International capital flows at the security level - evidence from the ECB's asset purchase programme[*]

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Abstract

We analyse euro area investors' portfolio rebalancing during the ECB's Asset Purchase Programme (APP) at the security level. Based on net purchases and sales of both domestic and foreign securities, we observe actual capital flows to the global set of individual securities, cleaned from valuation effects. Descriptive evidence shows that euro area investors adjusted their portfolios by shifting investments away from assets eligible to be bought under the Public Sector Purchase Programme (PSPP) and other euro area debt securities towards euro area equities as well as foreign debt. Our regression analysis – based on an international finance gravity model, augmented with security-level characteristics – confirms that euro area investors (in particular investment funds and households) actively rebalanced away from individual securities targeted under the PSPP. This rebalancing was particularly strong during the first six quarters of the programme, while we do not find evidence for significant portfolio adjustments in anticipation of the PSPP. Active net sales of PSPP-eligible securities by euro area investors were only partly offset by positive capital gains. Our analysis also reveals marked differences across sectors as well as country groups within the euro area, suggesting that quantitative easing has induced heterogeneous portfolio shifts.

Keywords: International Investment Patterns, Capital Flows, Sovereign Debt, Investor Heterogeneity, Quantitative Easing

JEL Classification: F21, F34, E52, G15

1 Introduction

Large scale asset purchase programmes (LSAPs) by central banks have become a popular tool of unconventional monetary policy since the global financial crisis to stimulate economic growth and fulfill inflation objectives in a zero lower bound environment. A major transmission channel of these policies to the real economy is portfolio rebalancing, induced by a decrease in long-term bond yields resulting from a scarcity of securities in the secondary market triggered by the central bank's purchases. Moreover, LSAPs exhibit spillovers to bonds with similar characteristics via "preferred-habitat investors" (Vayanos and Vila, 2009). Lower yields should induce investors to rebalance their portfolio to higher yielding assets, both domestic and foreign.

The ECB's unconventional monetary policy measures, covering the large scale asset purchase programme (APP), a negative deposit rate and and targeted longer-term refinancing operations (TLTROs), reduced euro area long-term risk-free rates by around 80 basis points since June 2014 (ECB, 2017b). The resulting yield differentials between euro area and foreign government bonds have played an important role for euro area capital flows since then (ECB, 2017a). Evidence from the euro area balance of payments shows that the introduction of the main component of the APP – namely the Public Sector Purchase Programme (PSPP) – was followed by significant net capital outflows (Figure 1).[1] At their peak in mid-2016, net outflows of portfolio investment reached an all-time high of nearly 5% of euro area GDP (Coeure, 2017). While non-residents account for sizable share of bond sales to the Eurosystem, euro area investors have been a major driving force behind the observed net outflows (Figure 2). Since the start of the PSPP in March 2015, net purchases of foreign securities by domestic investors have been almost entirely in the form of long-term bonds suggesting that domestic investors partly rebalanced their portfolios towards the closest substitute to PSPP eligible assets outside the euro area. In addition, the APP triggered substantial intra-euro area liquidity flows related to portfolio rebalancing as reflected in rising TARGET balances (Eisenschmidt et al., 2017).

This macro-based evidence shows that LSAPs can trigger substantial cross-border capital flows by way of the portfolio rebalancing channel. In an integrated international financial system, monetary policy impacts both domestic investment patterns and international capital flows. The growing complexity and interconnectedness of the international financial system as well as sector heterogeneity provide a strong case for incorporating micro data for policy analysis (Lane, 2015). Limitations of macro data pertain for instance to the limited extent of sectoral information on holders and issuers of assets, both in a domestic and cross-border context. Consistent country-level capital *flows* data are usually only available unilaterally, while bilateral data merely cover investment *positions*, are available at low frequencies and do not include the holdings of domestic securities (e.g. the IMF's Coordinated Portfolio Investment Survey, CPIS). Finally, only security-by-security data allow us to identify important asset specific characteristics such as the issuing entity, the yield and market prices, as well as the currency denomination or the

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[1]The PSPP accounts for approximately 80% of the entire asset purchase programme

maturity.

In this paper, we use security-by-security data from the European System of Central Banks (ESCB) Sectoral Securities Holding Statistics (SSHS) which offers a comprehensive, fully integrated, granular dataset of the security holdings of euro area residents.[2] As such we are able to integrate the analysis of domestic and international sectoral portfolios, similar to Heipertz et al. (2016) who use data on French sectoral portfolios to estimate how different sectors are affected by balance sheet contagion. Our dataset allows for providing a detailed account of euro area portfolio rebalancing - both at the country and sector level, incorporating domestic, euro area and global capital flows of euro area residents – over the first eight quarters of the PSPP period (2015Q1 to 2016Q4).

Our paper is the first – to the best of our knowledge – to analyse actual capital flows (i.e. net purchases or net sales) at the security level in a gravity model setting. While Boermans and Vermeulen (2016) also use SHSS data, they focus on the cross-sectional determinants of security holdings before the APP, rather than flows. With our augmented gravity model of bilateral capital flows at the security level, we are able to test several hypotheses with regard to the impact of the APP on portfolio rebalancing. Moreover, as our dataset also comprises the holdings of individual securities, we are able to decompose overall portfolio rebalancing of euro area investors into 'active' (i.e. capital flows) and 'passive' components (i.e. valuation changes due to fluctuations in security prices and exchange rates) in line with the theoretical model of Tille and van Wincoop (2010).

The SHSS data encompasses the security holdings and transactions of all economic sectors in euro area countries (with the exception of the monetary authorities), rather than singling out a specific sector. Exploiting this allows for examining heterogeneity among investors along various dimensions such as country of residence and sector. We argue that it is crucial to consider sectoral heterogeneity, especially when analysing the PSPP due to differing initial positions at the start of the programme (most notably in terms of exposure to public sector bonds, ECB (2017c)) and different degrees of investor sophistication, informational frictions, or different asset and liability management strategies as well as regulatory constraints which may imply heterogeneous responses across countries and sectors to policies such as the PSPP.

Our paper draws on the literature analysing international investment patterns, which typically uses gravity-type models that explain the observed proximity biases in international finance with information asymmetries. This framework relies on the theoretical models proposed by Martin and Rey (2004) and Okawa and van Wincoop (2012)) and empirically applied for instance by Portes and Rey (2005) and Lane and Milesi-Ferretti (2008) and more recently using SHSS data by Boermans and Vermeulen (2016). While much of the literature focuses on the cross-sectional determinants of bilateral portfolio investment patterns, the factors behind portfolio shifts over time have been less explored. A strand of the literature focused on financial

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[2]This dataset is collected according to Regulation ECB/2012/24, see http://www.ecb.europa.eu/ecb/legal/pdf/l_30520121101en00060024.pdf.

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market aspects such as return chasing (Bohn and Tesar, 1996), while more recently the drivers of portfolio investment dynamics after the global financial crisis (Galstyan and Lane, 2013) and euro area sovereign debt crisis (Beck et al. (2016)) have been examined. The literature on portfolio rebalancing using microdata has grown over time, but usually focuses only on a particular sector. While Calvet et al. (2008) examine the portfolio rebalancing of Swedish households, Hau et al. (2017) use data on around international equity funds and find that these repatriate capital after making an excess return on their foreign portfolio share relative to their domestic equity investment.

Our paper also contributes to the literature on the cross-border impact of LSAPs, which was triggered by the first rounds of the Federal Reserves' quantitative easing (QE). Neely (2010) shows that the Fed's QE significantly reduced not only domestic, but also foreign long-term bond yields, while Moore et al. (2013) find that QE also resulted in a significant increase in the foreign ownership of emerging market debt securities. Moreover, there is a broad consensus that the ECB's APP persistently reduced euro area long-term bond yields, both of targeted and other debt securities, while also boosting equity prices due to confidence effects (Altavilla et al. (2015), Andrade et al. (2016), and Fratzscher et al. (2016)). Event-studies focusing on the ECB's APP announcement show that these confidence effects had significant spillovers to the rest of the EU and global equity markets (Falagiarda et al. (2015); Georgiadis and Graeb (2016)). Examining the impact of monetary policy surprises associated with the ECB's APP, Bubeck et al. (2017) present high-frequency event-study evidence on the investment behaviour of mutual funds based in Luxembourg. They distinguish between an active channel (daily capital flows) and a passive channel (changes in the value), of which they found only the latter to be a significant driver of daily portfolio rebalancing.

Employing SHSS data, Koijen et al. (2016) show for the period 2015Q2 until 2015Q4 that foreign investors sold most assets in response to the PSPP, followed by banks and mutual funds, while the purchases of insurance companies and pension funds were positively related to purchases by the ECB. Boermans and Vermeulen (2018) suggest that euro area investors preference ("preferred habitat") for bonds with certain characteristics remained stable during the APP programme. Albertazzi et al. (2018) find that portfolio rebalancing has only been active in those euro area economies which were more affected by the crisis where positive wealth effects from higher asset prices translated into increased lending activity.

The rest of the paper is organized as follows: In Section 2, we explain our dataset and the empirical framework. We provide extensive descriptive evidence on the (international) portfolio rebalancing of euro area investors since the launch of the APP in Section 3. Section 4 presents our econometric results and Section 5 concludes.

2 Empirical Framework

2.1 Data

We use data on security-level portfolio holdings and transactions of all 19 euro area Member States from the European System of Central Banks (ESCB) Sectoral Securities Holding Statistics (SSHS).[3] The data are collected by National Central Banks from (i) financial investors and (ii) custodians.

It covers all short-term and long-term debt securities, listed shares, as well as investment fund shares that are identified with an unique International Securities Identification Number (ISIN). This split into financial instruments is in line with the instruments contained in National Accounts or Balance of Payments Statistics. The data are collected on a quarterly basis since 2013Q4 and we use releases until 2016Q4 for this analysis.[4] The SHSS data consist of *directly* and *indirectly* reported securities. A financial institution resident in the euro area is obligated to report securities that it holds as its own investment ("direct reporting") as well as securities that it holds in custody ("indirect reporting"). In order to avoid double reporting, only assets held in custody for non-financial investors are included in the SHS.[5] Investors in the data are defined by their country of domicile and sector. We follow the European System of Accounts (2010) and aggregate the data to six sectors: monetary and financial institutions (MFI) excluding monetary authorities, insurance companies and pension funds (ICPF), other financial institutions (OFI),[6] non-financial corporations (NFCs), general government and households. Using the ISIN for every security, we merge the SHSS data to individual asset characteristics obtained from the ESCB's Centralised Securities Database (CSDB) which contains information on more than six million debt and equity securities issued globally. Therefore, we can use information at the security-level, such as the instrument type, issuer country and institutional sector, currency of denomination, yields and original maturity.

2.2 Econometric approach

Our analysis builds on two approaches of estimating the determinants of international investment patterns and extends these to estimate the determinants of euro area investors' international capital flows at the security-level for the APP period. This framework relies on the theoretical models proposed by Martin and Rey (2004) and Okawa and van Wincoop (2012)) which focus on incomplete asset markets and transaction costs in international asset trade. Crucially, frictions in

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[3]This dataset is collected according to Regulation ECB/2012/24, see http://www.ecb.europa.eu/ecb/legal/pdf/l_30520121101en00060024.pdf

[4]Revised versions of our data are available with a significant time lag and we plan to update our analysis with the APP evolving.

[5]Double counting would happen if there are several intermediate financial institutions between the final non-financial investor and the financial institution holding assets in custody.

[6]These include important intermediaries such as mutual funds which represent the largest subgroup of this sector.

asset trade due to asymmetric information costs between home and foreign agents induce home and proximity biases in investors' portfolios. While Okawa and van Wincoop (2012) provide an encompassing formal theoretical framework to justify the use of gravity models in 'levels' (i.e. focusing on cross-border investment *positions*), we follow Galstyan and Lane (2013) who show empirically – for the global financial crisis – that a gravity-type framework also holds in 'first-differences'. Specifically, they estimate:

$$\Delta ln(A_{i,j,t,t-1}) = \alpha_i + \alpha_j + \gamma ln(A_{i,j,t-1}) + \beta Gravity_{i,j} + \epsilon_{i,j} \qquad (1)$$

where $\Delta ln(A_{i,j,t,t-1})$ is the log change (between t and $t-1$) in country i's bilateral portfolio holdings of securities issued by country j. $ln(A_{i,j,t-1})$ is the log of country i's bilateral portfolio holdings at t-1 of securities issued by country j which is included in order to control for the pre-existing 'level' of bilateral portfolio investment.[7] $Gravity_{i,j}$ controls for a set of bilateral variables which measure the extent of information asymmetries between two countries. Finally, α_i and α_j represent holder-country and issuer-country fixed effects.

We combine this dynamic, first-difference macro-data approach with a security-level analysis of sectoral cross-sectional investment patterns in order to be able to control for security-specific characteristics. We follow Boermans and Vermeulen (2016) who use the following empirical specification:

$$ln(A_{a,i,j}) = \beta_d^1 * x_a^1 + ... + \beta_d^k * x_a^k + \gamma_d Gravity_{i,j} + \alpha_i + \alpha_j + \epsilon_{a,i,j} \qquad (2)$$

where $ln(A_{a,i,j})$ is the log of country-sector i's portfolio holdings of security a issued by country-sector j (including domestic securities), which are explained by k security specific characteristics (x_a^1, ..., x_a^k), bilateral $Gravity_{i,j}$ factors, and holder-country-sector and issuer-country-sector fixed effects α_i and α_j.[8]

Combining (1) and (2), we specify the following model

$$ln(flow_{a,i,j,t}) = \beta_d^0 ln(A_{a,i,j,t-1}) + \beta_d^1 * x_{a,t}^1 + ... + \beta_d^k * x_{a,t}^k + \gamma_d Gravity_{i,j} + \alpha_i + \alpha_j + \epsilon_{a,i,j} \quad (3)$$

where $ln(flow_{a,i,j,t})$ represents the ln of country i's net transactions (i.e. net sales or purchases) cumulated over t (i.e. the PSPP period 2015Q1-2016Q4) of security a (either a debt instrument, listed share or investment fund share) issued in issuing country-sector j and purchased or sold by holder country-sector i.[9]

To our knowledge, our paper is the first attempt to estimate the determinants of actual capital flows (i.e. net purchases and sales) at the security level which allows us to truly capture

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[7]Galstyan and Lane (2013) find that during the Global Financial Crisis cross-border positions were reduced most where pre-crisis bilateral holdings were the largest which they interpret as a "reversion to the mean".

[8]Notably i and j refer to country-sectors in (2), rather than countries in (1).

[9]If net transactions over 2015Q1 - 2016Q4 are negative (indicating net sales of a security by a sector), we take the ln of the absolute value and multiply it with -1 to allow for a log distribution also in the case of net sales.

the *active* component of portfolio rebalancing rather mixing it with passive investment changes, such as valuation effects – on which we focus in the final part of our analysis – due to movements in prices or the exchange rate. $ln(flow_{a,i,j,t})$ is explained by the pre-PSPP holdings of a security $ln(A_{i,j,t-1})$ – defined as holdings at the end of 2014Q4, k asset specific characteristics $(x^k_{a,t})$ and $Gravity_{i,j}$, i.e. bilateral characteristics between holder country i and issuer-country j. We saturate our regression with fixed effects that capture unobserved holder sector-country characteristics (α_i) and unobserved issuer sector-country characteristics (α_j). The purpose is to capture financial frictions or multilateral resistance which differs across countries, but also between holder and issuer sectors. In all regressions, we cluster the standard errors at the holding country*sector pair level as the residual might be correlated with country and sector specific demand factors.

For the gravity components of our estimation, we first create a dummy variable for domestic holdings (*home*) which is equal to 1 if holder and issuer country are identical for a security. In the case of cross-border holdings, we add control variables commonly used in the literature:[10] data on the distance between i and j are retrieved from the CEPII database (which includes measures of domestic distance), while we obtain bilateral trade data on goods imports from the IMFs Direction of Trade Statistics.[11] Finally, we include an index capturing the similarity of two countries' languages from Melitz and Toubal (2014). This index ranges from 0 to 1 with increasing similarity of two countries' languages, which implies that we set index to 1 for domestic holdings.

Due to the security-level of our dataset, we are able to control for asset specific characteristics $(x^k_{a,t})$ that may influence investment behaviour directly. Specifically, we include the change in the outstanding amount of a security (at market prices) which signifies to what extent investors follow shifts in the market-portfolio, which should be the case under the assumptions of identical investor preferences, no financial frictions and efficient asset pricing. This benchmark gives us an important indication of the extent to which investors follow the predictions of the CAPM in which case the estimated coefficient should equal to unity. Moreover, our model comprises the currency denomination of a security using a binary variable for euro-denominated securities. In the case of debt securities, we also control for the original maturity of a security and in robustness estimations we include the average yield and rating of a security over the PSPP period.

Our empirical set-up allows for assessing heterogeneity between different groups of investors by estimating varying $(\beta^1_s,...,\beta^k_s)$ coefficients across sectors or country groups. The advantage of this approach is to be able to estimate the heterogeneous coefficients in a single regression so that one can directly infer statistical differences between the different coefficients.

As additional analyses and robustness tests, we perform various specifications of our regressions: (i) we substitute the gravity variables with bilateral fixed effects which pick up all

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[10]See Hellmanzik and Schmitz (2017) for a recent overview

[11]For domestic holdings, we set imports equal to 0. Other specifications such as taking the value of aggregate imports of country i leads to equivalent results.

unobserved bilateral characteristics that we do not control for explicitly with the set of gravity variables; moreover, we vary the composition of the sample by (ii) focusing only on foreign securities (i.e. excluding domestic holdings), (iii) excluding Ireland and Luxembourg from the analysis due to their large financial intermediation role; (iv) excluding short-term debt securities (i.e. those with an original maturity below 1 years) in the debt securities regressions.

2.3 Empirical implementation

2.3.1 Main hypothesis

Our econometric approach allows for controlling for a vast array of country-sector specific and security-specific factors. Thus, we can isolate the role of potential drivers of euro area capital flows since the launch of the PSPP, for which we specify a set of testable hypotheses in line with "textbook" portfolio rebalancing:[12]

1. *We expect euro area investors to be net sellers of the assets targeted by the Eurosystem under the PSPP and to rebalance into the closest substitutes.* As the price of bonds targeted in the PSPP increased significantly since the start of the programme, with the Eurosystem absorbing sizeable volumes of these securities, investors 'searching for yield' are expected to rebalance into debt securities that allow them to maintain a certain average yield in their portfolios.[13] Moreover, investors also consider the risk profile of their portfolios which – apart from individual investment strategies – is also influenced by regulatory restrictions, such as risk weights or eligibility for collateral. The security-level of our dataset allows to construct two exogenous variables which enable us to directly investigate our first hypothesis, namely *PSPP eligibility* and *PSPP substitute*. The former is equal to 1 for those debt securities which are eligible to be purchased by the Eurosystem under the PSPP.[14] The latter dummy variable equals 1 for securities issued by the public sector in non-euro area advanced economies which otherwise fulfill the requirements of the PSPP, e.g. a 10-year US treasury bond.[15] We label this variable *PSPP substitute* as we argue that investors will most likely perceive these securities as the closest substitutes to securities

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[12]For a discussion of portfolio rebalancing as a transmission channel of QE, see e.g. Coeure (2015).

[13]By December 2016, the stock of securities purchased by the Euosystem under PSPP summed up to 1.25 trillion EUR.

[14]The Eurosystem distributes the volume of bond purchases across countries according to each national central bank's share in the ECB capital key, which in turn is determined by a country's GDP and population shares. Securities eligible to be bought under the PSPP are (i) securities issued by euro area governments or (ii) securities of international or supranational institutions. In addition, they need fulfill certain requirements, e.g. a maturity between 2 and 30 years, ratings above credit quality step 3 in the Eurosystem's harmonised rating scale (i.e. at least a rating *BBB-* from Standard&Poor's or Fitch, *BBBL* from DBRS, or *Baa3* from Moody's) and the yield to maturity has to be above the deposit facility rate, which was equal to -20bp at the time of the launch of the programme in January 2015. More detailed information and the full list of eligible international or supranational institutions can be found at https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html.

[15]These include sovereign debt securities issued by Australia, Canada, Czech Republic, Denmark, Hong Kong, Japan, New Zealand, Norway, Singapore, Sweden, Switzerland, United Kingdom, and the United States

targeted under PSPP. If this mechanism is at play, we should find a significantly negative coefficient for *PSPP eligible* and a positive coefficient for *PSPP substitute*.

2. *We expect investors to rebalance into securities with longer maturities.* As the euro area yield curve shifted downwards but did not reverse during APP (ECB (2017b), De Santis (2016)), we suggest that investors need to increase the average maturity of their debt securities in order to achieve a certain yield.

3. *We expect a weakening of the home bias and euro-denomination bias in <u>debt</u> securities, but a continued preference for euro-denominated <u>equity</u>.* Euro area yields declined not only for those debt securities targeted under the PSPP, but also for other euro area and euro-denominated securities due to spill-overs to private sector-issued debt securities. In the case of euro area NFCs yields were directly impacted by the Corporate Sector Purchase Programme (CSPP) in the last six months of our period of observation. Moreover, observed net sales of debt securities issued by MFIs reflect to some extent negative net issuance due to the broad-based deleveraging and funding substitution towards the Eurosystem's targeted longer-term refinancing operations (TLTROs). Under this open market operation, the ECB has offered long-term funding at attractive conditions to banks since June 2014. For the period before 2014, Boermans and Vermeulen (2016) show that there is a significant home as well as euro denomination bias in the holdings of securities. We test our hypothesis by including a home as well as a euro denomination dummy in our regressions.

At the same time, we expect net purchases of euro area equity securities whose prices increased in the APP period, which was partly driven driven by the confidence boost of the APP as well as improved economic growth expectations in the euro area (Coeure, 2017). As we analyse debt and equity in separate estimations, we expect to find a significant positive home as well as euro denomination bias for equity, but not for debt securities when analysing capital flows after the start of the APP.

For all the hypotheses, we expect significant heterogeneity among sectors within the euro area for several reasons. First, sectors vary in their degree of professionalism with regard to portfolio allocations which implies a larger role for information asymmetries for certain sectors, in particular in changing financial market conditions as during the APP period. Second, the model of Brunnermeier and Sannikov (2016) shows that accommodative monetary policy that boosts the prices of assets held by balance sheet-impaired sectors relaxes their financial constraints and allows them to increase their lending activity. Different investment behavior can also be due to due to regulatory restrictions, such as risk weights attached to particular securities (such as sovereign bonds) or eligibility for collateral. Finally, different sectors might manage assets heterogeneously under different business models, e.g. due to different restrictions on the liability side of their balance sheet in terms of maturity or currency denomination. Timmer (forthcoming) shows that banks and investment funds respond in a pro-cyclical manner to price changes, while

insurance companies and pension funds act counter-cyclically. The author shows that these heterogeneous responses can be explained by differences in their balance sheet structure. While banks have a need for liquid assets as deposits are easily redeemable, pension funds might prefer longer-term assets to match their longer-term liabilities. From this, we can deduce several more specific hypotheses. We expect "less restricted" sectors such as insurance companies and pension funds, but also households to show a positive coefficient for the maturity variable as these sectors in particular would need to purchase longer term assets in order to keep yield constant. On the other hand, banks might not be willing or able to sell PSPP eligible assets due their "risk free"-classification in the Basel regulations and their eligibility as collateral in the Eurosystem's refinancing operations.

2.3.2 Extensions of baseline approach

In order to shed more light on the mechanisms of international portfolio rebalancing, we provide two extensions to our baseline approach, focusing on different time horizons of portfolio reallocations and isolating not only the active part of portfolio rebalancing (i.e. net purchases and sales), but also considering the determinants of the passive rebalancing such as changes in valuation and the overall impact on portfolio rebalancing.

In order to grasp time dynamics, we vary the time frame of the analysis. While our basline approach covers the 8 quarters since the start of the PSPP, we analyse the short-term (2 quarters) and medium-term (6 quarters) rebalancing. Most empirical studies on the financial impact of these policies argues that the largest movements in yields took place at the moment of the announcement of the PSPP (e.g. see Krishnamurthy and Vissing-Jorgensen (2011) for the US or Altavilla et al. (2016) and De Santis (2016) for the euro area). Therefore, we want shed light on the question of whether or not portfolio rebalancing occured instantaneously, or with a time lag, and whether it has been maintained throughout the duration of the programme. Moreover, we test whether our analysis gives different result if we start it in the third quarter of 2014, which includes the ECB's credit easing package of June 2014[16] and to account for potential anticipation effects for an LSAP in the euro area following Draghi (2014) in his speech at Jackson Hole.

Furthermore, as put forward in the theoretical model of Tille and van Wincoop (2010), we distinguish the *active* (i.e. net purchases) and the *passive* channel of portfolio rebalancing and substitute to this end our dependent variable $ln(flow_{a,h,s})$ with (i) $\Delta(ln(stock_{a,h,s}))$ which represents the change in the stock of the holding and (ii) $[\Delta ln(stock_{a,h,s}) - ln(flow_{a,h,s})]$ which are the passive changes in holdings that are not due to transactions, such as valuation changes resulting from fluctuations in security prices and exchange rates. Ahmeda et al. (2016) apply this concept to US capital flows targeting EMEs and Bubeck et al. (2017) implement it for daily portfolio shifts following ECB monetary policy announcements related to the APP.

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[16]https://www.ecb.europa.eu/mopo/implement/omo/tltro/html/index.en.html

3 Descriptive evidence

We provide descriptive evidence on the 'active' portfolio rebalancing (i.e. in terms of net transactions) of euro area investors since the launch of the PSPP. By constructing these statistics from the security-level SHS dataset we are able to provide additional insights compared to analysis which rests entirely on aggregate statistics such as the balance of payments statistics presented in Figures 1 and 2. Starting with transactions in debt securities, Figure 3 shows that euro area investors were net sellers of securities eligible to be bought by the Eurosystem under the Public Sector Purchase Programme (PSPP) in the period 2015Q1 to 2016Q4, which is in line with our hypothesis 1. In fact, more than EUR 250 bn PSPP eligible securities were sold in net terms by euro area investors in the period 2015Q1 to 2016Q4. However, even larger net sales by euro area residents were recorded for other debt securities issued in the euro area, of which the largest share was those issued by euro area banks. These net sales can be mainly attributed to both spillovers from the PSPP programme and the negative net issuance of bonds by the banking sector.

Net sales of euro area debt instruments were mirrored in sizeable net purchases of foreign debt securities by euro area residents. More than half of these net purchases were foreign debt securities that are not issued by the public sector, thereby closely matching the net sales of non-eligible euro area area debt securities. Moreover, in line with our hypothesis number 1, we also observe significant net purchases (around 350bn EUR) of foreign sovereign debt securities, of which around 40% qualify as close substitutes for PSPP eligible assets.[17]

Figure 4 shows which sectors drove these overall patterns: MFIs and households accounted for the largest net sales of PSPP eligible and other euro area debt securities, while ICPFs were net buyers of both types of euro area debt securities. OFIs – mainly investment funds – bought the largest amounts of PSPP substitutes as well as foreign debt securities in general, followed by MFIs and ICPFs. In terms of investors' country of residence, the rebalancing towards non-euro area debt securities was driven by the financial centres Ireland and Luxembourg as well as Germany and France to a lesser extent, while Spanish investors sold the largest amount of PSPP eligible securities, followed by the Netherlands, Germany, France, and Italy (see Figure 5). Italy on the other hand stands out as resident investors were the largest net sellers of other euro area debt securities, followed by Germany and France.

Figure 6 also includes equity securities, i.e. investment fund shares and listed shares, to investigate the transmission of quantitative easing from targeted securities towards other instruments. In our analysis, securities are split into those issued by euro area residents (left) and foreign securities (right) in Figures 6 - 8. As already observed, euro area investors were overall net sellers of euro area debt securities and mainly rebalanced their portfolios towards euro area investment fund shares, debt securities issued outside the euro area, and to a lesser extent to

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[17]Sovereign debt of foreign advanced countries with similar characteristics to the assets purchased under the PSPP. See Section 2.3.1 for a precise definition

euro area and foreign listed shares. Figure 7 provides important insights into the sectoral 'flow-of-funds' behind these aggregate flows: the net sales of euro area debt securities were driven by MFIs and households, while insurance companies and pension funds (ICPFs), households and OFIs bought the largest amounts of euro area investment fund shares as shown on the left hand side of Figure 7. On the right hand side, we can observe that OFIs – i.e. investment funds – were by far the largest net buyers of foreign debt securities, followed by MFIs and ICPFs. This suggests that MFIs and to a lesser extent also ICPFs were buying foreign debt securities directly, while in particular households channelled their investments into overseas debt securities via investment funds. Figure 8 shows that the largest net purchases of euro area investment fund shares originated from Germany, Italy, Spain and France.[18]

Figure 9 sheds more light on euro area flows into investment fund shares. Based on additional security characteristics from the ESCB's Centralised Securities Data Base (CSDB), we differentiate investment funds by their main investment mandate. The graph shows that the largest net inflows by euro area residents went into 'mixed' investment funds, followed by investment funds with explicit mandates to invest in bonds. Particularly households and ICPFs were large net buyers of 'mixed' funds, while for OFIs bond funds constituted the largest type. Aggregate ECB investment fund statistics show that euro area investment funds mainly bought shares of other investment funds, debt securities and listed shares in our period of analysis. Combining the evidence contained in Figures 7 and 9 confirms that at the end of the investment chain, OFIs channelled large funds towards the acquisition of non-euro area debt securities.

In terms of geographical composition, Figure 10 shows that euro area residents were net sellers of debt securities issued in their home countries, while they invested heavily into US debt securities, followed by those issued in the United Kingdom and in the rest of the world. This is in line with our hypothesis number 3, suggesting a decline in the home bias of debt securities. Furthermore, large net purchases of US debt securities are in line with our hypothesis on closest substitutes (number 1) and can also be explained by the substantial yield differentials between the euro area and the US since the start of the start of the ECB's unconventional monetary policy. Indeed, the largest net purchases of debt securities by euro area residents were recorded for those issued by the US government sector, followed by US NFCs and the British government sector.

MFIs and households in particular sold domestic securities, while OFIs' net purchases focused almost entirely on extra-euro area debt securities, with the US and UK accounting for the largest shares. On the right hand side of Figure 10, we see that the majority of net equity purchases consists of those issued by domestic and other euro area residents, which mainly reflect investment fund shares. The geographical composition is mirrored in changes in currency exposures. In particular, Figure 11 shows an increase in the exposure to debt securities denominated

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[18]The large purchases of investment fund shares were driven by ICPFs in Germany and France and by households in Italy and Spain. In turn, Luxembourg-based OFIs accounted for 86% of all euro area OFI net purchases of extra-euro area government bonds.

in US dollar, but also the British pound, while net purchases of equities were euro-denominated. Strikingly, all sectors were net buyers of US dollar-denominated debt, with more than half of net purchases being conducted by OFIs as shown in Figure 12. ICPFs and to a much smaller extent OFIs were net buyers of euro denominated debt securities.

We also consider our second hypothesis, i.e. that investors will rebalance their portfolio to longer term securities. Figure 13 points to evidence in this direction as the majority of net purchases of debt securities fell within the bucket of assets with an original maturity of more than 10 years. Moreover, the vast majority of net sales consist of assets with a maturity between 2 to 5 years after origination. Figure 14 shows that the large net purchases of assets with a minimum maturity of 10 years is driven by ICPFs and OFIs. In particular for the latter, we suggest that the switch to longer-term maturities is due to a "search for yield" while for ICPFs these purchases are likely due to the inherent need to match longer-term liabilities with longer-term assets. The large net sales of 2-5 year securities were – just like the sales of PSPP eligible assets – mainly driven by MFIs and households.

Summing up, we find strong support for our hypotheses by looking at descriptive evidence. Euro area investors rebalanced their portfolios from domestic and other euro area debt securities to foreign debt. As large net purchases of euro area investment fund shares were also recorded, the acquisition of foreign debt appears to have been partly channelled – in particular for households – through mutual funds. Overall, this confirms that investors were "searching for yield" and investing in the "closest substitutes" to securities targeted under the PSPP, i.e. sovereign debt of advanced countries outside the euro area. We also find evidence for portfolio rebalancing towards longer term maturities as more than 50% of net purchases consisted of securities with a maturity exceeding 10 years. While the aggregate patterns for the euro area are in line with "textbook portfolio rebalancing", we find sector heterogeneity as for instance ICPFs were net buyers of PSPP eligible assets and other euro area debt securities since the launch of the PSPP.

4   Rebalancing under the microscope: empirical results

4.1   Overall results

Table 1 presents the overall estimation results for equation (3) focusing on euro area country-sector net purchases/sales of individual debt securities cumulated over the PSPP period 2014Q4 to 2016Q4. Starting with our main hypotheses introduced in Section 2.3.1, we observe in column (1) that the PSPP eligibility dummy is significantly negative. This confirms hypothesis number 1, i.e. that euro area investors significantly rebalanced their portfolio away from individual securities targeted under the PSPP, even controlling for a vast array of security-specific and country-sector specific factor. In column (2), we add our "PSPP substitute" variable which turns out to be insignificant overall. This might be because investors buy PSPP substitutes through an indirect channel, e.g. they buy investment fund shares which then invest in PSPP

substitutes so that the overall coefficient is insignificant. Another explanation can be found in Figure 3 as investors purchase sizable amounts of non-sovereign debt issued outside the euro area instead of direct substitutes for PSPP eligible assets. This suggests that the "search for yield" is more important in explaining portfolio rebalancing patterns constant risk. Across all estimation in Table 1, we can confirm hypothesis number 2, as we find a significantly positive coefficient on the original maturity variable which indicates that euro area investors were net buyers of relatively more long-term securities. This might be driven be the general decrease in yields, enticing investors to shift to longer-term securities in order to achieve a certain yield within one asset class. The euro dummy fails to be significant, which is in line with hypothesis 3 and therefore suggests an increased rebalancing towards foreign debt securities, especially considering that Boermans and Vermeulen (2016) find evidence for a strong preference for holding euro-denominated debt securities in the pre-APP period.

The coefficient for the other variables show that our novel augmented gravity model at the security-level delivers very reasonable results (column 2). Specifically for the security-specific variables, we estimate a negative coefficient for the pre-PSPP holding variables, confirming the mean reversion also found by Galstyan and Lane (2013), as investors sold (bought) assets that they held relatively large (small) amounts of before the programme started, i.e. in 2014Q4. For the change in the outstanding amount (at market prices) over the PSPP period, we find a significantly positive coefficients which is in line with the predictions of the CAPM as investors were partly following developments of the overall market portfolio.[19] For the gravity variables, we observe for the home variable a significantly positive coefficient, showing that euro investors were more than proportionally buying domestic assets over the PSPP period, which somewhat contradicts our hypothesis number 2. While the volume of trade exhibits a positive sign as expected, the distance between countries remains insignificant, which might be due to the high correlation of these two variables. Moreover, we find language similarity to be insignificant.

In columns (3) to (6), we perform various modifications to these baseline results. In column 3, we exclude all domestic securities (i.e. the net purchases of those securities issued in the residence country of the investor). The results remain largely similar, with the exception of the trade variable which turns negative. In column (4), we replace the bilateral variables with bilateral fixed effects which leaves our baseline results for the other coefficient almost unchanged, suggesting that our set of gravity variables capture the bilateral dimension very well. Next, we exclude all observations that feature Ireland and Luxembourg – both as investor or issuing countries – due to their large importance as financial centres in the euro area. While the results remain largely in line with the baseline, the coefficient on domestic securities roughly doubles, unsurprisingly indicating a much larger home bias for net purchases of debt securities once we exclude the financial centres (column 5). In addition, the coefficient on the trade

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[19]Boermans and Vermeulen (2016) show lower coefficients for cross-sectional holdings before APP ranging from 0.13 for ICPF to 0.55 for households. The authors suggest that an explanation for these low numbers - compared to a predicted coefficient of 1 derived from the CAPM - might be that individual bonds may have several substitutes.

variable increases in size and significance, which is reasonable since trade linkages as drivers of capital flows appear less relevant for the sophisticated investment fund industry in Ireland and Luxembourg compared to the rest of the euro area countries. In column (6), we only include long-term debt securities (i.e. those with an original maturity of more than 12 months), which delivers very similar results and likely being driven by the large share of these securities in overall debt securities (around 95% in our sample).[20]

In Table 2, we present the main specification results for equity securities, split into investment fund shares (left) and other listed equity (right). We find some evidence for hypothesis 3 as there is a significant positive coefficient on the euro denomination dummy in the case of investment fund shares (column 1), which is in line with our descriptive analysis. However, this variable is insignificant for listed equity (column 5). Taken together with the descriptive evidence, this suggests that euro area investors wanted to achieve higher yields — via investment fund shares – while at the same time buying these shares denominated in euro in order to be at least partly shielded from exchange rate fluctuations.

In line with results for debt, we find the pre-PSPP holdings and the change in the market capitalisation to be significantly negative and positive, respectively. Both variables exhibit larger (absolute) coefficients for investment fund shares. The gravity variables (trade and common language) as well as the home bias are only significant with the expected signs for listed equity. This suggests that investors prefer domestic corporate shares or corporate shares from countries with strong trade relationships and more similar languages. Flows into investment fund shares are however not influenced by these gravity factors, which is intuitive as the domicile of an investment fund appears to be of secondary (if any) importance compared to the mandate or target of a fund. All results are robust to excluding domestic securities (columns 2 and 6), including bilateral fixed effects (columns 3 and 7) and excluding Ireland and Luxembourg (columns 4 and 8).

4.2   Sector heterogeneity

In Table 3, we run our main specification, but estimate heterogeneous coefficients by interacting all independent variables with sector dummies. As outlined in Section 2.3.1, we expect significant heterogeneity among sectors due to different regulatory restrictions, asset management strategies and sophistication with regard to financial market developments. This heterogeneity is clearly reflected in our results, especially considering the coefficients which respond to our main hypotheses.

In particular, with regard to hypothesis 1, OFIs show "textbook portfolio rebalancing" as we find a significant negative coefficient for PSPP eligibility. At the same time OFIs invested significantly in the assets that we define as closest substitute to the PSPP-eligible securities.

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[20]In unreported robustness estimations, we include the average yield and rating of a security over the PSPP period. Both variables turn out to be insignificant, while the other variables remain largely unaffected. However, our sample size shrinks by about 50% and 75%, respectively, in these estimations.

Combining this with our descriptive evidence (see Figure 6 - 8) and taking into account the "flow-of-funds" within the euro area, these investment patterns reflect to a large extent the "channelling" of the underlying, ultimate investors' preferences via investment funds. This also implies that the insignificance of the closest substitute in Table 1 is likely to be driven by the fact that other sectors are channelling their investments into closest substitutes via OFIs rather than investing into foreign sovereign debt directly. German households, for example, are more likely to purchase a Luxembourg-based investment fund with a mandate to invest in overseas sovereign debt, rather than buying a US treasury directly.

Moreover, we find that non-financial corporations and households were significant net sellers of euro denominated assets and especially PSPP eligible assets, suggesting that these two sectors in particular made use of investment funds to gain exposure to foreign sovereign debt. For MFIs and insurance companies and pension funds on the other hand the PSPP eligible coefficient is insignificant, while the one on euro-denomination is significantly positive. This is in line with banks having an incentive to hold PSPP eligible assets because of the zero risk weight attached to them and due to their role as collateral in monetary policy operations. The fact that the PSPP eligibility coefficient is not significant for MFIs, while Figure 4 showed that MFIs were the sector with the largest net sales of PSPP securities may be puzzling at first sight. However, it is important to note that the regression analysis controls for a vast array of factors, as in particular the pre-PSPP level of PSPP-eligible assets which were the largest for MFIs as well as country-sector fixed effects. Moreover, the regression results are further underpinned by the fact that MFIs' net sales of other euro area debt securities were three times larger than those of PSPP eligible debt securities (Figure 4).

Insurance companies and pension funds naturally prefer PSPP eligible and euro denominated debt securities to match their often long-term and euro denominated liabilities. This is also reflected in a strong preference for net purchases of longer-term securities, which is particularly large for this sector together, followed by NFCs and households, which is thus in line with our second hypothesis, while failing to be significant for MFIs and ICPFs.

The home bias as well as the trade variable are significant for all sectors besides OFIs, which might be due to their residence being largely in euro area financial centre countries as well as a higher degree of sophistication in asset management, leading to stronger portfolio diversification. Finally, we can see that the negative coefficient on pre-PSPP holdings and the positive sign on changes in the outstanding amounts of a security remain significant across all sectors.

In Table 4, we repeat the sectoral specification for equities, again split into net purchases of investment fund shares (left panel) and other listed equity (right panel). We find a significant euro denomination preference across all sectors for investment fund shares. This is in line with our suggestion that some investors have partly "channelled" their investment in PSPP substitutes through euro area investment funds, which then bought these assets on their behalf (see Table 3). For listed shares, MFIs, ICPFs and OFIs exhibit a significant home bias in net

purchases as well as more net purchases of securities issued by countries with whom they are connected through a strong trade relationship. Conversely, gravity variables are insignificant or even contrary to common patterns for investment fund shares. This might be the case as investment products are often very standardised in comparison to corporate equity, where more informational frictions might be driving the gravity pattern. In addition, equity issued by investment funds are concentrated in Luxembourg and Ireland, i.e. supply is not evenly distributed. The negative coefficient on pre-PSPP holdings and the positive sign on changes in the outstanding amounts of a security remain significant across all sectors.

4.3 Country heterogeneity

The sovereign debt crisis exposed significant country-differences in terms of macroeconomic and financial stability within the euro area. Accordingly, Albertazzi et al. (2018) and Koijen et al. (2016) analyse the impact of PSPP focusing on a potential difference in the transmission between the (formerly) stressed and the other 'non-stressed' euro area countries.[21] Table 5 reports the estimation results split by debt and equity securities. With regard to hypothesis number 1, we observe that both country groups were significant net sellers of PSPP eligible securities, but the coefficients is almost three times as large for stressed countries. A positive home bias is only observed for non-stressed countries, which indicates that investors from stressed countries rebalanced away more strongly from domestic and PSPP-eligible assets. Moreover, the 'reversion to the mean' is significantly stronger for stressed countries, showing that investors were more active in cutting overweight pre-PSPP positions. As regards our second hypothesis, only investors of non-stressed countries increased significantly their investment in longer-term maturity bonds, which may be driven by the fact that yields were lower in these countries, thus the pressure to shift into longer-term maturities was more pressing. With respect to hypothesis number 3, both country groups were significant net buyers of euro-denominated equity, which is not the case for debt, reflecting the overall rebalancing from euro area debt towards euro area equity. Also in terms of equity, only non-stressed countries buy relatively more domestic assets as well as assets from countries with stronger trade relationships.

4.4 Time dynamics

Next we consider the time dynamics in euro area portfolio rebalancing for debt securities during the APP period in Table 6, in which our baseline estimation covering the 8 quarters since the start of the PSPP is displayed in column (3). In column (1), we consider the determinants of 'short-term' rebalancing (in the two quarters since the start of the PSPP, 2015Q1 to 2015Q2) for which we already observe significant coefficients on the investments away from PSPP eligible assets and euro-denominated debt securities. Moreover, for net purchases in this short-term

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[21]The group of (formerly) stressed countries consists of Cyprus, Greece, Italy, Portugal and Spain. We exclude Ireland and Luxembourg from these estimations due to their large financial intermediation role.

period, we find a relatively strong positive coefficient on changes in the outstanding amount of a security – suggesting that investors generally follow the market portfolio – and a significant reversion to the mean.

In the second column we analyse net purchases cumulated over the medium-term (6 quarters), in which the negative coefficients on PSPP eligibility and euro-denomination turn larger than in the short-term and also larger than in our baseline estimation covering 8 quarters, suggesting that in this period the rebalancing forces of euro area investors were the strongest. Moreover, the coefficient on the original maturity of a security becomes significant (with the usual positive sign, albeit not as large as in the third column), which indicates that investors switched over the medium-term to longer-term maturities, likely reflecting the extended period of low yields. Thus, in the medium-term estimations all three of our hypothesis are confirmed. From this point on, trade and home bias also start to become significant, which might suggests that investors are reverting to some extent to familiar investment patterns after the initial surprise of the (size of) the PSPP programme.

Importantly, net sales of euro denominated assets were only significant in the short- and medium-term, but not in column 3, which might be in line with the strong announcement effects of the programme (Georgiadis and Graeb, 2016) and also possibly reflect that the need for euro assets of certain sectors prevents a rebalancing away from euro-denominated securities over a longer time period.

In column (4) we test whether our analysis gives different results if we start it in the third quarter of 2014, which includes the ECB's credit easing package of June 2014[22] and to account for potential anticipation effects for an LSAP in the euro area following Draghi (2014)'s speech at Jackson Hole. Interestingly, even though the estimation period also covers the whole PSPP period, we do not find a significant coefficient for PSPP eligibility which indicates that euro area investors did not actively rebalance away from PSPP eligible securities in anticipation of the PSPP, but only since the actual start of the programme. This suggest that investors were betting on making gains on the increasing prices of debt securities in the run-up to the PSPP, while becoming net sellers of these securities later on, likely due to the extended low-yield environment.

To explore these patterns across sectors we zoom in on the time dynamics of the PSPP eligibility coefficients for each sector (Table 7). We find that the overall pattern of the strongest rebalancing in the medium term (6 quarters) is driven by OFIs and households. Households are the only sector that shows significant sales of PSPP eligible assets in the short term (2 quarters) and possibly even in anticipation of the programme.

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[22]https://www.ecb.europa.eu/mopo/implement/omo/tltro/html/index.en.html

4.5 Active vs. passive rebalancing

Finally, motivated by the theoretical model of Tille and van Wincoop (2010), we shed more light on the different dynamics of the *active* (i.e. net purchases) and the *passive* channels of portfolio rebalancing. We analyse euro area investors' active versus passive portfolio rebalancing as changes in overall holdings can arise both from net purchases/sales and from capital gains resulting from fluctuations in security prices and exchange rates.[23]

In Table 8 column (1), our dependent variables are, respectively, the cumulated net purchases of debt securities over 2015Q1-2016Q4 $ln(flow_{a,h,s})$, the corresponding change in holdings from 2014q4 until 2016q4 $\Delta(ln(stock_{a,h,s}))$ in column (3) and in column (2) the difference – i.e. $[\Delta ln(stock_{a,h,s}) - ln(flow_{a,h,s})]$ as valuation changes. While running a full regression analysis, we zoom in on hypothesis 1 and observe – as in our baseline estimation – a negative coefficient on PSPP eligibility for transactions. Moreover, we obtain a positive coefficient in the 'passive' rebalancing estimation implying that euro area investors recorded significant positive valuation gains in PSPP eligible assets relative to all other debt securities held during this period. For changes in overall holdings, we do not find a significant coefficient for PSPP eligible asset during our period of analysis (column 3). This emphasises the importance of analysing actual transactions rather than proxing these with changes in holdings.

Across sectors, the second panel of Table 8 shows that the observed aggregate patterns are driven by OFIs, MFIs and households, albeit to varying degrees. Significant net sales and positive valuation gains in PSPP-eligible securities are found for all three sectors, while a significant (and negative) coefficient in the overall change in holdings estimation is only obtained for households.[24]

Descriptive evidence on the aggregate volumes of the active and passive rebalancing components by sector (Figure 15) highlights that sizeable valuation gains in PSPP eligible assets were achieved by ICPFs, i.e. the sector that continued to be a net buyer of these assets, while MFIs and households recorded large net sales of these assets and only small valuation gains during the PSPP period. OFIs on the other hand, generated more sizeable valuation gains, while selling PSPP eligible assets, thereby offsetting part of the net sales.

The results in this subsection highlight that the *active* (i.e. net purchases) and *passive* channels of portfolio rebalancing in PSPP eligible securities were working in opposite directions during the PSPP period. Thereby, overall net sales of these securities by euro area investors were only partly offset by positive valuation gains.

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[23]A subsample is used as (1) this analysis is only possible for those securities that were held by a certain sector both before the launch of the PSPP (i.e. at the end of 2014Q4) as well as at the end of our sample period, i.e. 2016Q4 and (2) we can only analyse securities for which holdings as well as transactions were reported.

[24]In this subsample, significant (at the 10% level) net sales of PSPP-eligble securities are recorded for MFIs.

5 Conclusion

Our paper analyses is – to the best of our knowledge – the first to analyse actual international capital flows (i.e. net purchases or net sales) at the security level in a gravity model setting. With our augmented gravity model of bilateral capital flows at the security level, we are able to test three main hypotheses with regard to the impact of the APP on portfolio rebalancing, for which we emphasize significant sector and country heterogeneity within the euro area:

First, we expected euro area investors to be net sellers of the assets targeted by the Eurosystem under the PSPP and to rebalance into the closest substitutes. Descriptively, we observe that euro area investors rebalanced their portfolios from domestic and other euro area debt securities towards foreign debt. Our regression analysis confirms that euro area investors significantly rebalanced away from individual securities targeted under the PSPP. In particular, OFIs show "textbook porfolio rebalancing" as they invested significantly in the assets that we define as closest substitute to the PSPP-eligible securities. Moreover, we find that non-financial corporations and households were significant net sellers of euro denominated assets and especially PSPP eligible assets, suggesting that these two sectors in particular made use of investment funds to gain exposure to foreign sovereign debt. MFIs and insurance companies and pension funds on the other hand are not found to be significant net sellers of PSPP eligible assets and were significant net buyers of euro denominated securities, due to regulatory and balance sheet management reasons. We find that both the (formerly) stressed and non-stressed euro area countries were significant net sellers of PSPP eligible securities, but the impact has been larger for stressed countries. Overall, we observe that investors were "searching for yield" and investing in the "closest substitutes" to securities targeted under the PSPP, i.e. sovereign debt of advanced countries outside the euro area.

Second, we expected investors to rebalance into securities with longer maturities, for which we find significant evidence as euro area investors were net buyers of relatively more long-term securities. This was particularly pronounced for ICPFs, followed by NFCs and households, while failing to be significant for MFIs and OFIs. Overall, net purchases of securities with a maturity exceeding 10 years made up 50% of net debt.

Third, we expected a weakening of the home bias and euro-denomination bias in <u>debt</u> securities, but a continued preference for euro-denominated <u>equity</u>. Indeed, we observe evidence for a rebalancing away from euro-denominated debt securities, while there is still a positive bias for euro denominated investment fund shares. Taken together with the descriptive evidence, this suggests that euro area investors wanted to achieve higher yields — via investment fund shares – while at the same time buying these shares in euros so as to being shielded from exchange rate fluctuations.

We also investigate for for potential anticipation effects of the PSPP following Draghi (2014) speech at Jackson Hole, but find that euro area investors did not actively rebalance away from PSPP eligible securities in anticipation of the PSPP, but only since the actual start of the

programme.

Finally, as our dataset also comprises the holdings of individual securities, we are able to decompose overall portfolio rebalancing of euro area investors into 'active' (i.e. capital flows) and 'passive' components (i.e. valuation changes due to fluctuations in security prices and exchange rates) in line with Tille and van Wincoop (2010). This analysis reveals the importance of analysing actual transactions rather than proxing these with changes in holdings. Moreover, we find that active net sales of PSPP-eligible securities by euro area investors were only partly offset by positive capital gains.

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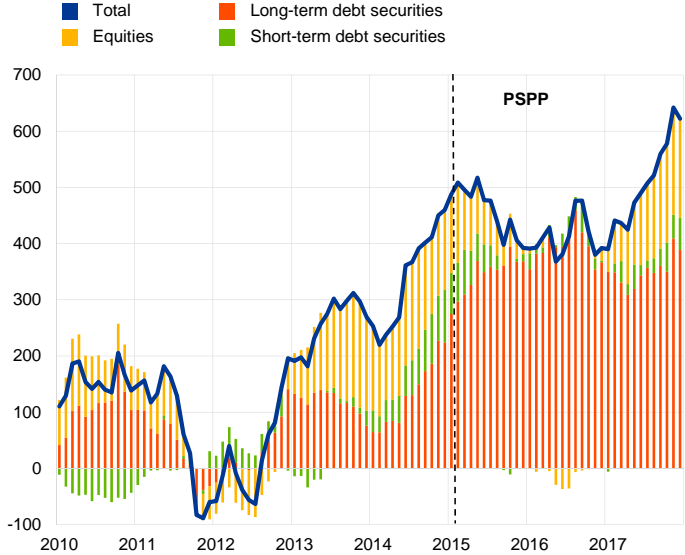
6 Figures

Figure 1: Breakdown of euro area net portfolio investment flows
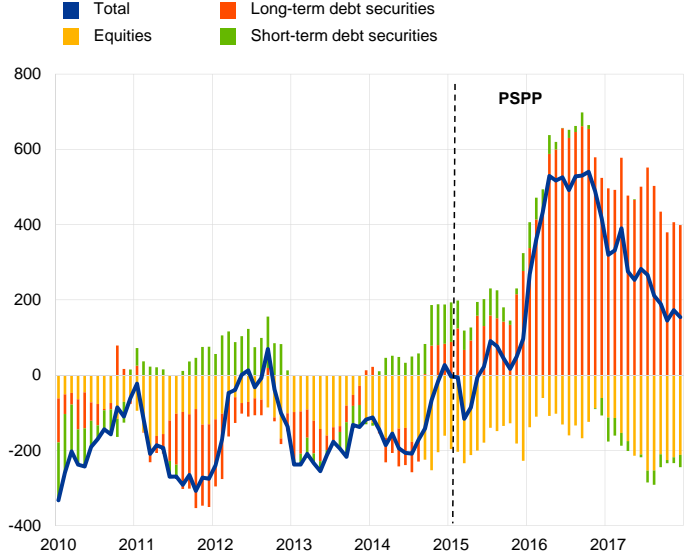
Notes: A positive (negative) number indicates net outflows (inflows) from (into) the euro area. Equity includes investment fund shares. Last observation is December 2017. 12-month cumulated sums in bn EUR.

Figure 2: Breakdown of euro area portfolio investment outflows

Notes: A positive (negative) number indicates net purchases (sales) of non-euro area securities by euro area investors. Equity includes investment fund shares. Last observation is December 2017. 12-month cumulated sums in bn EUR.
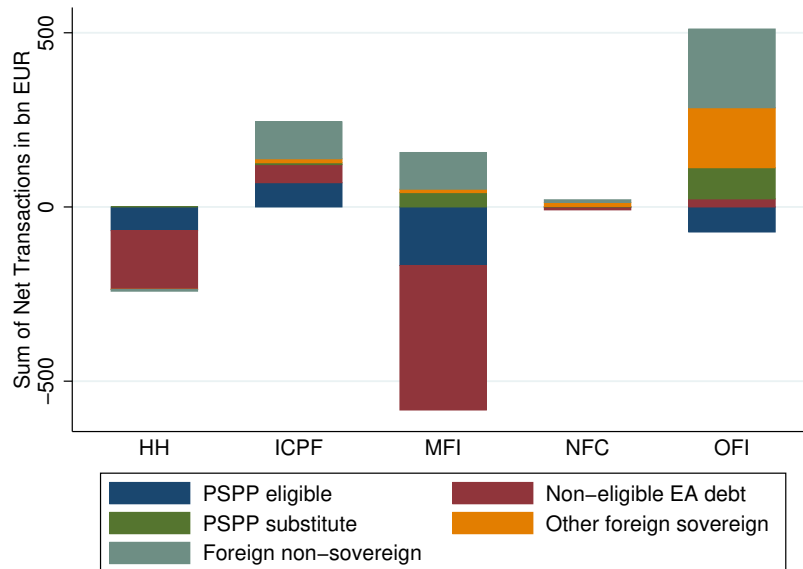
Figure 3: Net debt purchases

Figure 4: Net debt purchases by sector

Figure 5: Net debt purchases by country
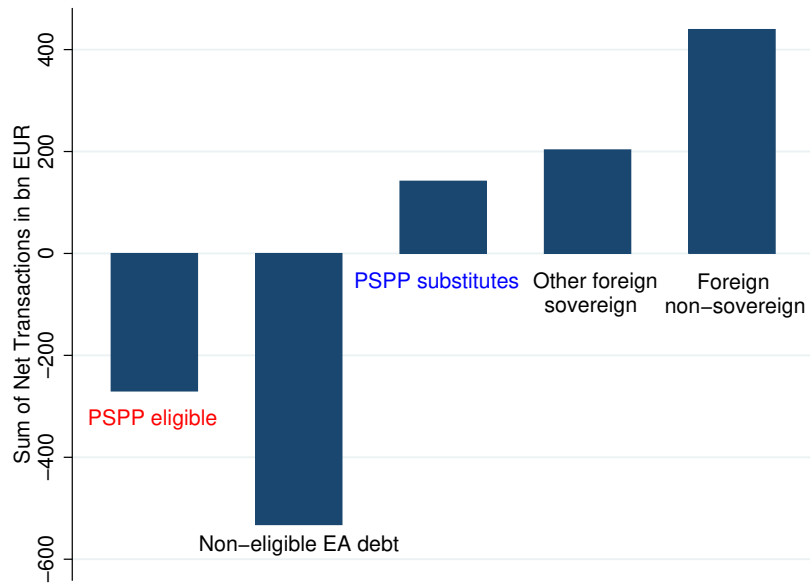
Notes: Cumulated net purchases from 2015Q1-2016Q4. PSPP eligible assets are securities eligible to be bought under the APP programme. PSPP substitutes are sovereign debt securities from advanced countries outside the euro area which also fulfill the rest of the eligibility criteria of the PSPP programme. Data is in bn EUR.
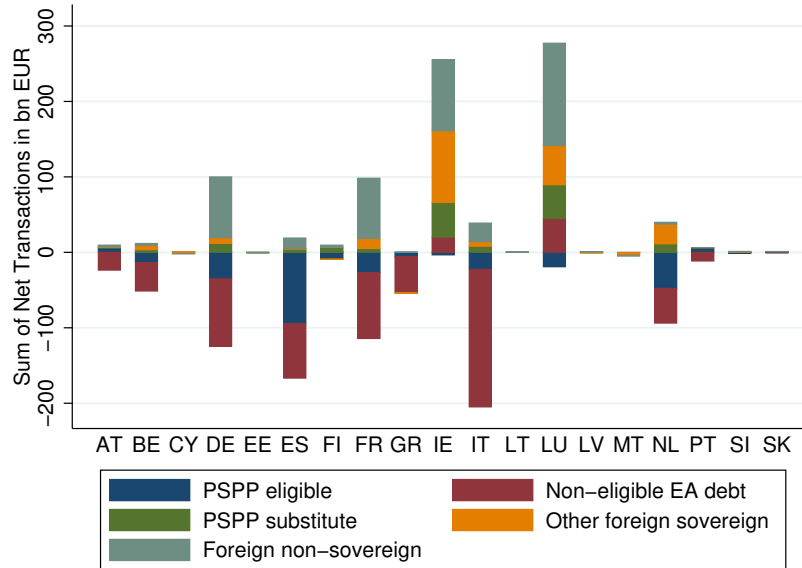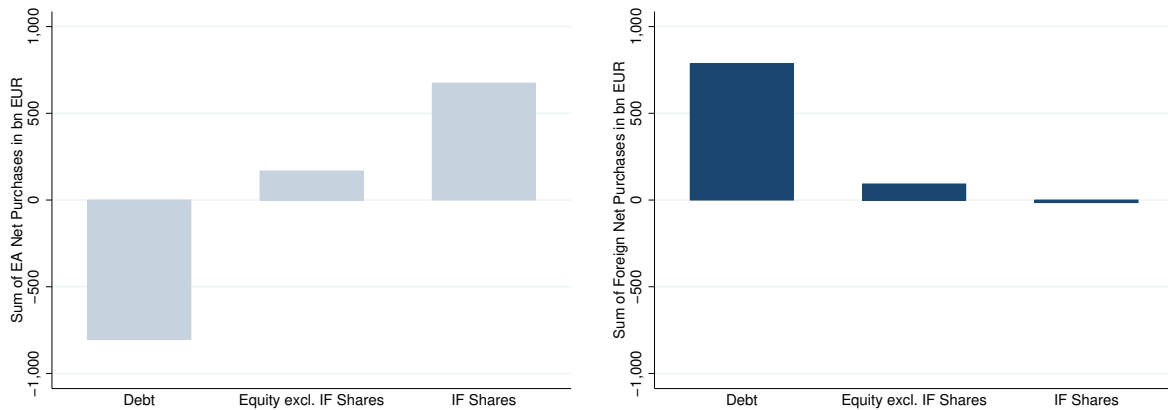
Figure 6: Net purchases: intra-(LHS) and extra-euro area (RHS)

Notes: Cumulated net purchases from 2015Q1-2016Q4 of euro area securities on the left and out-of-euro area assets on the right hand side. Data is in bn EUR.

Figure 7: Net purchases by sector: intra-(LHS) and extra-euro area (RHS)

Source: ECB
Notes: Cumulated net purchases from 2015Q1-2016Q4 of euro area securities on the left and out-of-euro area assets on the right hand side. Data is in bn EUR.
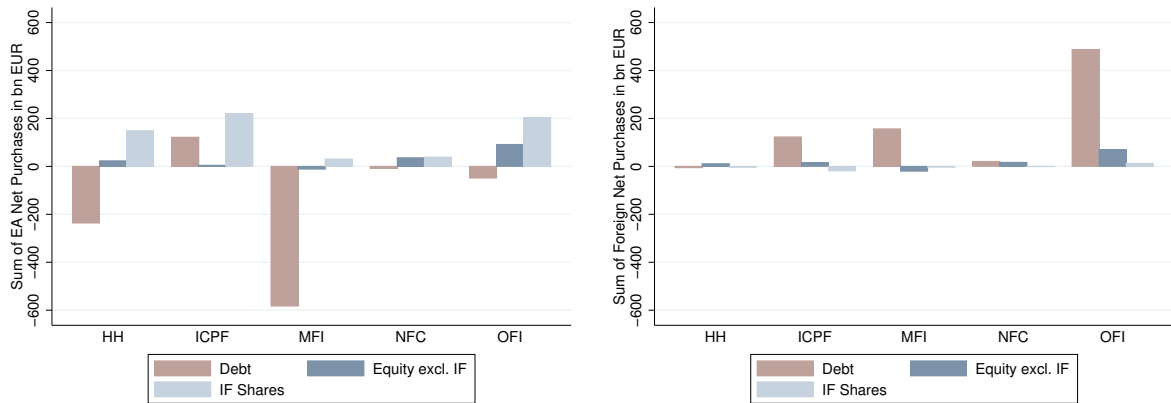
Figure 8: Net purchases by country: intra-(LHS) and extra-euro area (RHS)
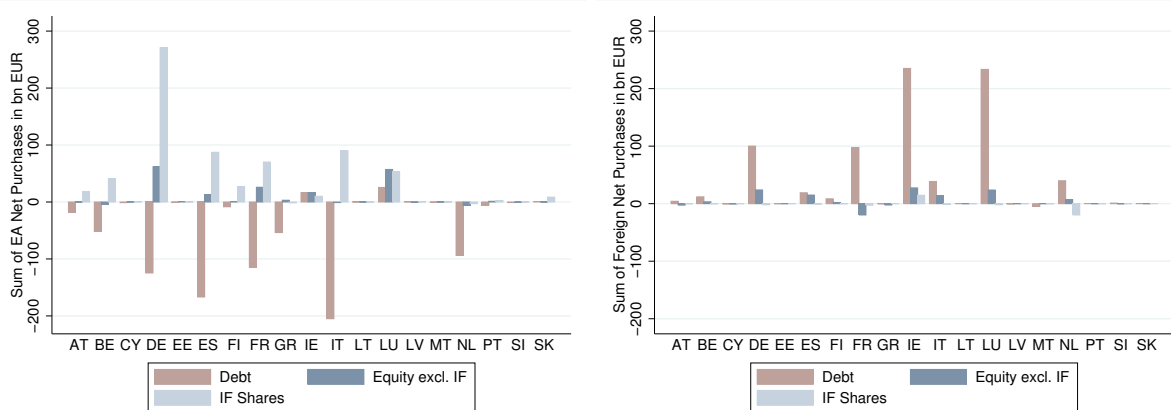
Source: ECB
Notes: Cumulated net purchases from 2015Q1-2016Q4 of euro area securities on the left and out-of-euro area assets on the right hand side. Data is in bn EUR.

Figure 9: Net purchases of investment fund shares split by their main mandate
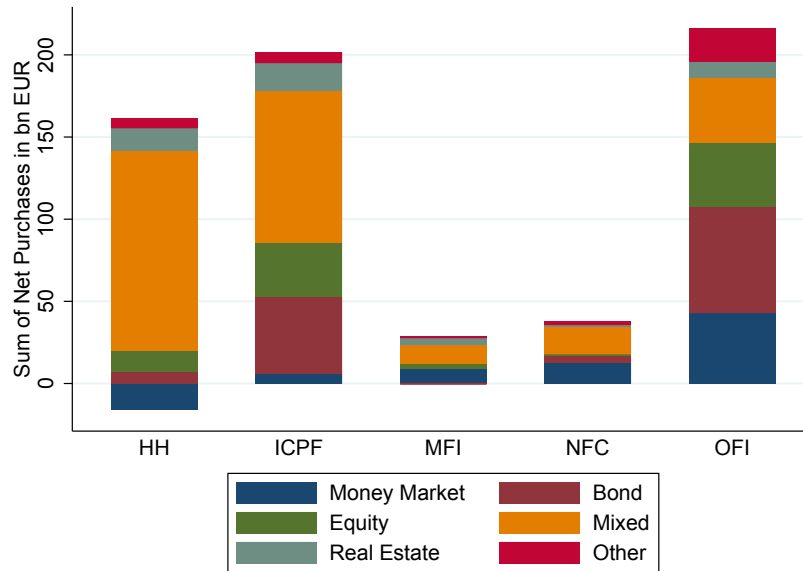
Figure 10: Net purchases: debt (LHS) and equity (RHS)
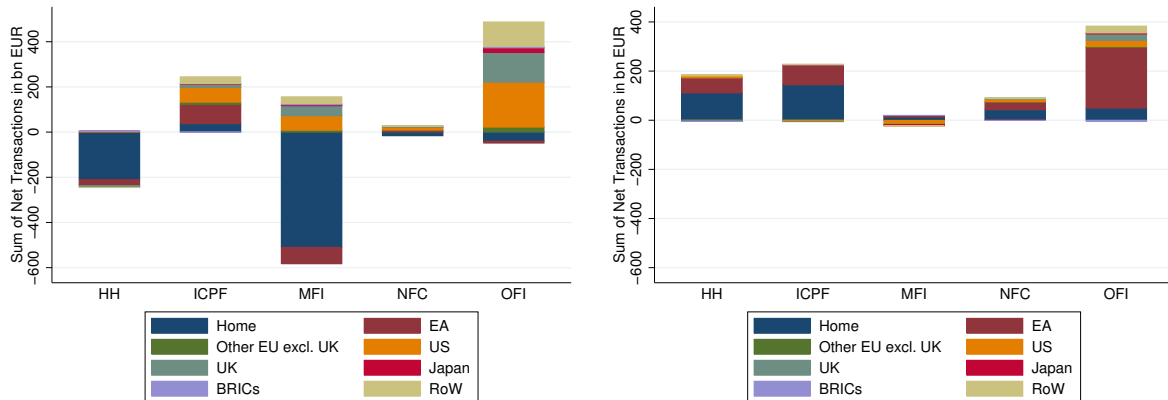
Figure 11: Net purchases by currency: debt (LHS) and equity (RHS)
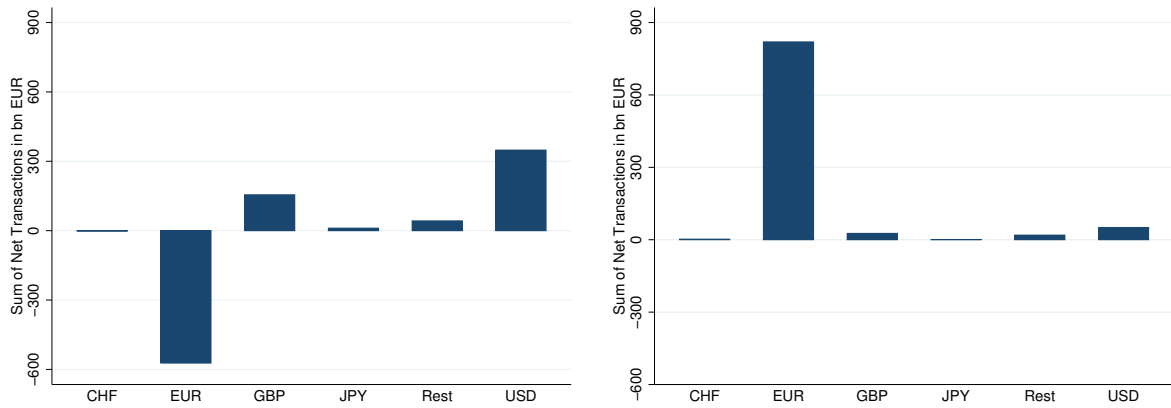
Notes: Cumulated net purchases from 2015Q1-2016Q4 of debt securities on the left and equity securities on the right hand side. Data is in bn EUR.

Figure 12: Net purchases by sector: debt (LHS) and equity (RHS)
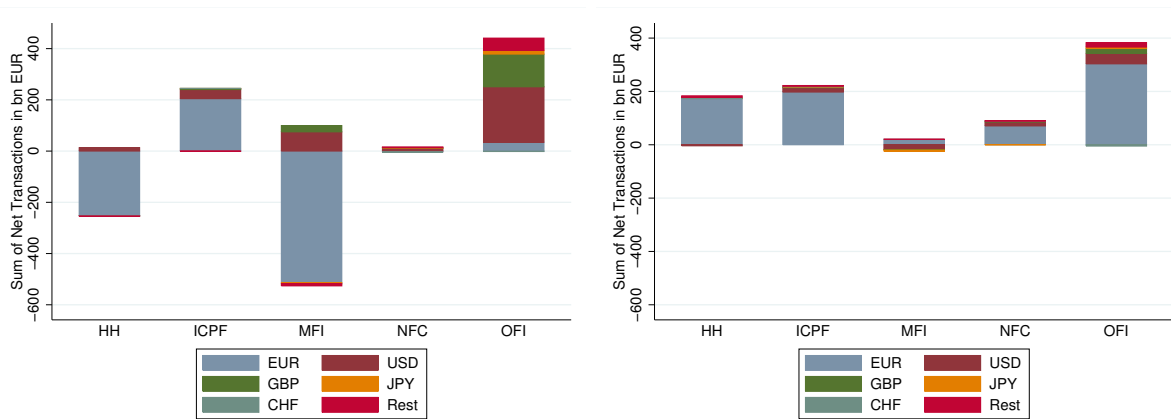
Notes: Cumulated net purchases from 2015Q1-2016Q4 of debt securities on the left and equity securities on the right hand side. Data is in bn EUR.

Figure 13: Net debt purchases
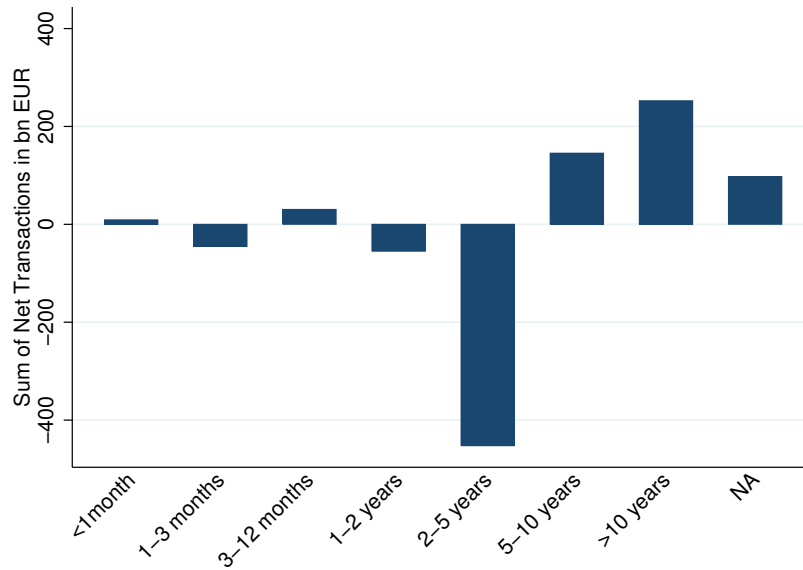
Source: ECB
Notes: Cumulated net debt purchases from 2015Q1-2016Q4 split by maturity (at origination) buckets. Data is in bn EUR.

Figure 14: Net debt purchases by sector
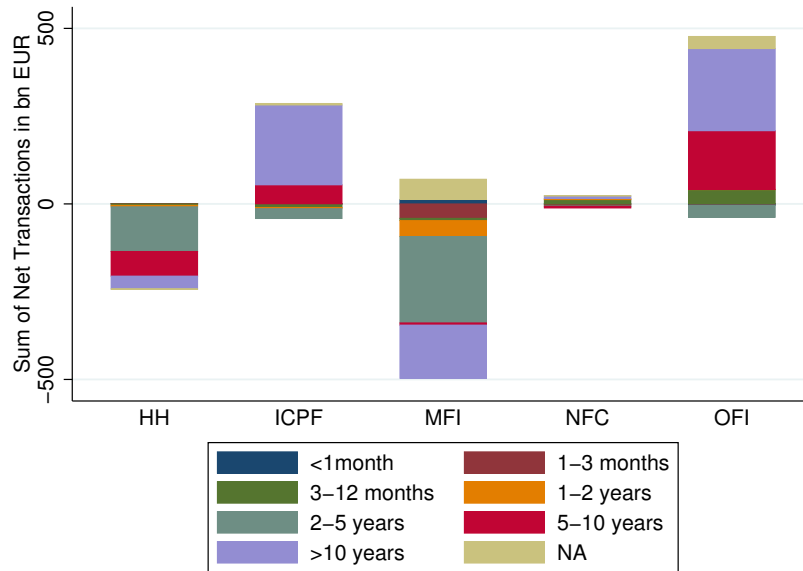
Source: ECB
Notes: Cumulated net debt purchases from 2015Q1-2016Q4 split by maturity buckets. Data is in bn EUR.

Figure 15: Net debt purchases, change in holdings, and valuation effects by sector
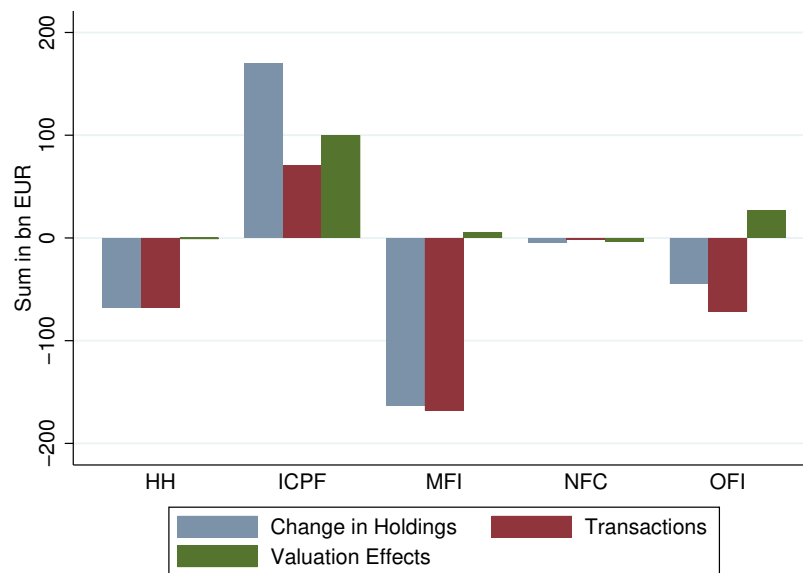
7 Tables

Table 1: Baseline estimation: debt securities

	(1) All	(2) All	(3) Foreign	(4) Bilateral FE	(5) no IE&LU	(6) only LT
$\ln(\text{Hold}_{pre})$	-0.624***	-0.624***	-0.615***	-0.654***	-0.733***	-0.629***
	(-10.22)	(-10.22)	(-8.24)	(-10.84)	(-13.45)	(-9.89)
Δ Amount Out	0.508***	0.508***	0.473***	0.505***	0.509***	0.510***
	(26.36)	(26.35)	(30.29)	(26.74)	(23.16)	(26.34)
Home	5.403**	5.403**			10.59***	5.542**
	(2.07)	(2.07)			(2.66)	(2.10)
$\ln(\text{Distance})$	0.0375	0.0375	-0.240		0.230	0.0460
	(0.21)	(0.21)	(-1.15)		(1.34)	(0.25)
$\ln(\text{Trade})$	0.227**	0.227**	-0.371**		0.407***	0.230**
	(2.45)	(2.45)	(-2.00)		(2.78)	(2.44)
Common Language	0.0250	0.0251	0.881		-0.154	0.0478
	(0.05)	(0.05)	(1.35)		(-0.33)	(0.10)
EUR	-0.390	-0.390	-0.258	-0.338	-0.301	-0.394
	(-1.33)	(-1.33)	(-0.91)	(-1.26)	(-0.84)	(-1.29)
$\ln(\text{original maturity})$	0.516***	0.517***	0.302*	0.567***	0.809***	0.437**
	(3.14)	(3.13)	(1.96)	(3.63)	(6.74)	(2.00)
PSPP eligibility	-0.746***	-0.746***	-0.640**	-0.809***	-0.852***	-0.711**
	(-2.76)	(-2.76)	(-2.16)	(-3.10)	(-2.85)	(-2.61)
PSPP substitute		0.0856	-0.0729	0.170	0.328	0.318
		(0.18)	(-0.16)	(0.34)	(0.70)	(0.46)
Observations	660750	660750	438455	683006	549519	629473
Holder country-sector FE	yes	yes	yes	yes	yes	yes
Issuer country-sector FE	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is the ln of the sum of all transactions of debt securities during the PSPP period (2015q1-2016q4). T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 2: Baseline estimation: equity securities

	Investment Fund Shares				Equity Securities			
	(1) All	(2) Foreign	(3) Bilateral FE	(4) no IE&LU	(5) All	(6) Foreign	(7) Bilateral FE	(8) no IE&LU
ln(Hold_pre)	-0.526***	-0.617***	-0.550***	-0.548***	-0.237***	-0.251***	-0.236***	-0.247***
	(-10.42)	(-19.12)	(-10.85)	(-9.72)	(-6.07)	(-5.98)	(-6.27)	(-5.37)
Δ Amount Out	0.555***	0.514***	0.559***	0.573***	0.308***	0.308***	0.308***	0.285***
	(22.29)	(15.65)	(23.76)	(21.17)	(14.70)	(14.35)	(14.62)	(17.69)
Home	-1.698			5.913	6.408*			6.757*
	(-0.62)			(1.41)	(1.95)			(1.74)
ln(Distance)	-0.290	-0.0296		-0.0699	0.207	0.194		0.251
	(-1.24)	(-0.15)		(-0.32)	(1.08)	(1.06)		(1.21)
ln(Trade)	-0.134	0.342		0.124	0.268**	0.349**		0.267*
	(-1.29)	(1.46)		(0.82)	(2.13)	(2.03)		(1.86)
Common Language	-0.992	-1.097		-1.840***	1.639***	1.472**		1.412**
	(-1.52)	(-1.43)		(-2.94)	(2.72)	(2.29)		(2.15)
EUR	1.075***	1.230***	1.189***	1.192***	0.268	0.300	0.268	0.166
	(6.92)	(7.78)	(7.57)	(7.12)	(1.09)	(1.08)	(1.14)	(0.60)
Observations	287839	205663	307307	242484	273805	259651	285390	220398
Holder country-sector FE	yes	yes	yes	yes	yes	yes	yes	yes
Issuer country-sector FE	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable is the ln of the sum of all transactions of equity securities during the PSPP period (2015q1-2016q4). T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 3: Sectoral estimation: debt securities

	(1) MFI	(2) ICPF	(3) OFI	(4) NFC	(5) HH
ln(Hold$_{pre}$)	-0.680***	-0.529***	-0.487***	-0.636***	-0.793***
	(-7.26)	(-6.01)	(-4.81)	(-8.01)	(-10.60)
Δ Amount Out	0.641***	0.516***	0.491***	0.481***	0.450***
	(9.27)	(11.00)	(19.44)	(27.66)	(21.43)
Home	11.29***	7.245**	2.229	7.551**	10.58***
	(4.96)	(2.51)	(0.62)	(2.40)	(5.09)
ln(Distance)	0.214	0.390**	0.0115	0.0724	0.387**
	(1.16)	(2.22)	(0.05)	(0.43)	(2.31)
ln(Trade)	0.410***	0.300***	0.114	0.290**	0.426***
	(4.95)	(2.72)	(0.96)	(2.61)	(5.86)
Common Language	-0.227	1.224*	0.826	0.287	-0.753
	(-0.36)	(1.68)	(1.11)	(0.35)	(-1.23)
EUR	0.684***	1.247*	-0.299	-0.928***	-2.186***
	(2.92)	(1.77)	(-0.82)	(-3.30)	(-8.73)
ln(original maturity)	-0.152	1.196***	0.261	0.918***	0.918***
	(-0.48)	(3.20)	(0.98)	(10.42)	(7.63)
PSPP eligibility	-1.329	-0.0849	-1.174***	-0.787*	-1.486***
	(-1.32)	(-0.19)	(-2.86)	(-1.69)	(-3.99)
PSPP substitute	-0.313	-1.109	1.907***	-0.592	-0.314
	(-0.33)	(-1.31)	(3.15)	(-0.72)	(-0.39)
Observations			660654		
Holder country-sector FE			yes		
Issuer country-sector FE			yes		

Notes: The dependent variable is the ln of the sum of all transactions of debt securities during the PSPP period (2015q1-2016q4). T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 4: Sectoral estimation: equity securities

	Investment Fund Shares					Equity Securities				
	(1) MFI	(2) ICPF	(3) OFI	(4) NFC	(5) HH	(6) MFI	(7) ICPF	(8) OFI	(9) NFC	(10) HH
$\ln(\text{Hold}_{pre})$	-0.259***	-0.484***	-0.459***	-0.582***	-0.684***	-0.498***	-0.132	-0.306***	-0.241***	-0.189***
	(-3.51)	(-3.20)	(-6.85)	(-5.25)	(-12.99)	(-7.19)	(-1.17)	(-4.60)	(-3.07)	(-3.12)
Δ Amount Out	0.337***	0.591***	0.575***	0.544***	0.559***	0.240***	0.375***	0.426***	0.213***	0.252***
	(5.48)	(7.64)	(21.99)	(15.24)	(14.73)	(9.91)	(9.85)	(14.08)	(8.68)	(10.71)
Home	-1.599	-3.105	-3.762	-4.285*	-2.323	8.878***	12.04***	6.436***	4.938	1.163
	(-0.45)	(-1.00)	(-1.39)	(-1.73)	(-0.66)	(3.40)	(4.09)	(2.96)	(1.49)	(0.52)
ln(Distance)	-0.444*	-0.307	0.0392	-0.343	-0.396	0.359	0.626*	0.421**	-0.191	-0.0217
	(-1.86)	(-1.17)	(0.17)	(-1.45)	(-1.64)	(1.45)	(1.90)	(2.04)	(-0.99)	(-0.13)
ln(Trade)	-0.186	-0.110	-0.252**	-0.246***	-0.137	0.410***	0.527***	0.275***	0.130	0.0929
	(-1.66)	(-0.73)	(-2.22)	(-2.73)	(-0.98)	(4.53)	(3.69)	(2.97)	(1.00)	(1.10)
Common Language	-2.303	1.577	0.0171	-0.551	-1.198*	-0.466	2.522	2.110**	1.063*	1.889***
	(-1.56)	(0.77)	(0.02)	(-0.38)	(-1.94)	(-0.27)	(0.87)	(2.17)	(1.98)	(4.13)
EUR	0.489***	1.883***	0.959***	1.867***	0.792***	-0.661	0.164	0.328	-0.760	-0.534
	(4.24)	(7.88)	(3.40)	(5.11)	(3.82)	(-1.06)	(0.35)	(0.64)	(-1.54)	(-1.53)
Observations	287839					273805				
Holder country-sector FE	yes					yes				
Issuer country-sector FE	yes					yes				

Notes: The dependent variable is the ln of the sum of all transactions of equity securities during the PSPP period (2015q1-2016q4). T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 5: Country-group estimation: debt and equity securities

	(1) Debt Stressed	(2) Debt Non-stressed	(3) Equity Stressed	(4) Equity Non-stressed
$\ln(\text{Hold}_{pre})$	-0.896***	-0.688***	-0.464***	-0.342***
	(-9.28)	(-14.05)	(-9.51)	(-8.04)
Δ Amount Out	0.548***	0.497***	0.410***	0.414***
	(9.61)	(23.89)	(14.96)	(18.47)
Home	4.335	9.246**	3.422	8.484***
	(0.95)	(2.35)	(0.89)	(2.78)
$\ln(\text{Distance})$	-0.396	0.0569	-0.0289	0.196
	(-1.40)	(0.37)	(-0.08)	(0.90)
$\ln(\text{Trade})$	0.259	0.357**	0.161	0.265**
	(1.52)	(2.48)	(1.20)	(2.50)
Common Language	1.361	-0.0743	1.222	-0.823
	(1.38)	(-0.16)	(1.47)	(-1.40)
EUR	0.0439	-0.395	1.810***	0.761***
	(0.07)	(-0.97)	(7.41)	(4.63)
$\ln(\text{original maturity})$	0.332	0.894***		
	(1.23)	(8.45)		
PSPP eligibility	-1.807***	-0.652*		
	(-2.70)	(-1.77)		
Observations	549419		462910	
Holder country-sector FE	yes		yes	
Issuer country-sector FE	yes		yes	

Notes: The dependent variable is the ln of the sum of all transactions of debt/equity securities during the PSPP period (2015q1-2016q4). T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 6: Extension of the baseline estimation: Time Dimension

	(1) From 15Q1 until 15Q2	(2) From 15Q1 until 16Q2	(3) From 15Q1 until 16Q4	(4) From 14Q3 until 16Q4
$\ln(\text{Hold}_{pre})$	-0.285***	-0.562***	-0.624***	-0.673***
	(-3.39)	(-8.96)	(-10.22)	(-9.11)
Δ Amount Out	0.666***	0.545***	0.508***	0.514***
	(19.58)	(28.15)	(26.35)	(27.58)
Home	-0.424	5.395*	5.403**	5.079**
	(-0.16)	(1.81)	(2.07)	(2.09)
ln(Distance)	-0.285	0.0127	0.0375	0.0161
	(-1.38)	(0.06)	(0.21)	(0.08)
ln(Trade)	0.0100	0.223**	0.227**	0.211**
	(0.11)	(2.19)	(2.45)	(2.55)
Common Language	0.0652	0.128	0.0251	-0.395
	(0.08)	(0.22)	(0.05)	(-0.73)
EUR	-0.562**	-0.708**	-0.390	-0.515
	(-2.07)	(-2.49)	(-1.33)	(-1.55)
ln(original maturity)	0.277	0.395**	0.517***	0.423*
	(1.33)	(2.14)	(3.13)	(1.82)
PSPP eligibility	-0.464*	-1.000***	-0.746***	-0.544
	(-1.67)	(-4.58)	(-2.76)	(-1.63)
PSPP Substitute	-0.117	-0.147	0.0856	0.422
	(-0.35)	(-0.31)	(0.18)	(0.58)
Observations	667377	661928	660654	477217
Holder country-sector FE	yes	yes	yes	yes
Issuer country-sector FE	yes	yes	yes	yes

Notes: The dependent variable is the ln of the sum of all transactions of debt securities during period specified on top of the column. T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 7: Extension of the sectoral estimation: Time Dimension and PSPP eligibility

	(1) From 15Q1 until 15Q2	(2) From 15Q1 until 16Q2	(3) From 15Q1 until 16Q4	(4) From 14Q3 until 16Q4
MFI	-1.150	-1.470	-1.329	-1.284
	(-1.49)	(-1.59)	(-1.32)	(-1.24)
ICPF	-0.416	-0.547	-0.0849	0.250
	(-0.89)	(-1.15)	(-0.19)	(0.60)
OFI	-0.115	-1.018***	-1.174***	-0.846
	(-0.29)	(-2.87)	(-2.86)	(-1.47)
NFC	-0.992	-0.971	-0.787*	-0.691
	(-1.47)	(-1.57)	(-1.69)	(-1.21)
HH	-0.751*	-1.473***	-1.486***	-1.437***
	(-1.94)	(-3.95)	(-3.99)	(-3.51)
Observations	667377	661928	660750	475318
Holder country-sector FE	yes	yes	yes	yes
Issuer country-sector FE	yes	yes	yes	yes

Notes: Excerpts from full regression tables. The dependent variable is the ln of the sum of all transactions of debt securities during period specified on top of the column. T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 8: Extension: Active vs. Passive Rebalancing and PSPP eligibility

	(1) Net transactions	(2) Passive rebalancing	(3) Δ Holdings
I. Overall specification	-1.405***	1.368***	-0.0369
	(-3.40)	(3.62)	(-0.81)
II. Sectoral specification			
MFI	-2.402*	2.453**	0.0503
	(-1.82)	(2.05)	(0.39)
ICPF	-0.241	0.271	0.0299
	(-0.48)	(0.57)	(0.65)
OFI	-1.899***	1.905***	0.00594
	(-3.00)	(3.16)	(0.14)
NFC	-0.823	0.799	-0.0236
	(-1.08)	(1.10)	(-0.40)
HH	-1.703***	1.520***	-0.183***
	(-2.90)	(2.82)	(-2.64)
Observations	320664	320664	320664
Holder country-sector FE	yes	yes	yes
Issuer country-sector FE	yes	yes	yes

Notes: Excerpts from full regression tables.The same number of observations is used in both specifications. The dependent variable is for column (1) the ln of the sum of all transactions of debt securities during the PSPP period (2015q1-2016q4), for column (3) the ln change in holdings from end of 2014Q4 until 2016Q4, and for column (2) the difference between (1) and (2). T-statistics in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.