ISA, the US’ counterpart of Eurosystem’s TARGET accounts\(^6\)). These two developments have resulted in decisive advancements in the redistribution of central bank money.

4. Central bank balance sheet composition

In this section a systematic classification of the regional central bank balance sheets is presented, relying on the methodology suggested by Pattipeilohy (2016). This systemic classification allows for an empirical assessment of the development in balance sheet composition in a uniform context, both through time and across regions. The section is outlined as follows. First the methodology is discussed. Next, an analysis of the time-series is presented. Finally, a comparative analysis is provided between the Eurosystem and Federal Reserve System from a pre-crisis to a post-crisis perspective.

4.1 Methodology

In order to analyze developments in the composition of regional central bank balance sheets according to a uniform standard, the methodology suggested by Pattipeilohy (2016) has been followed. Essentially, this set-up consists of three steps.

First, a systematic classification is applied to the central bank balance sheets. This allows for a uniform analysis of changes in the composition of central bank balance sheets. In this systematic classification, the central bank balance sheets are decomposed into six categories, three on each side of the balance sheet. On the left, central bank assets are divided into foreign exchange holdings (FX), and domestic private (L) and public (G) sector debt. On the right, central bank liabilities are divided into banknotes in circulation (Bn), and liabilities to the banking sector (Rs) and to the government (Rg). According to this decomposition, we have categorized the individual balance sheet items of the Eurosystem and the Federal Reserve System. See table 2 for the schematic classification of the Eurosystem balance sheet, and table 3 for the Federal Reserve System. As not all balance sheet items match with one of the categories, a number of items is dropped. For example, from the liabilities of the Federal

\(^6\) A key difference between ISA and TARGET is that ISA is the actual settlement. While ISA is settled ultimately once a year, TARGET accounts are by default not settled. Eventually, this creates a growing wedge between member states, as some countries become a net contributor (e.g. the Bundesbank) without ever being compensated by the receiving central banks. See Cour-Thimann (2013) for an extensive comparison between the two.
Reserve System we leave out reverse purchase agreements, deferred availability cash items and total capital, as these items do not match with one of the categories for liabilities.

[Insert Tables 2 - 4]

Second, based on these categories, four indicators for the relative distribution of assets and liabilities are computed, two on each side of the balance sheet. See table 4 for the indicators. The indicators are constructed in such a way that one indicator can change independent of the other three, which gives the possibility to assess the configuration of central bank balance sheets along four dimensions \([G/L – (G+L)/FX – Rg/Rs – (Rg+Rs)/Bn]\). In theory, the central bank can affect each ratio independently. For instance, if a central bank raises banknotes in circulation in an attempt to boost economic activity (i.e. Bn increases), it can choose to expand its foreign and domestic holdings (FX and G+L) in equal amounts. Alternatively, the central bank may sterilize the operation by reducing liabilities to the government and private sector (Rg and Rs). As a consequence, only the ratio \((Rg+Rs)/Bn\) is affected. In reality, however, central bank interventions generally tend to affect several ratios at once.

[Insert Figure 5]

Third, the taxonomy of Pattipeilohy (2016) is applied to the categories. In figure 5 the four dimensions are illustrated graphically on a logarithmic scale, with the maximum and minimum set to respectively 100 and 0.01. In the same figure, a taxonomy is applied to identify the configuration of central bank balance sheets through time and across regions. The taxonomy is set as follows. If more than half of central bank asset holdings is foreign-currency denominated, the central bank is identified as foreign exchange holder \((FX > (G+L))\). By contrast, the central bank is classified as domestic holder if more than half of central bank asset holdings is denominated in the domestic currency \((FX < (G+L))\), with a further distinction in Treasuries holder \((if \ G > L)\) or private sector lender \((if \ G < L)\). Turning to the liabilities, a central bank is identified as note issuer if total deposits are less than 10% of banknotes in circulation \((Bn > 10 (Rg + Rs))\). The threshold of 10% seems reasonable considering the share of banknotes in circulation in relation to total deposits of central banks in our sample. Otherwise, a central bank
is identified as government’s banker (if $R_g > R_s$) or bankers’ banker (if $R_g < R_s$). Over time, a central bank can thus be identified vastly different over time depending on the type and structure of the balance sheet operations it conducts.

4.2 Central bank balance sheet composition through time

In figures 6 and 7 display the developments in composition of regional central bank balance sheets in the Eurosystem from 1999 to 2015, respectively for the distribution of assets and liabilities. A first look at the distribution of assets and liabilities of the Eurosystem as a whole exposes some interesting features. In terms of assets composition, until 2007 the Eurosystem is classified as foreign exchange holder, with foreign-currency denominated assets being the largest component of the total asset portfolio. As predicted by the European Commission (1990), the foreign exchange holdings should decline from the launch of EMU by about one half, as central bank activities would center more on the management of assets within the Eurozone. Whereas in reality, the pre-EMU legacy of foreign exchange holdings still dominated the asset portfolio of national central banks for close to a decade after the start of EMU (see, e.g., Nagel, 2012).

[Insert Figures 6 and 7]

Eventually, the prediction of the European Commission finally seemed to come around, at least partially. From 2007 onwards, the share of foreign currency holdings steeply declined as central bank activities centered more on the management of assets within the Eurozone. In contradiction to the prediction, however, this change was not a direct result of the EMU but rather due to the liquidity interventions by the ECB. To fulfil the liquidity demand of financial counterparties within the Eurosystem the ECB stepped in as lender of last resort by introducing a wide variety of purchasing programs. These programs were aimed at recovering liquidity intermediation to domestic credit institutions. As a consequence, the Eurosystem is classified as private sector lender (i.e. $G < L$) from 2007 onwards. After a period of fairly stable distribution of assets, the national central banks shifted their asset holdings from the private sector to national governments in 2015. Under the Expanded Asset Purchasing Program (EAPP), national central banks acquired large chunks of government bonds and to a smaller extent asset-backed securities, covered bonds and corporate bonds.
In terms of liabilities, from the start of the EMU the Eurosystem overall functioned as a *Bankers’ banker*. National central banks primarily funded themselves through financial intermediaries. To steer and manage economic and financial conditions, the ECB mainly targets its operations through financial intermediaries with banknotes in circulation and deposits of banks as counterparts of the asset operations (see, e.g., Reichlin et al, 2010). Overall, developments in the composition of the balance sheet of the Eurosystem, both for assets and liabilities, are fairly dense, i.e. changes in the configurations are relatively small and in the same classification. This may be an indication of equal and symmetric distribution of monetary policy across the euro area.

However, the graphs of the regional central bank balance sheet composition illustrate that the aggregate balance sheet of the Eurosystem masks significant idiosyncrasies and asymmetries across member states. A first noticeable observation is the vastly different starting points of the balance sheet configurations. From the launch of the EMU, the distribution of assets and liabilities is widely dispersed. For instance, the central bank assets in Greece, Italy and Portugal comprise mostly government bond holdings (G) whereas, on the other hand, the central banks of Luxembourg and Germany are chiefly *private sector lenders* (L). Supposedly, the launch of the EMU should have resolved asymmetries vis-à-vis member states yet the distribution of assets and liabilities on regional central bank balance sheets frequently move in opposite direction.

As a reaction to the crisis, and in order to reduce heterogeneity in financial markets among member states, the ECB introduced a wide variety of balance sheet policies. Even though the ECB’s operations may have reduced heterogeneity in financial markets (see, e.g., Praet, 2012), the configuration of central bank balance sheets became more dispersed across the euro area. The initial crisis response of the ECB managed to push central bank activity in a similar direction as policy challenges were fairly even across the union. Whereas during the sovereign debt crisis, the composition of central bank balance sheets strongly diverged. Liquidity interventions of the ECB were specifically targeted peripheral countries, creating a north-south divide. By contrast, a relative convergence in balance sheet composition reappears with the introduction of the Expanded Asset Purchasing Program (EAPP). Under the EAPP, the ECB purchased a large quantity of government bonds (G), and to a smaller extent euro denominated asset-backed securities, covered bonds and, as of the second quarter of 2016, corporate bonds. From March 2015 until March 2016 this average monthly figure amounted to €60 billion. In
spite of the EAPP, the composition of asset holdings recorded fairly even increases in the share of government bond holdings (G) as opposed to private sector lending (L).

[Insert Figures 8 and 9]

From figure 7 and 8, it is clearly detected that the distribution of assets and liabilities on the balance sheet of Reserve Banks in the US behaves more homogenous through time than it does for central banks in the euro area. While the composition of balance sheets remains fairly stable in the pre-crisis period (2002-2006), notable changes are observed since the emergence of the crisis from 2007 onwards. However, overall changes in the composition of balance sheet of Reserve Banks are in the same direction, which is in stark contrast with the diversity in balance sheet changes in the euro area. This is exemplified by the marked movement southwards of assets in 2008. After the fall of Lehman, the Federal Reserve introduced the Term Auction Facility (TAF). Through the TAF, the Fed auctioned term funds to depository institutions to alleviate elevated pressures in short-term funding markets. Not only was the TAF open for domestic depository institutions, through the TAF also foreign depository institution could receive dollar lending when refinancing of their dollar-denominated holdings was troubled. The TAF was executed in coordination foreign counterparties, i.e. the Bank of Canada, the Bank of England, the European Central Bank, and the Swiss National Bank.

After 2009, the Fed implemented a more active management of liquidity conditions through its Quantitative Easing (QE) programs. As a consequence, the composition of the twelve Reserve Banks moved in similar direction towards domestic private sector lending. In total, the Fed conducted three rounds of QE. In these round of quantitative easing, the Fed purchased unprecedented amounts of domestic bank debt, mortgage-backed securities, and Treasury securities. These securities were mainly purchased from banks and other financial intermediaries, and thus resulted in an increase in its liabilities to domestic depository institutions. Consistent to this, as of 2008 all Reserve Banks were classified as Bankers’ Banker whereas prior to the crisis the Federal Reserve System mainly resorted to controlling liquidity via Federal Reserve notes (i.e. Note Issuer).
4.3 Concentration of central bank balance sheet composition

Figure 10 demonstrates the dispersion in regional central bank balance sheet composition within the Eurosystem from a pre-crisis (2006) to a post-crisis (2015) perspective, and figure 11 does the same for the Federal Reserve System. These graphs illustrate the relative concentration of balance sheet configurations, both before non-standard balance sheet policies were deployed, and after. A reduction of heterogeneity between member states or districts in spite of the liquidity interventions by central banks, may thus result in an increased density of central bank balance sheet configurations.

[Insert Figures 10 and 11]

In terms of relative distribution of assets, a noticeable difference is observed between the two currency unions. Prior to the crisis, the configuration of central bank assets across the euro area was heavily dispersed. The systematic classification ranged from *Foreign Exchange Holder* (central bank of Portugal), with holdings of foreign-currency denominated assets mostly comprising government bonds, to *Private Sector Lender* (central banks of Austria and Luxembourg). For the most part, this polarization reversed with the introduction of the non-standard balance sheet policies of the ECB. Especially the Expanded Asset Purchasing Program (EAPP) resulted in a strong convergence in the relative distribution of central bank assets. Under the EAPP, the ECB purchased large amounts of government bonds from all of its member states to reduce tensions on sovereign debt markets.

While the dispersion of central bank asset holdings in the euro area reduced in spite of the non-standard monetary policy of the ECB, the dispersion is still considerably than it is in the United States. Both before and after the crisis, the inter-district concentration of central bank asset holdings is much higher among Reserve Banks. Before the fall of Lehman Brothers in 2008, the outright assets holdings of the Reserve Banks comprised for the most part dollar-denominated government debt (Treasury bills, notes and bonds). Whereas, after the global financial fallout, and especially upon the large scaled asset purchasing programs of the Fed, the Reserve Banks traded government debt for domestic private sector lending. The increase in private sector lending was a result of the prolonged disruption of financial markets which called upon increased intervention by the Federal Reserve.
In terms of the composition of central bank liabilities, again the dispersion is higher in the euro area. In general, national central banks within the Eurosystem moved more towards Bankers’ Banker after the global financial fallout, only notable exceptions are the central banks of Ireland and Greece which moved in opposite direction. Turning to the Federal Reserve System, prior to the crisis the Reserve Banks funded their asset operations by issuing more notes and bonds, i.e. the Reserve Banks were classified as Note Issuers. Since the global financial fallout, however, the increased asset purchases were primarily from financial intermediaries (i.e. the Reserve Banks turned into Bankers’ Bankers). In all, considerably more uniformity is documented in the composition of regional balance sheets within the Federal Reserve System compared to the Eurosystem.

5. Heterogeneity in balance sheet composition

As shown in the previous section, the design of central bank balance sheets varied greatly over time and across regions. In this section, quantitative measures aimed at capturing overall heterogeneity and coherence in balance sheet composition within a monetary union are presented. First, section 5.1 presents metrics to gauge overall heterogeneity. Second, section 5.2 demonstrates the measures for the coherence in the changes in balance sheet composition. Finally, section 5.3 discusses the results.

5.1 Metrics for heterogeneity

If the composition of central bank balance sheets in a monetary union converged over time, i.e. a reduction in heterogeneity, this can be taken as evidence that monetary policy is distributed more evenly across regions. Using the disaggregated balance sheets of the Federal Reserve and the Eurosystem, we compute two empirical metrics for the heterogeneity in regional balance sheets. First, we create Euclidean distances as a measure for total bilateral (dis)similarity over the plane \([G/L – (G+L)/FX – RG/Rs – (Rg+Rs)/Bn]\). The Euclidean distance is a convenient and widely appreciated mathematical tool to measure the distance between two points in Euclidean plane over \(n\)-dimensions. As we have four dimensions, the measure is described as:

\[
d_i(g_l, g_f x, r_g r_s, r_g r_s b_n) = \sqrt{\sum_{i=1}^{j} \sum_{j=1}^{j} (g_{l i} - g_{l j})^2 + (g_{f x i} - g_{f x j})^2 + (r_{g r s i} - r_{g r s j})^2 + (r_{g r s b n i} - r_{g r s b n j})^2}
\]
In which the distances between country $i$ and country $j$ are quadrated and summed. Here $I$ and $J$ equal 12, and reflect the number of member states (districts) in the euro area (United States). Our reasoning for the choice to keep the composition of member states fixed as of 2001 is twofold. First, the fixed composition reassures that we have an identical number of regions in both monetary unions. Second, the fixed composition avoids that the metrics become cluttered with very diverse developments in the composition of balance sheets due to the entrance of relatively small member states.

All Euclidean distances are stored in a 12x12 matrix $D_t$ in year $t$. Of this matrix $D_t$ we only consider the lower triangular in order to avoid double counting of the quadrated deviations. Furthermore, we remove all Euclidean distances of a country w.r.t. itself (e.g., AT-AT). To derive one measure for the heterogeneity in balance sheet composition, all remaining elements in the matrix will be averaged over the number of remaining elements. In addition, the Euclidean distances for assets $[G/L-(G+L)/FX]$ and liabilities $[RG/Rs-(Rg+Rs)/Bn]$ are computed separately, as it may reveal the cause of a potential growing heterogeneity in balance sheet configuration.

The second measure for overall heterogeneity encompasses cross-sectional standard deviations of the shares of balance sheet items in relation to total assets and liabilities. This measure captures the relative convergence (divergence) of the shares of components of central bank balance sheet towards (from) other central banks. To this end we calculate:

$$c_t = \sqrt{\sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{h=1}^{H} (a_{i,t,h} - a_{j,t,h})^2}$$

In which $a$ denotes the share of balance sheet item $h$ in relation to total assets or liabilities for country $i$ in year $t$. Here $H$ refers to all items of the schematic balance sheet of table 1. Again all deviations are quadrated and summed over the 12 member states and districts (i.e. $I$ and $J$ equal 12). All deviations are captured in a 12 x 12 matrix $C_t$ in time $t$, which we decompose in the same way as the dissimilarity matrix $D_t$. An advantage of this measure over the metric for (dis)similarity is the ability to include all balance sheet items. For example, in the measure for
(dis)similarity we exclude inter-regional settlements\(^7\) between central banks which may be very informative for the redistributive effects of monetary policy.

The interpretation of the two metrics is identical. If the composition of central bank balance sheets becomes more dispersed, heterogeneity increases among regions. This increase in heterogeneity is reflected by a rise in the dissimilarity and cross-sectional deviations. Ideally, for a smooth transmission of monetary transmission and an even distribution of accommodative monetary policy across regions the central bank would want to keep heterogeneity in the composition of regional central bank balance sheets to a minimum.

5.2 Coherence in balance sheet composition

Next to the two measures for heterogeneity in balance sheet composition, an additional two measures will be constructed to capture the coherence in balance sheet composition through time. While the former two measures gauge the dispersion in balance sheet design, the latter measures for coherence will actually assess the overall synchronicity and similarity of changes in the composition of regional central bank balance sheets. The techniques are borrowed from the credit cycle literature (see, e.g., Mink et al, 2012).

Let \(d a_{i,h}(t)\) denote the first difference of the share of balance sheet item \(h\) in relation to total assets or liabilities in country (district) \(i\) in the euro area (US) for time \(t\). Furthermore, let \(d a_{g,h}(t)\) denote the first difference of the same share of central bank \(g\) for time \(t\). Here \(g\) refers to the Eurosystem (again in fixed composition) or Federal Reserve System. However, the correlation between \(d a_{i,h}(t)\) and \(d a_{g,h}(t)\) may be high if one country (district) is the main contributor to the central bank, as is the case with the Bundesbank (Federal Reserve of New York). To avoid having a high correlation of \(d a_{i,h}(t)\) with \(d a_{g,h}(t)\), the balance sheet items contribution of country (district) \(i\) will be removed from the total of central bank \(g\).

Synchronicity between the change in the composition of balance sheet items in country/district \(i\) and the EMU reference at time \(t\) is defined as the product of the country \(i\) and EMU change in composition, scaled by the absolute value of this product:

\(^7\) The inter-regional settlements refer to Target (ISA) for the euro area (US). These settlements are netted on the balance sheet of individual Reserve Banks. For comparison, Target accounts are also netted.
This measure provides an indication of synchronicity in balance sheet composition and equals 1 if the composition of the entire balance sheet in country/district i moves in the same direction as the EMU/FED reference, and equals -1 when they move in opposite directions. The measure can easily be transformed to assess overall synchronicity in the region, and is computed by:

\[ \eta_i(t) = \frac{d a_{i,h}(t) d a_{g,h}(t)}{|d a_{i,h}(t) d a_{g,h}(t)|} \]

The measure for synchronicity is defined on a [-1, 1] scale. In case of full synchronicity of changes in balance sheet composition, the measure equals 1. By contrast, the measure will equal -1 when the change in balance sheet composition in all countries/districts are split in half, with one half moving in one direction and the other half in opposite direction.

While high correlation in the direction of changes in balance sheet composition results in a high synchronicity, this does not preclude that changes are of the same magnitude. To capture the harmony in amplitudes of changes in balance sheet composition, a measure for similarity will be defined by:

\[ \gamma_i(t) = 1 - \frac{|d a_{i,h}(t) - d a_{g,h}(t)|}{\frac{1}{n} \sum_{i=1}^{n} |d a_i(t)|} \]

This measure is defined on a scale [1-\(n\), 1]. In case of full similarity, i.e. the change of balance sheet composition in country/district i is identical to the union reference, the measure will equal 1. That is, the changes are identical and perfectly synchronized. As for the measure of synchronicity, this measure can easily be transformed to assess overall similarity in the region, and is computed by:
\[ \gamma(t) = 1 - \frac{\left| da_{i,h}(t) - da_{g,h}(t) \right|}{\frac{1}{n} \sum_{i=1}^{n} \left| da_{i,h}(t) \right|} \]

This measure equals 1 if the change in balance sheet composition in all countries are identical to each other, which would result in a perfectly smooth transmission and equal distribution of monetary policy across regions in a currency union.

5.3 Results

The top panels of figure 12 show the average dissimilarity in balance sheet composition. This figure displays the overall dispersion in bilateral distances. Indeed, these graphs confirm that the configuration of Reserve Banks’ balance sheets behave more homogenous through time than for national central banks in the euro area. Over fairly the entire sample, total dissimilarity in balance sheet composition is higher in the euro area.

With respect to regional central banks in the euro area one can distinguish three periods. First, in the years prior to the crisis the dissimilarity was relatively low and stable. Second, from the start of the crisis overall dissimilarity increased with a major peak during the European sovereign debt crisis. The crisis period played out vastly different on the balance sheets of national central banks, as liquidity operations of the ECB were mainly tapped by financially distressed countries which mainly consisted of peripheral countries. This created a general divergence in the composition of central bank balance sheets. To sidestep the general divergence, in the early phase of the crisis (i.e. 2007-2008) the asset configuration actually converged as policy challenges were very similar across regions. However, the funding of these operations differed vastly. Similar developments were present in 2011. Finally, total dissimilarity in the design of central bank balance sheets decreased persistently after the acute phase of the European sovereign debt crisis as balance sheets were more homogenously restructured in terms of balance sheet policies.

[Insert Figure 12]
Turning to the dissimilarity in balance sheet composition within the Federal Reserve System in the United States, fairly stable configurations are displayed throughout the sample. Two interesting features stand out. First, the dissimilarity in the distribution of liabilities is extremely low, and very close to zero. This implies that the way Reserve Banks fund themselves is almost identical. Throughout the sample, Reserve Banks chiefly financed themselves via the issuance of Federal Reserve notes, reverse purchase agreements with financial intermediaries, and other deposits held by depository institutions. The latter of these items primarily consists of reserve balances and service-related balances, and was the main contributor to central bank liabilities since the start of the crisis (see figure 4). Second, the fairly stable dissimilarity in the distribution of assets was substantially disrupted in 2007-2008 as the composition of balance sheets strongly converged across regions. In the United States, the initial crisis response of the Federal Reserve during the early phase of the global financial fallout played out relatively even on the balance sheets of individual Reserve Banks. Yet, even though dissimilarity increased thereafter, total dissimilarity has been considerably lower in the US over time in comparison to the euro area.

This picture is confirmed when considering the cross-sectional deviations (bottom panels of figure 12). Once more, the uniformity in the developments of balance sheet composition is depicted by lower cross-sectional standard deviations. That is, the shares of balance sheet items of Reserve Banks are more similar to each other than those of the national central banks in the euro area. However, one marked exception stands out. Heterogeneity in the composition of balance sheets of Reserve Banks increased substantially during 2008-2009, and was considerably higher in this period than in the euro area. The reasoning for the increase is twofold. First, by the end of 2007 the Fed opened the Term Auction Facility (TAF) together with other major central banks. Through the TAF, the Fed and the other central banks provided liquidity to domestic and foreign depository institutions (in domestic currency). The liquidity was mainly tapped in 2008. However, the distribution of TAF-liquidity was not equally distributed across districts, at the same time leading to a divergence in inter-regional settlements (ISA). Second, in 2009 the Fed purchases unprecedented amounts of Mortgage-Backed Securities (MBS) to reduce financial distortions. As a consequence, in some districts the balance sheet of the Reserve Bank now mainly comprised MBS-holdings. And as the measure for cross-sectional deviation picks up the deviation in the share of balance sheet items with respect to the total size of individual regions with respect to others, the outlier of one
Reserve Bank causes a peak in cross-section deviations. These two breakdowns are not part of the dissimilarity measure, and thus only show up in the cross-sectional deviations.

Tables 5 and 6 display the measure for coherence in balance sheet changes. As figure 12 shows that considerably more uniformity is present in the United States, it is interesting to examine whether this uniformity also translates in higher synchronicity and similarity of changes in the composition of central bank balance sheets. Table 5 shows the mean synchronicity in the composition of (1) the total balance sheet, (2) assets, and (3) liabilities. In terms of the total balance sheet, the synchronicity is almost twice as high in the United States as in the euro area. Most of this high synchronicity stems from the changes in the composition of liabilities, as generally the distribution of liabilities moves in the same direction across Reserve Banks. Another interesting feature is the fact that the measures for synchronicity are exclusively positive in the United States while there are negative measures calculated in the euro area. In particular, the composition of the total balance sheet moves in opposite direction for the central banks of Ireland and the Netherlands in comparison to the EMU reference (which excludes the holdings and liabilities of the respective central bank).

Table 6 shows the mean similarity in the composition of (1) the total balance sheet, (2) assets, and (3) liabilities. In terms of similarity, the difference between the United States and the euro area is even more pronounced. All three measures for similarity of balance sheet composition are positive in the United States, and negative in the euro area. This implies that, on average, the change in the composition of balance sheets is in opposite direction of other central banks and of a different magnitude. The highest dissimilarity is found to be for the central banks of Greece and Portugal, which both suffered the most from financial distress, while the changes in balance sheet composition are most similar for the central banks of Germany and Spain. In all, the changes in the composition of regional central bank balance sheets appear to be highly dissimilar in the euro area. By contrast, the redistributive effects of monetary policy are found to be more similar in the United States. In this respect, the Federal Reserve System has already gained valuable experience in managing the balance sheet for a smooth transmission and fairly even distribution of monetary policy across districts.
6. Conclusion

The central bank balance sheet is crucial in understanding the transmission and redistributive effects of monetary policy, as changes in the distribution of assets and liabilities have direct consequences for the functioning of the economy and financial markets. While a snapshot of the consolidated balance sheet in monetary unions can provide valuable information on the policy goals, to fully understand the transmission, distribution and effectiveness of monetary policy across regions the evolution of regional central bank balance sheets need to be observed. In this paper we presented a novel harmonized database for a disaggregated balance sheet of the Eurosystem and the Federal Reserve System in order to explore the regional asymmetries in balance sheet composition over time.

In the empirical application we find that for the euro area developments in the composition of regional central bank balance sheets are less synchronous than in the United States, while more synchronicity is observed towards the end of our sample. In fact, the more diverse policy challenges became in the euro area the more divergence we observe in the composition of central bank balance sheets. By contrast, the redistributive effects of monetary policy in the United States remained fairly stable as balance sheet policies by the Fed resulted in very similar changes in size and composition of Reserve Banks’ balance sheets. We also examined the overall heterogeneity in the developments of balance sheet configuration. The low level of synchronicity in developments in the composition of regional central bank balance sheets within the Eurosystem directly translated into more heterogeneity over time. Especially during the European sovereign debt crisis, idiosyncrasies and asymmetries in the development of regional balance sheets resurfaced.
References


### Table 1: Schematic balance sheet of the Eurosystem

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gold and gold receivables</td>
<td>1. Banknotes in circulation</td>
</tr>
<tr>
<td>2. Claims on non-euro area residents denominated in foreign currency</td>
<td>2. Liabilities to euro area credit institutions related to monetary policy operations denominated in euro</td>
</tr>
<tr>
<td>2.1 Receivables from the IMF</td>
<td>2.1 Current accounts (covering the minimum reserve system)</td>
</tr>
<tr>
<td>2.2 Balances with banks and security investments, external loans and other external assets</td>
<td>2.2 Deposit facility</td>
</tr>
<tr>
<td>3. Claims on euro area residents denominated in foreign currency</td>
<td>2.3 Fixed-term deposits</td>
</tr>
<tr>
<td>4. Claims on non-euro area residents denominated in euro</td>
<td>2.4 Fine-tuning reverse operations</td>
</tr>
<tr>
<td>4.1 Balances with banks, security investments and loans</td>
<td>2.5 Deposits related to margin calls</td>
</tr>
<tr>
<td>4.2 Claims arising from the credit facility under ERM II</td>
<td></td>
</tr>
<tr>
<td>5. Lending to euro area credit institutions related to monetary policy operations denominated in euro</td>
<td>3. Other liabilities to euro area credit institutions denominated in euro</td>
</tr>
<tr>
<td>5.1 Main refinancing operations</td>
<td>4. Debt certificates issued</td>
</tr>
<tr>
<td>5.2 Longer-term refinancing operations</td>
<td></td>
</tr>
<tr>
<td>5.3 Fine-tuning reverse operations</td>
<td>5. Liabilities to other euro area residents denominated in euro</td>
</tr>
<tr>
<td>5.4 Structural reverse operations</td>
<td>5.1 General government</td>
</tr>
<tr>
<td>5.5 Marginal lending facility</td>
<td>5.2 Other liabilities</td>
</tr>
<tr>
<td>5.6 Credits related to margin calls</td>
<td>6. Liabilities to non-euro area residents denominated in euro</td>
</tr>
<tr>
<td>6. Other claims on euro area credit institutions denominated in euro</td>
<td>7. Liabilities to euro area residents denominated in foreign currency</td>
</tr>
<tr>
<td>7. Securities held for monetary policy purposes</td>
<td>8. Liabilities to non-euro area residents denominated in foreign currency</td>
</tr>
<tr>
<td>7.2 Other securities</td>
<td>8.1 Deposits, balances and other liabilities</td>
</tr>
<tr>
<td>8. General government debt denominated in euro</td>
<td>8.2 Liabilities arising from the credit facility under ERM II</td>
</tr>
<tr>
<td>9. Intra-Eurosystem claims</td>
<td>9. Counterpart of special drawing rights allocated by the IMF</td>
</tr>
<tr>
<td>9.1 Participating interest in the ECB</td>
<td>10. Intra-Eurosystem liabilities</td>
</tr>
<tr>
<td>9.2 Claims equivalent to the transfer of foreign reserves</td>
<td>10.1 Liabilities equivalent to the transfer of foreign reserves</td>
</tr>
<tr>
<td>9.3 Claims related to the issuance of ECB debt certificates</td>
<td>10.2 Liabilities related to the issuance of ECB debt certificates</td>
</tr>
<tr>
<td>9.4 Net claims related to the allocation of euro banknotes within the Eurosystem</td>
<td>10.3 Net liabilities related to the allocation of euro banknotes within the Eurosystem</td>
</tr>
<tr>
<td>9.5 Other claims within the Eurosystem</td>
<td>10.4 Other liabilities within the Eurosystem (net)</td>
</tr>
<tr>
<td>10. Items in course of settlement</td>
<td>11. Items in course of settlement</td>
</tr>
<tr>
<td>11. Other assets</td>
<td>12. Other liabilities</td>
</tr>
<tr>
<td>11.1 Coins of euro area</td>
<td>12.1 Off balance sheet instruments’ revaluation differences</td>
</tr>
<tr>
<td>11.2 Tangible and intangible fixed assets</td>
<td>12.2 Accruals and income collected in advance</td>
</tr>
<tr>
<td>11.3 Other financial assets</td>
<td>12.3 Sundry</td>
</tr>
<tr>
<td>11.4 Off balance sheet instruments’ revaluation differences</td>
<td>13 Provisions</td>
</tr>
<tr>
<td>11.5 Accruals and prepaid expenses</td>
<td>14 Revaluation accounts</td>
</tr>
<tr>
<td>11.6 Sundry</td>
<td>15 Capital and reserves</td>
</tr>
</tbody>
</table>

Note: Intra-Eurosystem claims and liabilities items are netted within the Eurosystem and are thus absent on the Eurosystem balance sheet. In line with the “Explanatory note accompanying the disaggregated Eurosystem financial statement” of the ECB, over- and under-reporting in A11 (Other assets) is offset against Intra-Eurosystem claims. By the same token, over- and under-reporting in L12 (Other liabilities), L14 (Revaluation accounts) and L15 (Capital and reserves) is offset against Intra-Eurosystem liabilities.
### Table 2: Classification of Eurosystem balance sheet items

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX 1. Gold and gold receivables</td>
<td>Bn 1. Banknotes in circulation</td>
</tr>
<tr>
<td>2. Claims on non-euro area residents denominated in foreign currency</td>
<td></td>
</tr>
<tr>
<td>3. Claims on euro area residents denominated in foreign currency</td>
<td></td>
</tr>
<tr>
<td>4. Claims on non-euro area residents denominated in euro</td>
<td></td>
</tr>
<tr>
<td>11. Other assets</td>
<td></td>
</tr>
<tr>
<td>L 5. Lending to euro area credit institutions related to monetary policy operations denominated in euro</td>
<td>Rs 2. Liabilities to euro area credit institutions related to monetary policy operations denominated in euro</td>
</tr>
<tr>
<td>6. Other claims on euro area credit institutions denominated in euro</td>
<td>3. Other liabilities to euro area credit institutions denominated in euro</td>
</tr>
<tr>
<td>7. Securities of euro area residents denominated in euro -CBPP</td>
<td>4. Debt certificates issued</td>
</tr>
<tr>
<td>G 8. General government debt denominated in euro</td>
<td>Rg 5. Liabilities to other euro area residents denominated in euro -General Government</td>
</tr>
<tr>
<td>7. Securities of euro area residents denominated in euro -SMP -PSPP -Other securities than SMP, PSPP, and CBPPs</td>
<td></td>
</tr>
</tbody>
</table>

Note: For the best fit with the categories, the classification utilizes a selection of all items on the balance sheet of the Eurosystem.

### Table 3: Classification of Fed balance sheet items

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX Gold certificate account</td>
<td>Bn Federal reserve notes</td>
</tr>
<tr>
<td>SDR account</td>
<td></td>
</tr>
<tr>
<td>Central bank liquidity swaps</td>
<td></td>
</tr>
<tr>
<td>Foreign currency denominated assets</td>
<td></td>
</tr>
<tr>
<td>Coin</td>
<td></td>
</tr>
<tr>
<td>Other assets</td>
<td></td>
</tr>
<tr>
<td>L Mortgage-backed securities</td>
<td>Rs Term deposits held by depository institutions</td>
</tr>
<tr>
<td>Repurchase agreements</td>
<td>Other deposits held by depository institutions</td>
</tr>
<tr>
<td>Loans</td>
<td></td>
</tr>
<tr>
<td>Unamortized premiums (net, minus discounts)</td>
<td></td>
</tr>
<tr>
<td>Net portfolio holdings of Maiden LLC</td>
<td></td>
</tr>
<tr>
<td>G US Treasury securities</td>
<td>Rg US Treasury, general account</td>
</tr>
<tr>
<td>Federal agency debt securities</td>
<td>Foreign official</td>
</tr>
<tr>
<td></td>
<td>Other deposits</td>
</tr>
<tr>
<td></td>
<td>Earnings remittances due to the US Treasury</td>
</tr>
<tr>
<td></td>
<td>Other liabilities and accrued dividends</td>
</tr>
</tbody>
</table>

Note: See Table 2.

### Table 4: Relative distribution of assets and liabilities

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic or foreign exchange holder $\frac{(G + L)}{FX}$</td>
<td>Note issuer or banker $\frac{(Rg + Rs)}{Bn}$</td>
</tr>
<tr>
<td>Treasury holder or private sector lender $\frac{G}{L}$</td>
<td>Government’s or bankers’ banker $\frac{Rg}{Rg}$</td>
</tr>
</tbody>
</table>
### Table 5: Synchronicity of changes in balance sheet composition

<table>
<thead>
<tr>
<th></th>
<th>Eurosystem</th>
<th>Federal Reserve System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Assets</td>
</tr>
<tr>
<td>Austria</td>
<td>0.273</td>
<td>0.257</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.248</td>
<td>0.171</td>
</tr>
<tr>
<td>Germany</td>
<td>0.230</td>
<td>0.186</td>
</tr>
<tr>
<td>Greece</td>
<td>0.087</td>
<td>0.029</td>
</tr>
<tr>
<td>Spain</td>
<td>0.317</td>
<td>0.214</td>
</tr>
<tr>
<td>Finland</td>
<td>0.068</td>
<td>0.043</td>
</tr>
<tr>
<td>France</td>
<td>0.242</td>
<td>0.257</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.025</td>
<td>-0.014</td>
</tr>
<tr>
<td>Italy</td>
<td>0.155</td>
<td>0.171</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.093</td>
<td>0.057</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-0.019</td>
<td>0.071</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.062</td>
<td>0.029</td>
</tr>
<tr>
<td>EU</td>
<td>0.144</td>
<td>0.123</td>
</tr>
</tbody>
</table>

Note: The table displays means of individual countries (districts) and EMU (US)-wide synchronicity in balance sheet developments over the sample 2002-2015 (2003-2015). The total synchronicity refers to the change in all balance sheet items (assets and liabilities). P-values: ***p<0.01, **p<0.5, *p<0.1, for two-sided test of the mean difference of synchronicity between assets/liabilities with respect to the total synchronicity.

### Table 6: Similarity of changes in balance sheet composition

<table>
<thead>
<tr>
<th></th>
<th>Eurosystem</th>
<th>Federal Reserve System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Assets</td>
</tr>
<tr>
<td>Austria</td>
<td>-0.113</td>
<td>-0.250</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.310</td>
<td>-0.106</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.066</td>
<td>-0.026</td>
</tr>
<tr>
<td>Greece</td>
<td>-0.698</td>
<td>-1.218**</td>
</tr>
<tr>
<td>Spain</td>
<td>-0.091</td>
<td>-0.317*</td>
</tr>
<tr>
<td>Finland</td>
<td>-0.332</td>
<td>-0.293</td>
</tr>
<tr>
<td>France</td>
<td>-0.404</td>
<td>-0.192*</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.430</td>
<td>-0.499</td>
</tr>
<tr>
<td>Italy</td>
<td>-0.188</td>
<td>-0.202</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>-0.206</td>
<td>-0.141</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-0.385</td>
<td>-0.294</td>
</tr>
<tr>
<td>Portugal</td>
<td>-0.573</td>
<td>-0.485</td>
</tr>
<tr>
<td>EU</td>
<td>-0.316</td>
<td>-0.335</td>
</tr>
</tbody>
</table>

Notes: see notes of table 5.
Figure 1: Central bank balance sheets in the euro area, assets (€mlns)

Legend Assets

- Gold and gold receivables
- Claims on non-euro area residents denominated in foreign currency
- Claims on euro area residents denominated in foreign currency
- Claims on non-euro area residents denominated in euro
- Lending to euro area credit institutions related to monetary policy operations denominated in euro
- Other claims on euro area credit institutions denominated in euro
- Securities of euro area residents denominated in euro
- General government debt denominated in euro
- Other assets
- Intra-Eurosystem Claims
Figure 2: Central bank balance sheets in the euro area, liabilities (€ mlns)

Legend Liabilities
- Banknotes in circulation
- Liabilities to euro area credit institutions related to monetary policy operations denominated in euro
- Other liabilities to euro area credit institutions denominated in euro
- Debt certificates issued
- Liabilities to other euro area residents denominated in euro
- Liabilities to non-euro area residents denominated in euro
- Liabilities to euro area residents denominated in foreign currency
- Liabilities to non-euro area residents denominated in foreign currency
- Counterpart of special drawing rights allocated by the IMF
- Other liabilities
- Revaluation accounts
- Capital and reserves
- Intra-Euros system liabilities
Figure 3: Central bank balance sheets in the United States, assets (\$ mlns)

Federal Reserve System

Boston

Note: We have excluded ISA positions as they appear only on one side of the balance sheet, i.e. it reflects net position on the asset side, which may include negative amounts (these are classified as gross liabilities for the Eurosystem).

Legend Assets

- Gold certificate account
- Special drawing rights certificate account
- Coin
- U.S. Treasury securities: Bills
- U.S. Treasury securities: Notes and bonds
- Federal agency debt securities
- Mortgage-backed securities
- Unamortized premiums (net)
- Repurchase agreements
- Loans
- Net portfolio holdings of Maiden Lane LLC
- Items in process of collection
- Bank premises
- Central bank liquidity swap
- Foreign currency denominated assets
- Other assets
Figure 4: Central bank balance sheets in the United States, liabilities ($ mlns)

Legend Liabilities

- Federal Reserve notes, net
- Reverse purchase agreements
- Term deposits held by depository institutions
- Other deposits held by depository institutions
- U.S. Treasure, General Account
- Foreign official
- Other
- Deferred availability cash items
- Earnings remittances due to the U.S. Treasury
- Other liabilities and accrued dividends
- Capital
Figure 5: Indicator-based taxonomy, assets and liabilities

Assets

Liabilities
Figure 6: Indicator-based taxonomy for the Eurosystem, assets
Note: graphs for ECB, LT and LV are removed from the figure. The ECB has no liabilities to the government, and only occasionally to the banking sector, and thus ends up with 0 positions. For convenience, and saving space, we have removed the ECB from the graphs. The graphs of Lithuania and Latvia are removed due to the limited time spent in the Eurozone. The three graphs are available upon request.
Figure 7: Indicator-based taxonomy for the Eurosystem, liabilities
Note: See notes on figure 5.
Figure 8: Indicator-based taxonomy for the Federal Reserve System, assets

G+L/FX
Atlanta

Chicago

St. Louis

Minneapolis

Kansas City

Dallas

San Francisco
Figure 9: Indicator-based taxonomy for the Federal Reserve System, liabilities
Figure 10: Indicator-based taxonomy for the Eurosystem, 2006 vs 2015

Note: in the upper-left panel the ECB is removed from the graph as it had no domestic assets, i.e. G and L are both 0.

1 AT = Austria, BE = Belgium, CY = Cyprus, DE = Germany, EA = Euro Area total, ECB = European Central Bank, EL = Greece, ES = Spain, EST = Estonia, FI = Finland, FR = France, IE = Ireland, IT = Italy, LT = Lithuania, LU = Luxembourg, LV = Latvia, MT = Malta, NL = the Netherlands, PT = Portugal, SI = Slovenia, SK = Slovakia.
Figure 11: Indicator-based taxonomy for the Federal Reserve System, 2006 vs 2015

Note: in the upper-left panel all other districts (10, see arrow) are in the upper right corner as the ratio exceeded 100, and in the upper-right panel 9 districts are in the middle of the consolidated Fed and the Federal Reserve of Cleveland.

1 ATL = Atlanta, BOS = Boston, CHI = Chicago, CLE = Cleveland, DAL = Dallas, KC = Kansas City, MIN = Minneapolis, NY = New York, PHI = Philadelphia, RI = Richmond, SF = San Francisco, STL = St. Louis
Figure 12: Heterogeneity in balance sheet composition

Bilateral Dissimilarity

Cross-sectional Standard Deviation

Note: the lines are assets (blue), liabilities (green), and total (black).
Data Appendices

Appendix A: Reconciliation of the data

The following justifies, and provides more details on, the reconciliations within our dataset. As domestic accounting standards differ from the one followed by the European Central Bank (ECB) we observed substantial mismatches between the reporting by national central banks and the Eurosystem. After carefully documenting and examining all series from the annual reports of NCBs, we performed a large set of adjustments to achieve maximum harmonization. All adjustments are addressed per individual item and country. To reassure that the information from the annual reports is trustworthy, we perform an additional check with the disaggregated balance sheet published by the ECB as of August 2016 and with Datastream. Our database proved to be a good match with these databases.

Before turning to the individual reconciliation, one general remark on the 2007 Eurosystem accounts: In the process of harmonization we noticed that the 2008 balance sheet of the Eurosystem, which also includes a reflection on 2007, proved to be a better fit with the 2007 balance sheets of the national central banks. The 2008 annual report seems to have corrected for mismatches, most likely due to the entrance of Slovenia in 2007.

Assets

1. Gold and gold receivables

   *Eurosystem, 2007.* Mismatch between 2007 and 2008 reports on the 2007 totals. We have used the 2008 report for the best match. Difference (€29 mln) may be caused by the entry of Slovenia to the Eurozone in 2007 corrected for in the 2008 annual report.

2. Claims on non-euro area residents denominated in foreign currency

   (Sub-items: 2.1 Receivables from the IMF; 2.2 Balances with banks and security investments, external loans and other external assets)


   *France, 1999-2015.* Due to national accounting standards, the Banque de France (BdF) reports two separate items containing claims on non-euro area residents denominated in foreign currency. The respective reporting by the BdF is as follows:

      A2 Foreign exchange assets (excl. relations with the IMF)
      2.1 Foreign exchange assets held with non-euro area residents
      2.2 Foreign exchange assets held with euro area residents
      A3 Relations with the IMF
      3.1 Financing provided to the IMF
      3.2 Acquisitions of Special Drawing Rights
To derive the harmonized series on the claims on non-euro area residents denominated in foreign currency, we have extracted both A2.1 and A3 from the report. Next we removed accrued interest receivable reported under these items. Interest receivable, in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks, is reported under item 11.5 (Accruals and prepaid expenses).

3. Claims on euro area residents denominated in foreign currency

*Euros system, 1999 and 2007.* Mismatch between 1999 and 2000 reports on the 1999 totals; and between the 2007 and 2008 reports. We have used the 2000 and 2008 report for the best match. Difference (1999: €27 mln, and 2007: €2 mln) may be caused by the start of the Euro Area in 1999 and the entry of Slovenia to the Eurozone in 2007, which appears corrected in the next annual report.

*France, 1999-2015.* See notes on item 2, we have extracted A2.2 and harmonized this data with claims on non-euro area residents denominated in foreign currency by simultaneously removing interest receivables and transferring these to item 11.5 (Accruals and prepaid expenses).

*Germany, 2008.* The 2008 financial statement of the Bundesbank originally included a post of around €18.4 bln related to foreign currency swap agreements (mainly in USD under the Term Auction Facility) for carrying out refinancing operations in foreign currency to domestic financial institutions. However, there was a mismatch of equal magnitude when consolidating the data with the Eurosystem. We encountered an almost identical mismatch on the liability-side (liability item 3: Liabilities to euro-area residents denominated in foreign currency). The Bundesbank has netted their positions before reporting to the ECB\(^8\). For this reason, we have left out the post of around €18.4 bln related to foreign currency swap agreements and did the same on the liability side.

4. Claims on non-euro area residents denominated in euro

(Sub-items: 4.1 Balances with banks, security investments and loans; 4.2 Claims arising from the credit facility under ERM II)

*All, 1999.* In the 1999 this item used to record claims on non-Eurosystem central banks arising from transactions made through the Trans-European Automated Real-time Gross settlement Express Transfer system (TARGET) payment system. The TARGET system is a platform for the clearing of cross-border settlements between National Central Banks (NCBs) and central banks located outside of the euro area. The system went live in 1999. We observed a substantial mismatch in the claims on non-euro area residents denominated in euro directly related to the TARGET accounts. In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks we have transferred all TARGET amounts to asset item 9 (Intra-Eurosystem Claims). In addition, for matching purposes we have assumed the TARGET accounts of the central bank of Portugal to be close to €2.4 bln. The central bank of Portugal delivers no specific reference to TARGET-claims. We therefore attributed the remaining mismatch to Portugal in relation to TARGET. Ireland, Luxembourg and the ECB are exempted here as the former two had TARGET-liabilities whilst the latter does not settle transactions through TARGET payment system.

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\(^8\) This has been confirmed by the statistics department of the Bundesbank after email correspondence.
France, 1999-2015. Over the years, the BdF has also reported interest receivables on non-euro area residents under this item. We have transferred these amounts to item 11.5 (Accruals and prepaid expenses) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

Ireland, 2002-2007. Over the course of 2002 to 2007, we observed an over-reporting by the Central Bank and Financial Services Authority of Ireland related to reverse purchase agreements provided to Eurosystem counterparties. We have cross-checked this item with Table A2 on the financial statement of the Central bank of Ireland from its website and with the financial database Datastream. For the purpose of harmonization we have transferred these reverse purchase agreements (2002: €697 mln, 2003: €1.3 bln, 2004: €702 mln, 2005: €267 mln, 2006: €324 mln, 2007: €485 mln) to item 11 (other assets).

Greece, 2002 and 2003. In the years 2002 and 2003 the total over-reporting of the NCBs and the ECB in comparison with the Eurosystem is exactly the amount reported by the Bank of Greece. These accounts (2002: €126 mln, 2003: €521 mln) only included balances with banks, security investments and loans. The Bank of Greece, unfortunately, did not provide comments on the annual accounts in these years. We therefore made the decision to transfer these amounts to item 7 (securities of euro area residents denominated in euro) as faced an under-reporting of exactly this amount under the respective heading.

Eurosystem, 2004. Mismatch between 2007 and 2008 report on 2007 amounts. We have used the 2007 report as it yielded a perfect fit, the remainder of €5 bln has been transferred to item 11 (other assets) in line with the 2007 financial statements.

5. Lending to euro area credit institutions related to monetary policy operations denominated in euro

(Sub-items: 5.1 Main refinancing operations; 5.2 Longer-term refinancing operations; 5.3 Fine-tuning reverse operations; 5.4 Structural reverse operations; 5.5 Marginal lending facility; 5.6 Credits related to margin calls)

France, 1999-2015. Over the years, the BdF has also reported interest receivables on non-euro area residents under this item. We have transferred these amounts to item 11.5 (Accruals and prepaid expenses) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks. In addition, we observed an under-reporting in 2002 related to item 5.5 (marginal lending facility). The marginal lending facility, one of the standing facilities of the ECB, is aimed to obtain overnight liquidity. It seems, however, that France has reported the liquidity obtained through the marginal lending facility under item 9 (intra-eurosystem claims) which happens once overnight funding is not settled the next day. We have adjusted this accordingly with a transfer of €210 mln from item 9. Furthermore, in 1999 the BdF seemed to have reported €32mln under fine-tuning reverse operations (item 5.3) but should be recorded under marginal lending facility (item 5.5); and the amount of €399 mln has been recorded under the marginal lending facility which should have been under item credits related to margin calls (item 5.6). We have made the corresponding adjustments.

Eurosystem, 2007. Mismatch between 2007 and 2008 reports on the 2007 totals. We have used the 2008 report for the best match. Difference (€3mln) may be caused by the entry of Slovenia to the Eurozone in 2007 corrected for in the 2008 annual report.

9 For the financial statement (Table A2) in xls-format, see the website of the Central bank of Ireland: http://www.centralbank.ie/polstats/stats/cnab/Pages/Money%20and%20Banking.aspx
6. Other claims on euro area credit institutions denominated in euro

_Eurosystem, 1999._ In the 2000 annual report on the 1999 financial statement we observed an under-reporting of €166 mln in other claims on euro area credit institutions denominated in euro. We were unable to retrieve this amount from the annual reports. Therefore, we decided to transfer the amount to item 11.3 (other financial assets) where it most likely to have been reported by NCBs instead.

_Ireland, 2004._ In 2004, we observed an over-reporting corresponding to the Central Bank and Financial Services Authority of Ireland related to reverse purchase agreements provided to Eurosystem counterparties. We have cross-checked this item with Table A2 on the financial statement of the Central bank of Ireland from its website and with the financial database Datastream. For the purpose of harmonization we have transferred these reverse purchase agreements at an amount of €197 mln to item 11 (other assets).

_ECB and Eurosystem, 2007._ Mismatch between 2007 and 2008 reports on the 2007 totals. We have used the 2008 annual report for the ECB and the Eurosystem to derive the best match. In the 2007 report money market deposits and current accounts held with euro area residents were recorded under this heading. After reclassification of these accounts as dedicated portfolio in 2008, the amount of €100 mln has been transferred to item 11.3 (other financial assets) for both the ECB and the Eurosystem.

_Malta, 2008._ In 2008 the total over-reporting of the NCBs and the ECB in comparison with the Eurosystem is exactly the amount reported by the central bank of Malta. These accounts only included fixed-term deposits consisting of balances with bank. We have transferred the amount of €164 mln to item 11 (other assets).

_Ireland and Eurosystem, 2009 and 2010._ The Central Bank and Financial Services Authority of Ireland has been the first central bank through which the ECB has provided ELA to troubled financial institutions with an exceptional urgency to acquire liquidity. The ELA accounts of Ireland in 2009 and 2010 were recorded under item 11.6 (Sundry) in the financial statements. For consistency purposes we have transferred €11.5 bln and €49.5 bln of ELA from item 11, respectively in 2009 and 2010. These amounts were also added to the Eurosystem total.

_Cyprus, 2011._ Mismatch between 2010 and 2011 reports on the 2010 totals. We have used the 2011 report for the best match. Difference (€3.5 bln) is caused by the recording of Exceptional Liquidity Assistance (ELA). This amount is transferred from item 11.6 (Sundry). To be consistent in our sample, all ELA provided through central banks is recorded under this item.

7. Securities of euro area residents denominated in euro

(Sub-items: 7.1 Securities held for monetary policy purposes; 7.2 Other securities)

_France, 1999-2015._ Over the years, the BdF has also reported interest receivables on non-euro area residents under this item. We have transferred these amounts to item 11.5 (Accruals and prepaid expenses) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

_ECB, 2001._ The ECB has decided to reclassify these holdings as a dedicated portfolio. The difference (€4.4 bln) has in full been transferred to items 11.3 (other financial assets).

_Eurosystem, 2001 and 2007._ Mismatch between 2001 and 2002 report on 2001 totals, and between 2007 and 2008 reports on the 2007 totals. We have used the 2002 report to get a match on the 2001 total, and transferred the difference (€3.6 bln) to item 11.3 (other financial assets). Furthermore, the 2007 financial statements delivered a perfect fit, therefore the difference
between the 2007 and 2008 reports (€47.9 bln) has been transferred to item 11.3 (other financial assets).

**Greece, 2002 and 2003.** See notes on item 4 (claims on non-euro area residents denominated in euro). The under-reporting under this heading matches perfectly the over-reporting in item 4.

**Ireland, 2002 and 2004-2007.** In 2002 and over the years 2004-2007, we observed an over-reporting by the Central Bank and Financial Services Authority of Ireland. In these years, the headings include securities of euro area residents denominated in euro which were held to maturity (HTM – 2002: €812 mln, 2004: €857 mln, 2005: €1.76 bln, 2006: €1.77 bln, 2007: €2.7 bln). In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks HTM portfolios are recorded under item 11.3 (other financial assets).

**Malta, 2008.** Mismatch between 2008 and 2009 reports on the 2008 totals. We have used the 2009 report for the best match. The difference (€14.6 mln) is caused by a reclassification of Malta Government Treasury bills which is transferred to item 11.3 (other financial assets).

8. **General government debt denominated in euro**

**Eurosystem, 2001.** Mismatch between 2001 and 2002 report on 2001 totals. We have used the 2002 report to get a match on the 2001 total, and transferred the difference (€881 mln) to item 11.3 (other financial assets).

9. **Intra-Eurosystem Claims**

(Sub-items: 9.1 Participating interest in the ECB; 9.2 Claims equivalent to the transfer of foreign reserves; 9.3 Claims related to the issuance of ECB debt certificates; 9.4 Net claims related to the allocation of euro banknotes within the Eurosystem; 9.5 Other claims within the Eurosystem (net))

This heading includes all claims related to cross-border settlements between national central banks and the ECB. All over- and under-reporting in the other headings is reconciled with Intra-Eurosystem claims as this heading is where all misreporting has showed up.

**All, 1999.** See notes on item 4 (Claims on non-euro area residents denominated in euro). We have transferred an amount of close to €22.3 bln in relation to TARGET accounts from item 4 to this heading. In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks TARGET settlements should be reported under item 9.5 (Other claims within the Eurosystem (net)).

**France, 2002.** See notes on item 5 (Lending to euro area credit institutions related to monetary policy operations denominated in euro). We have transferred an amount of €210 mln in relation to the Marginal Lending Facility from this heading to item 5.

**All, 1999-2015.** See notes on item 11 (Other assets). All misreporting (over and under) over the years in item 11 has been reconciled with this heading. Once we observed an over- (under-) reporting in item 11 we have transferred amounts from (to) Intra-Eurosystem claims as national central banks have most likely recorded cross-border claims on other national central banks or financial institutions under this heading.

10. **Items in course of settlement**
All, 1999-2015. The legal framework for accounting and financial reporting in the European System of Central Banks requires this heading to be included under item 11 (other assets) as an individual sub-item. We have transferred this entire heading to a new individual sub-item under item 11.

11. Other assets

(sub-items: 11.1 Coins of euro area; 11.2 Tangible and intangible fixed assets; 11.3 Other financial assets; 11.4 Off balance sheet instruments’ revaluation differences; 11.5 Accruals and prepaid expenses; 11.6 Sundry)

France, 1999-2015. See notes on items 2, 3, 4, 5, and 7. Under these headings the BdF has recorded interest receivables, which in compliance with legal framework for accounting and financial reporting in the European System of Central Banks should have been reported under item 11.5 (Accruals and prepaid expenses). We have transferred all related amounts from the headings to item 11.5.

Eurosystem, 1999, 2001, and 2007. See notes on item 4, 6, 7 and 8. We have transferred an amount of €166 mln from item 6 to item 11 due to a mismatch in 1999, amounts of €3.6 bln and €881 mln from resp. item 7 and 8 in 2001 due to mismatches, and the amounts of €5 bln and €48 bln from resp. items 4 and 7 in 2007 due to reclassifications.

Ireland, 2002-2007. See notes on items 4, 6, and 7. We have transferred amounts related to reverse purchase agreements from items 4 and 6 to item 11, due to over-reporting. In addition we have transferred Held-To-Maturity portfolios (HTM) from item 7 to item 11 in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

ECB and Eurosystem, 2007. See notes on item 6 (Other claims on euro area credit institutions denominated in euro). We have transferred an amount of €100 mln from item 6 to item 11 due to reclassification of dedicated portfolios of money market deposits and current accounts with euro area residents.

Malta, 2008. We have transferred the amount of €164 mln from item 6 to item 11 in relation to fixed-term deposits, and of €14.6 mln from item 7 to item 11 due to a reclassification of Malta Government Treasury bills.

Ireland and Eurosystem, 2009 and 2010. See notes on item 6 (Other claims on euro area credit institutions denominated in euro). The ELA accounts of Ireland in 2009 and 2010 were recorded under item 11 (other assets) in the financial statements. For consistency purposes we have transferred €11.5 bln and €49.5 bln of ELA from item 11 to item 6, respectively in 2009 and 2010. These amounts were also deducted from the Eurosystem total.

Cyprus, 2011. See notes on item 6 (Other claims on euro area credit institutions denominated in euro). The ELA accounts of Cyprus in 2011 was recorded under item 11.6 (Sundry) in the financial statements. In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks we have transferred €3.5 bln of ELA from item 11 to item 6.

Eurosystem, 1999-2015. All over- and under-reporting under this heading has been reconciled with item 9 (Intra-Eurosystem claims), and resulted in both transfers from and to this heading. The annual reports of several national central banks do not provide a full distinction of assets under this heading which impedes us to examine which posts can be related to cross-border settlements with other central banks within the euro area and therefore should have been reported under item 9. This forced us to reconcile all over- and under-reporting by adjusting
the totals of the Eurosystem, instead of attributing this to an individual central bank. The largest transfer totaled €1.3 bln from this heading to item 9 in 2008, which was 0.6% of the Eurosystem total. The other transfers were smaller and accounted for even lower percentages of the Eurosystem totals.

**Liabilities**

1. **Banknotes in circulation**

Ireland, 2002. The legal framework for accounting and financial reporting in the European System of Central Banks requires this heading to be composed of euro banknotes in circulation in accordance with the banknote allocation key\(^{10}\) and of national banknotes that are no longer legal tender. In the 2002 annual report of the Central Bank and Financial Services Authority of Ireland national banknotes have been recorded under item 10.3 (Net liabilities related to the allocation of euro banknotes within the Eurosystem) and partly under item 13 (Provisions – provision for redemption of Irish Pound banknotes). The respective amounts of €299.7 mln and €60 mln were transferred to this heading, item 1 (Banknotes in circulation).

2. **Liabilities to euro area credit institutions related to monetary policy operations denominated in euro**

(Sub-items: 2.1 Current accounts (covering the minimum reserve system); 2.2 Deposit facility; 2.3 Fixed-term deposits; 2.4 Fine-tuning reverse operations; 2.5 Deposits related to margin calls)

Eurosystem, 1999 and 2007. Mismatch between 1999 and 2000 reports on the 1999 totals; and between 2007 and 2008 reports on the 2007 totals. The 1999 records resulted in an over-reporting, which has been corrected in the 2000 financial statement. The difference (€154 mln) has been transferred to item 12.3 (Sundry). In addition, we have used the 2008 report for the best match on the 2007 statements. Difference (€2 mln) may be caused by the entry of Slovenia to the Eurozone in 2007 corrected for in the 2008 annual report.

France, 1999-2015. Over the years, the BdF has also reported interest payables on euro area credit institutions under this item. We have transferred these amounts to item 12.2 (Accruals and income collected in advance) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks. In addition we transferred €17 mln for 1999 to item 3 (Other liabilities to euro area credit institutions denominated in euro) as the under-reporting under this heading seemed to result from a mismatch in the accounts for the BdF.

3. **Other liabilities to euro area credit institutions denominated in euro**

France, 1999. See notes on item 2 (Liabilities to euro area credit institutions related to monetary policy operations denominated in euro).

4. **Debt certificates issued**

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\(^{10}\) See the ECB’s legal framework on the banknote allocation key, amended in accordance with the entrance of new countries to the Eurozone, on its website: https://www.ecb.europa.eu/ecb/legal/html/index.en.html.
5. Liabilities to other euro area residents denominated in euro
(Sub-items: 5.1 General government; 5.2 Other liabilities)

*Eurosystem, 1999.* Mismatch between 1999 and 2000 report on the 1999 accounts. We used both reports to get a perfect fit. We recorded the item 5.1 (General government) of the 1999 financial statement, but we applied the 2000 report to the sub-item 5.2 (Other liabilities). The difference (€1.1 bln) is transferred from item 6 (liabilities to non-euro area residents denominated in euro) as the over-reporting under this heading almost identically matched with the under-reporting under item 5.

*Ireland, 1999.* The 1999 financial statements record an amount of €3.6 bln of Liabilities to other euro area residents denominated in euro. This appears to be in full recorded under item 5.1 (General government), even though it consists fund held on behalf of the Eircom pension fund totaling €1 bln. We recorded the corresponding totals under item 5.1.

*France, 1999-2015.* Over the years, the BdF has also reported interest payables on euro area credit institutions under this item. We have transferred these amounts to item 12.2 (Accruals and income collected in advance) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks. In addition, in 1999 and 2000 we observed an over-reporting which was linked to the BdF. Using the combined annual accounts of 2000 it appears that the mismatch was due to the lack of netting with its participating interests in 5 domestic credit institutions. We assumed that the same has happened in 1999. We expected these mismatches to be related to the TARGET system, and therefore decided to transfer the difference (1999: €620 mln; 2000: €2 bln) to item 10.4 (Other liabilities within the Eurosystem (net)).

6. Liabilities to non-euro area residents denominated in euro

*Eurosystem, 1999.* See notes on item 5.

*All, 1999.* In 1999 this heading included TARGET liabilities to non-euro area central banks. In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks, TARGET accounts totaling €23.5 bln are to be recorded under item 10 (Intra-eurosystem liabilities). We have adjusted the headings accordingly. In addition, the Eurosystem totals have been adjusted using the 1999 annual report of the central bank of Austria in which an overview of the Eurosystem accounts are presented. The difference of €1.2 bln returns under the heading item 15 (Capital and reserves), which is in connection with the management of foreign currency reserves.

*France, 1999-2015.* Over the years, the BdF has also reported interest payables on euro area credit institutions under this item. We have transferred these amounts to item 12.2 (Accruals and income collected in advance) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

*Eurosystem, 2003.* After going through all financial statements and cross-checking with Datastream, €315 mln was still unaccounted for. We made the decision to reclassify this amount to other liabilities (item 12). It is most likely that the missing amount has been reported under this item.

7. Liabilities to euro area residents denominated in foreign currency
France, 1999-2015. Due to national accounting standards, the Banque de France (BdF) reports one overarching items containing liabilities denominated in foreign currency. The respective reporting by the BdF is as follows:

P2 Foreign exchange liabilities

To retrieve the harmonized series on the liabilities to euro area residents denominated in foreign currency we have matched the over- and under-reporting under headings 7 (liabilities to euro area residents denominated in foreign currency) and 8 (liabilities to non-euro area residents denominated in euro). In addition, we removed accrued interest payables which were reported under this item and transferred the amounts to item 12.2 (Accruals and income collected in advance) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

Germany, 2008. See the notes on asset-item 3 (Claims on euro area residents denominated in foreign currency). This heading includes mainly US dollar liabilities to the ECB, euro area banks, and branches of euro area banks located outside the euro area. It is a countervailing post of asset-item 3. We observed an over-reporting of around €18.4 bln, the same amount as on the asset side, which appeared to be due to netting claims and liabilities to euro area residents denominated in foreign currency by the Bundesbank before reporting to the Eurosystem. We have deducted this amount both from the assets and liabilities to be consistent with the Eurosystem accounts.

8. Liabilities to non-euro area residents denominated in foreign currency

(Sub-items: 8.1 Deposits, balances and other liabilities; 8.2 Liabilities arising from the credit facility under ERM II)

France, 1999-2015. See notes on headings 7 (liabilities to euro area residents denominated in foreign currency). We have harmonized the series under this heading with item 7 after deduction of the interest payables.

9. Counterpart of special drawing rights allocated by the IMF

France, 1999-2015. Over the years, the BdF has also reported interest payables on euro area credit institutions under this item. We have transferred these amounts to item 12.2 (Accruals and income collected in advance) in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

10. Intra-Eurosystem liabilities

(Sub-items: 10.1 Liabilities equivalent to the transfer of foreign reserves; 10.2 Liabilities related to the issuance of ECB debt certificates; 10.3 Net liabilities related to the allocation of euro banknotes within the Eurosystem; 10.4 Other liabilities within the Eurosystem (net))

All, 1999. See notes on item 6 (Liabilities to non-euro area residents denominated in euro). We have transferred an amount of close to €23.5 bln in relation to TARGET accounts from item 6 to this heading. In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks TARGET settlements should be reported under item 10.4 (Other liabilities within the Eurosystem (net)).
France, 1999 and 2000. See notes on item 5. We expected the mismatches on item 5 to be related to the TARGET system, and therefore decided to transfer the difference (1999: €620 mln; 2000: €2 bln) to item 10.4 (Other liabilities within the Eurosystem (net)).

ECB, 2000 and 2001. See notes on item 12 (other liabilities). We transferred the amounts of respectively €4 bln and €4.5 bln to item 10 in relation to the ECB’s reported capital (intra-eurosystem liabilities).

Eurosystem, 2001. See notes on item 14 (revaluation accounts). We transferred an amount of €31 mln from this heading to item 14 in line with the 2002 report.

Greece, 2001 – 2003. See notes on item 14 (revaluation accounts). Over-reporting matched with the Greek amount of €207 mln transferred to this heading.

Ireland, 2002. See notes on item 1. We transferred an amount of €299.7 mln from this heading to item 1 (banknotes in circulation) in relation to national banknotes with no longer legal tender, which should be reported under item 1 in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

ECB, 2002-2015. See notes on item 15 (capital and reserves). We transferred all capital-related amounts of the ECB from item 15 to this heading in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

Ireland, 2005. See notes on item 14 (revaluation accounts). Due to a mismatch between a digital file of the central bank of Ireland on the financial statement and the actually published annual report resulted in a transfer of €248 mln from this heading to item 14.

All, 1999-2015. See notes on item 12 (other liabilities), item 14 (revaluation accounts), and item 15 (capital and reserves). All misreporting (over and under) over the years in items 12, 14, and 15 have been reconciled with this heading. Together with the disaggregated balance sheet data as of August 2016 the ECB published the “Explanatory note accompanying the disaggregated Eurosystem financial statement”. This document discloses that parts of items 12, 14, and 15 are offset against intra-eurosystem liabilities. In line of this, once we observed an over- (under-) reporting in one of the items we have transferred amounts from (to) Intra-Eurosystem liabilities as national central banks have most likely recorded cross-border liabilities on other national central banks or financial institutions under this heading.

11. Items in course of settlement

All, 1999-2015. The legal framework for accounting and financial reporting in the European System of Central Banks requires this heading to be included under item 12 (other liabilities) as an individual sub-item. We have transferred this entire heading to a new individual sub-item under item 12.

12. Other liabilities

(Sub-items: 12.1 Off balance sheet instruments’ revaluation differences; 12.2 Accruals and income collected in advance; 12.3 Sundry)

All, 1999-2015. This heading includes other liabilities, and its sub-items, but should also be record items in course of settlements, provisions and profits for the year, in compliance with legal framework for accounting and financial reporting in the European System of Central Banks. We adjusted this accordingly.
**ECB, 1999-2001.** Over the course of 1999-2001 we observed over- and under-reporting under this heading which matched perfectly with the under- and over-reporting in item 15 (capital and reserves) in relation to reverse purchase agreements. We corrected this accordingly with transfers to and from item 15 (from item 15 - 1999: €430 mln; to item 15 – 2000: €640 mln, 2001: €740 mln). Furthermore we observed an over-reporting in 2000 and 2001 which equaled the amount of capital reported by the ECB. We therefore decided to transfer the amounts of respectively €4 bln and €4.5 bln to item 10 (intra-eurosystem liabilities).

**Eurosystem, 1999, 2003, 2007, and 2015.** See notes on items 2 and 6. Mismatch in item 2 in 1999 has been recorded here, the difference (€154 mln) has been transferred to item 12.3 (Sundry). In addition, we still had an over-reporting which was almost identical to the amount of capital reported by the ECB. We chose to transfer an equal amount from item 10 (intra-Eurosystem liabilities) as the mismatch is most likely recorded here. Furthermore we observed an under-reporting in item 6, we made the decision to reclassify €315 mln to this heading. And there was a mismatch between 2007 and 2008 reports on the 2007 totals. For the best fit we used the 2008 annual report.

**France, 1999-2015.** See notes on items 2, 5, 6, 7, 8, and 9. Under these headings the BdF has recorded interest payables, which in compliance with legal framework for accounting and financial reporting in the European System of Central Banks should have been reported under item 12.2 (Accruals and income collected in advance). We have transferred all related amounts from the headings to item 12.2.

**Belgium, 1999-2015.** The central bank of Belgium has reported amortization accounts related to tangible and intangible fixed assets under item 15 (capital and reserves). In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks these amounts should be reported under this heading. We made the appropriate adjustments ranging from a minimum amount of €306 mln in 1999 to a maximum of €379 mln in 2006.

**Greece, 2002.** Mismatch between 2002 and 2003 on 2002 total assets/liabilities. To get the best fit on both sides of the balance sheet, we used the totals reported in the 2003 annual report and attributed the difference (€49 mln) to other liabilities which is increased by the same amount.

**The Netherlands, 2008 and 2012.** See notes on item 15 (capital and reserves). For the best fit we decided to record the amounts reported in the 2009 and 2013 reports and transfer the respective differences of €351 mln to, and €-104 mln from, item 12 (other liabilities).

**Ireland, 2005-2015.** The central bank of Ireland reports an individual heading for superannuation liabilities (pension fund), which in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks has to be recorded under this heading.


**Portugal, 2010 and 2011.** See notes on item 15 (capital and reserves). For the best fit we decided to record the amounts reported in the 2011 and 2012 reports and transfer the respective differences of €-121 mln from, and €81 mln to, item 12 (other liabilities).

**Latvia, 2014 and 2015.** See notes on item 15 (capital and reserves). We transferred respectively €37 mln and €30 mln for 2014 and 2015 to item 12 in relation to profit for the year.

**Lithuania, 2015.** See notes on item 14 (revaluation accounts). We made a transfer of €164 mln to item 12 in relation to pre-system unrealized gains.
*Eurosystem, 1999-2015.* All over- and under-reporting under this heading has been reconciled with item 10 (Intra-Eurosystem liabilities), and resulted in both transfers from and to this heading. The annual reports of several national central banks do not provide a full distinction of assets under this heading which impedes us to examine which posts can be related to cross-border settlements with other central banks within the euro area and therefore should have been reported under item 10. This forced us to reconcile all over- and under-reporting by adjusting the totals of the Eurosystem, instead of attributing this to an individual central bank. The largest transfer totaled €1.8 bln to this heading from item 10 in 2007, which was 3.5% of the Eurosystem total. The other transfers were smaller and accounted for substantially lower percentages of the Eurosystem totals.


*All, 1999-2015.* The legal framework for accounting and financial reporting in the European System of Central Banks requires this heading to be included under item 12 (other liabilities) as an individual sub-item. We have transferred this entire heading to a new individual sub-item under item 12.

*Portugal, 1999-2015.* Provisions by the central bank of Portugal are reported in two separate items: provisions for general risks and for monetary policy purposes. For comparison with the other central banks we record the sum of these two.

*Italy, 1999-2015.* Provisions by the central bank of Italy are reported in two separate items: provisions and provisions for general risks. For comparison with the other central banks we record the sum of these two.

*Ireland, 2002.* See notes on item 1. We transferred an amount of €60 mln from this heading to item 1 (banknotes in circulation) in relation to national banknotes with no longer legal tender, which should be reported under item 1 in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

14. Revaluation accounts

*Eurosystem, 2001.* Mismatch between 2001 and 2002 report on 2002 accounts. For the best fit we used the 2002 report, and transferred the difference of €31 mln from item 10 (intra-eurosystem liabilities) in line with the 2002 report.

*Greece, 2001 – 2003.* Over the course of 2001-2003 we observed an over-reporting of exactly €207 mln which is addressed in the ECB annual report to be due to the entrance of Greece in 2001. The 2001 annual report of the ECB discloses the contribution of the Bank of Greece under Article 49.2 of the Statue of the ECB which total €207 mln. As the mismatch under this heading is identical to this amount we decided to transfer these amounts to item 10 (intra-eurosystem liabilities).

*Ireland, 2005.* After cross-checking with the digital file on the financial statement of the central bank of Ireland, we discovered a mismatch between the file and the annual report in 2005 in relation to reverse purchase agreements which matches perfectly with the under-reporting. For the best fit we used the amounts reported in the file, and transferred the amount from item 10 (intra-eurosystem liabilities) as the difference of €248 mln showed up under item 10 in the digital file.

*Slovenia, 2008-2015.* The central bank of Slovenia recorded securities in euro under this heading, which most likely should have been reported under item 12 (other liabilities) as the

Lithuania, 2015. The central bank of Lithuania recorded pre-system unrealized gains under this heading, which is almost exactly the amount of the over-reporting. We therefore concluded that it should have been reported under item 12 (other liabilities), and made a transfer of €164 mln to item 12.

Eurosystem, 1999-2015. All over- and under-reporting under this heading has been reconciled with item 10 (Intra-Eurosystem liabilities), and resulted in both transfers from and to this heading. The annual reports of several national central banks do not provide a full distinction of assets under this heading which impedes us to examine which posts can be related to cross-border settlements with other central banks within the euro area and therefore should have been reported under item 10. This forced us to reconcile all over- and under-reporting by adjusting the totals of the Eurosystem, instead of attributing this to an individual central bank. The largest transfer totaled €168 mln to this heading from item 10 in 2013, which was not even 0.1% of the Eurosystem total. The other transfers were smaller and accounted for even lower percentages of the Eurosystem totals.

15. Capital and reserves

(Sub-items: 15.1 Capital; 15.2 Reserves)

Eurosystem, 1999. See notes on item 6. In the annual report of the central bank of Austria an oversight of the Eurosystem was provided as well, which provided a perfect match in item 6 and therefore we reported the difference under this heading. To go with the best match we have transferred an amount of €1.2 bln from item 6 to this heading, in connection with the management of foreign currency reserves.

ECB, 1999-2001. See notes on item 12 (other liabilities). Over- and under-reporting matched perfectly under this heading with item 12. We have adjusted this accordingly.

Belgium, 1999-2015. See notes on item 12 (other liabilities). Amortization accounts were misreported under this heading instead of item 12 in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks.

France, 1999-2015. The BdF reported separate items which in sum reflect the capital and reserve accounts. In particular the respective items are (in 1999 report):

- P11 Reserve for general banking risks
- P12 Revaluation reserve of State gold reserves
- P13 Revaluation reserve of State foreign exchange reserves
- P14 Capital, reserves and retained earnings

ECB, 2002-2015. From 2002 a reclassification took place in the legal framework for accounting and financial reporting in the European System of Central Banks which required the ECB’s capital now to be part of the Intra-Eurosystem liabilities as it consisted of paid-up capital by the NCBs. The ECB, however, still reports this as a separate item under this heading. We transferred all capital-related amounts of the ECB from this heading to item 10 (Intra-Eurosystem liabilities).

The Netherlands, 2008 and 2012. Mismatch between 2008 and 2009 reports on 2008 accounts, and between 2012 and 2013 reports on 2012 accounts. For the best fit we decided to record the
amounts reported in the 2009 and 2013 reports and transfer the respective differences of €351 mln to, and €-104 mln from, item 12 (other liabilities).

**Portugal, 2010 and 2011.** Mismatch between 2010 and 2011 reports on 2010 accounts, and between 2011 and 2012 reports on 2011 accounts. For the best fit we decided to record the amounts reported in the 2011 and 2012 reports and transfer the respective differences of €-121 mln from, and €81 mln to, item 12 (other liabilities).

**Latvia, 2014 and 2015.** The Latvijas central bank records profit for the year under this heading. In compliance with the legal framework for accounting and financial reporting in the European System of Central Banks this should be reported under item 12 (other liabilities). We therefore transferred respectively €37 mln and €30 mln for 2014 and 2015 to item 12.

**Eurosystem, 1999-2015.** All over- and under-reporting under this heading has been reconciled with item 10 (Intra-Eurosystem liabilities), and resulted in both transfers from and to this heading. The annual reports of several national central banks do not provide a full distinction of assets under this heading which impedes us to examine which posts can be related to cross-border settlements with other central banks within the euro area and therefore should have been reported under item 10. This forced us to reconcile all over- and under-reporting by adjusting the totals of the Eurosystem, instead of attributing this to an individual central bank. The largest transfer totaled €1.5 bln to this heading from item 10 in 2007, which was 2.2% of the Eurosystem total. The other transfers were smaller and accounted for even substantially percentages of the Eurosystem totals.

16. **Profit for the year**

**All, 1999-2015.** The legal framework for accounting and financial reporting in the European System of Central Banks requires this heading to be included under item 12 (other liabilities) as an individual sub-item. We have transferred this entire heading to a new individual sub-item under item 12.

**Netherlands, 1999.** In the 1999 annual report of De Nederlandsche Bank, profits for the year was not reported as a separate item. We extracted this from other liabilities and posted it separately.
Appendix B: Disaggregated balance sheets of the Eurosystem

In the following figures we display the time series in our database along the schematic balance sheet of the Eurosystem. We kindly refer to Appendix A for the justification of our adjustments to achieve harmonization over all central banks. To save space, the series of Latvia and Lithuania are not displayed, but are available upon request. These countries entered the Eurozone in respectively 2014 and 2015, and therefore conceal little information on balance sheet developments. Note also that the total gross sum of Intra-Eurosystem claims and liabilities have been added for the Eurosystem. In fact these series are netted in compliance with the legal framework for accounting and financial reporting in the European System of Central Banks and thus drop from the financial statements. By including the Intra-Eurosystem total positions we aim to show the size of cross-border transfers between NCBs in relation to the total Eurosystem balance sheet.

With respect to the classification of the balance sheet items, all items are conform the schematic balance sheet of the Eurosystem as presented in Table 1. The first series in each of the following legends resembles the bottom area in the graphs below and all series are stacked in consecutive order.

Legend Assets

- Gold and gold receivables
- Claims on non-euro area residents denominated in foreign currency
- Claims on euro area residents denominated in foreign currency
- Claims on non-euro area residents denominated in euro
- Lending to euro area credit institutions related to monetary policy operations denominated in euro
- Other claims on euro area credit institutions denominated in euro
- Securities of euro area residents denominated in euro
- General government debt denominated in euro
- Other assets
- Intra-Eurosystem Claims

Legend Liabilities

- Banknotes in circulation
- Liabilities to euro area credit institutions related to monetary policy operations denominated in euro
- Other liabilities to euro area credit institutions denominated in euro
- Debt certificates issued
- Liabilities to other euro area residents denominated in euro
- Liabilities to non-euro area residents denominated in euro
- Liabilities to euro area residents denominated in foreign currency
- Liabilities to non-euro area residents denominated in foreign currency
- Counterpart of special drawing rights allocated by the IMF
- Other liabilities
- Revaluation accounts
- Capital and reserves
- Intra-Eurosystem liabilities
Figure B1: Central bank balance sheet developments, Eurosystem, assets (€ mlns)
Figure B2: Central bank balance sheet developments, Eurosystem, liabilities (€ mlns)
Appendix C: Disaggregated balance sheet of the Federal Reserve System

The following figures display the disaggregated balance sheet of the Federal Reserve System of central banks. The data to construct these figures originate from the website\textsuperscript{11} of the Federal Reserve. Each week the Fed publishes a disaggregated balance sheet, decomposed into 12 regions, yet for the purpose of comparison with the Eurosystem we report the data on annual frequency. The legends of the graphs are as follows:

**Legend Assets**
- Gold certificate account
- Special drawing rights certificate account
- Coin
- U.S. Treasury securities: Bills
- U.S. Treasury securities: Notes and bonds
- Federal agency debt securities
- Mortgage-backed securities
- Unamortized premiums (net)
- Repurchase agreements
- Loans
- Net portfolio holdings of Maiden Lane LLC
- Items in process of collection
- Bank premises
- Central bank liquidity swap
- Foreign currency denominated assets
- Other assets

**Legend Liabilities**
- Federal Reserve notes, net
- Reverse purchase agreements
- Term deposits held by depository institutions
- Other deposits held by depository institutions
- U.S. Treasure, General Account
- Foreign official
- Other
- Deferred availability cash items
- Earnings remittances due to the U.S. Treasury
- Other liabilities and accrued dividends
- Capital

\textsuperscript{11} https://www.federalreserve.gov/monetarypolicy/bst_fedsbalancesheet.htm
Figure C1: Central bank balance sheet developments, Federal Reserve, assets ($ mlns)
Figure C2: Central bank balance sheet developments, Federal Reserve, assets ($ mlns)