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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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# Quantitative easing and preferred habitat investors in the euro area bond market*

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**Abstract**

Quantitative easing (QE) aims to lower long term interest rates and stimulate economic growth via the portfolio rebalancing channel. One of the assumptions for QE to work is that there are investors with strong preferences to hold long term bonds, i.e. so called preferred habitat investors. This paper investigates whether the ECB's Public Sector Purchase Programme (PSPP) affected euro area investors' demand for bonds using granular securities holdings data. The results show strong evidence that euro area investors acted as preferred habitat investors. These findings hold across all major euro area investors (banks, insurance companies, pension funds and investment funds). The results suggest that since the sellers of bonds in response to QE in the euro area are different from those that sold to the Fed, BoE and BoJ, policymakers need to pay particular attention to demand by non-euro area investors, especially if the ECB plans to reduce its balance sheet.

**Keywords**: quantitative easing, sovereign bonds, European Central Bank, PSPP, securities holdings statistics.
**JEL classifications**: E58, F42, G11, G15.

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# 1 Introduction

Since the global financial crisis of 2007-2009, central banks around the world have expanded their balance sheets owing to various unconventional monetary policy measures. The large-scale bond purchase programmes, often referred to as quantitative easing (QE), conducted by the major central banks are prime examples of central bank intervention in bond markets. By buying longer maturity bonds central banks aim to lower the yield curve at longer horizons. These lower yields should induce investors to rebalance their portfolio to higher yielding assets. In fact, the portfolio rebalancing channel is often cited as the main channel through which QE has an effect on financial markets and the wider economy (Krishnamurthy and Vissing-Jorgensen, 2011; D'Amico et al., 2012; Joyce et al., 2012).

The underlying mechanism of the portfolio rebalancing channel relies on imperfect substitutability between different classes of financial assets (e.g. Tobin, 1965; Modigliani and Sutch, 1966). This imperfect substitutability is caused by certain investor clienteles who prefer bonds with specific characteristics, i.e. they have a so-called preferred habitat, which makes them reluctant to sell their preferred bonds (Andrés et al., 2004; Vayanos and Vila, 2009). In such a setting, with bond demand segmented on e.g. maturity, long-term bond purchases by central banks lead to lower yields because only certain types of investors are willing to rebalance their portfolios. In this way, portfolio rebalancing models assume that there are market frictions among different investor types, in turn driving the impact of QE on bond yields (Christensen and Rudebusch, 2012; Hamilton and Wu, 2012; IMF, 2015; Neely, 2015). In this paper we aim to identify the presence of preferred habitat investors by testing how the ECB's quantitative easing affected bond holdings among different investors.

A burgeoning literature studying the effects of QE on bond markets has emerged since 2009. Most of the empirical papers in this field analyze the impact of asset purchases on bond prices. Many studies find supporting evidence for QE programmes in reducing bond yields and term premia in the United States (Gagnon et al., 2011; D'Amico and King, 2013), the United Kingdom (Joyce et al., 2011; Christensen and Rudebusch, 2012) and, more recently, the euro area (Altavilla et al., 2015; De Santis, 2016).[1] Related papers also find large spillovers from QE to other market segments, including corporate bonds (Gilchrist and Zakrajšek, 2013), equity markets (Kiley, 2014) and foreign bond markets (Fratzscher et al., 2016). The evidence on decreasing yields and transmission to other

[1] Some high-frequency studies on the impact of QE in the euro area are emerging that are in line with the studies showing reduced bond prices (Arrata and Nguyen, 2017; Schlepper et al., 2017).

markets provides evidence for the portfolio rebalancing channel.

An emerging research agenda focuses on the willingness of different investors to sell targeted bonds to central banks under QE. For example, Carpenter et al. (2015) find that the Federal Reserve mainly bought bonds from households and other non-bank financial institutions which led these investors to rebalance their portfolios towards corporate bonds. Similarly, Joyce et al. (2014) explain that the Bank of England mostly purchased bonds from insurance companies and pension funds that reinvested the proceeds in corporate bonds. In Japan, the very low interest rates on government bonds induced the Government Pension Investment Fund to shift its portfolio from sovereign bonds to higher yielding equities (Saito and Hogen, 2014). These papers suggest that QE works through pushing domestic investor demand away from sovereign bonds.

For the euro area, Koijen et al. (2017) show that, with the exception of the euro area banking sector, the ECB mainly purchased bonds from non-euro area investors, suggesting that other euro area investors did little to alter their sovereign bond portfolio composition in response to QE. Albertazzi et al. (2016) suggest that the ECB asset purchases did lead to rebalancing by euro area investors from vulnerable countries. Although these papers highlight potentially heterogeneous responses among investors which could drive portfolio rebalancing through QE, they point out that QE may work differently in the euro area. In fact, an open question in this literature is whether there are preferred habitat investors and, if so, whether QE changed the demand for bonds by euro area investors. One related study by Ferdinandusse et al. (2017) finds that the impact of QE on bond yields is larger when the share of preferred habitat investors in a country is larger. However, the authors assume that certain types of investors, e.g. pension funds, are preferred habitat investors. This assumption is not explicitly tested.

Preferred habitat investors are typically justified by the presumption that certain investors aim to match the duration of their assets and liabilities. In the euro area, there are important frictions which may explain the preferred habitat of different investors. For example, insurance companies and pension funds prefer to hold bonds with long maturities. To some extent, this demand for long maturities comes naturally, but it is also strengthened by supervisory rules. A recent study by Domanski et al. (2017) shows that in some cases insurance companies even increase their demand for long maturities when prices increase. This is because the duration of many insurance companies' assets is lower than the duration of their liabilities. In order to avoid a capital shortfall, insurance companies turn to safe

long-term government bonds when interest rates are very low.

Another well-documented tendency of euro area investors is home bias, which means a preferred habitat to hold a relatively high share of the portfolio in domestic assets (Lane and Milesi-Ferretti, 2008; Coeurdacier and Rey, 2013). These preferences suggest that euro area investors may react more weakly to price changes in euro area bonds because non-euro area bonds may not be desirable substitutes (Brutti and Sauré, 2016). Similarly, because of market frictions, euro area investors have a preference to hold assets denominated in the local currency (euro), in part to match assets and liabilities and avoid currency risk (Boermans and Vermeulen, 2016b; Burger et al., 2017). Furthermore, many euro-denominated securities can be used as collateral to obtain liquidity from the central bank, thereby rendering such bond holdings attractive to euro area investors. Moreover, sovereign debt issued by European governments is treated as risk-free under the Basel regulations for banks, which provides a strong incentive to hold these bonds (Bonner, 2016). Combined, these conditions highlight that euro area investors have a natural inclination to have fixed preferences for certain types of bonds, making them preferred habitat investors.

In January 2015, the ECB announced its Public Sector Purchasing Programme (PSPP), which had to some extent been anticipated, following the August 2014 Jackson Hole speech of ECB President Mario Draghi. The initial programme aimed to purchase around 60 billion euro on a monthly basis of mainly sovereign bonds from euro area countries using the ECB capital key to allocate purchases evenly across Member States' government bonds. This large-scale intervention in a specific bond market segment provides an ideal testing ground to identify whether there are preferred habitat investors and whether their preferences are time-invariant after a large policy shock. Using a unique dataset of holdings in individual bonds among different investors we can specify bond demand functions, allowing us to test whether QE changed the preferences for certain bond characteristics. In particular, our granular data allows us to identify all PSPP eligible bonds held by euro area investors. We obtain quarterly holdings information of individual bonds issued globally at the holder-country and holder-country-sector level. We study the period 2013Q4-2016Q4, such that our sample period starts more than one year before the QE programme was initiated and, ends two years after it was initiated.

The empirical results show that the Eurosystem asset purchases under the PSPP did not affect the coefficients of bond demand functions among euro area investors. This suggests that investors' preferred habitat for certain bonds remained stable over the period 2013-2016 despite the QE program.

These findings also hold among different investor types and investors from different euro area countries. These results also hold for PSPP eligible bonds, which are explicitly targeted by the ECB. This indicates that non-euro area investors were more eager to sell euro area sovereign debt than euro area investors.

The non-willingness of euro area investors to sell government bonds was an important aspect of for QE to work in the euro area. The strong preference to hold euro area government bonds is found across investors, i.e. banks, insurers, pension funds, investment funds and households all exhibited very persistent bond demand coefficients, which may have strengthened the effects of QE purchases. As the ECB stepped into the euro area sovereign bond market, mainly non-euro area investors substituted euro area bonds, suggesting they changed their behavior after QE, whereas most euro area investors did not alter their stance up to the end of 2016. While the success of QE in the euro area still needs to be evaluated we argue that at least the premise of QE to work according to the portfolio rebalancing models was fulfilled by the existence of preferred habitat investors in bond market.

This paper proceeds by describing the granular data on bond portfolios and the empirical methodology to derive bond demand functions in Section 2. Section 3 presents the cross-sectional determinants of bond demand and the changes in bond demand functions induced by QE. Several extensions are discussed in Section 4 and Section 5 concludes.

# 2 Data and empirical methodology

## 2.1 Data

We use the ESCB Securities Holdings Statistics (SHS), which provide information on the bond holdings at market values in individual securities worldwide for investors from all 19 euro area countries at the country level of the end-investor. For example, we observe total holdings of German investors in a particular bond, e.g. an Italian 10-year government bond with ISIN code IT0004594930. These data are collected on a quarterly frequency since 2013Q4 under a mandatory reporting framework (ECB, 2015).[2] The regulatory framework stipulates that the data collection by each euro area national central bank is based on the same data definitions and procedures ensuring cross-country comparability as well as high data quality. We use quarterly data for the periods 2013Q4 up to 2016Q4.

[2]Under Regulation (EU) No 1011/2012 (ECB/2012/24) end-investors report portfolio holdings directly or indirectly via custodian reporting to national central banks on a monthly or quarterly frequency.

For our purposes, some data cleaning is in order before obtaining the final sample. As is standard in the literature on international investment positions, we drop bond holdings in major financial centres and offshore destinations, because investors may channel investments to third-countries via financial centres. Inclusion of financial centres would create distortion as the issuer country is not the ultimate recipient of the investment. After such cleaning, we still observe bond investments in over 130 issuer countries. We also indirectly drop all net short positions in a bond, because we take the log of the holdings in the analysis. Except for households we exclude 'third-party' holdings, i.e. bond holdings held by foreign custodians, because of possible custodian bias which would create double counting because nearly all investor sectors must report directly or indirectly through the domestic custodians. We also focus only on bonds with original maturities of at least one year, and we exclude certificates (which are large in number but small in size and highly concentrated in a single issuer country). Securities that are matured but in distress are also discarded. Our individual bond holdings do not take into account possible derivative positions which implies we are not able to fully measure exposures on currencies, interest rates and duration risks with security-by-security holdings data. We also do not observe securities lending and repos because the holdings statistics only consider the economic ownership of assets.

[Table 1 about here.]

Table 1 shows that we observe 4.6 million investor-country bonds holdings (on average about 350,000 per period) with a mean position of log 14.38 or about 1.8 million. Our sample covers on average over EUR 8 trillion in bond holdings per period. Investors from a given euro area country hold about 19,000 different bonds.[3] There is a large variety in holdings, as shown by the 5% (EUR 13,000) and 95% (EUR 114 million) values in the distribution.

We match the holdings data from the SHS with the Centralised Securities Database (CSDB) using the International Security Identifier Number (ISIN). We include several key characteristics of bonds from the CSDB relevant to the investor's decision based on the existing empirical literature. The eligibility for PSPP purchases is the main variable of interest. We replicate the eligibility criteria of the PSPP dynamically at the individual bond level by using information on the residual maturity, current yield and sector and country of the issuer. For the sake of simplicity, we focus on sovereign

[3]Note that there is a large variety in this number across countries. The number of individual bond holdings is much higher for large euro area countries such as France and Germany, and much lower for smaller countries, such as Estonia and Slovenia.

bonds (as being either eligible or ineligible) and exclude all supranationals and agency bonds from the entire sample.

Following the I-CAPM literature we include the market value of a bond as a determinant of investor holdings (see e.g. Solnik, 1974). Ceteris paribus, we expect investors to invest more in a large EUR 10 billion bond compared to a smaller EUR 1 million bond. Recent studies studies show the importance of currency denomination at the individual bond (Boermans and Vermeulen, 2016b; Maggiori et al., 2018), therefore we include a currency dummy that equals one if a bond is euro denominated.

Since investors have strong preferences regarding the maturity of bonds (see e.g. Vayanos and Vila, 2009), we include the residual maturity of bonds as a control variable. As perpetuals do not have a maturity date we include a dummy to indicate if a bond is a perpetual. We include several more dummies to indicate if a bond has a floating coupon, whether it is a covered bond, if it issued by a SPV and finally, if it is eligible collateral for liquidity transactions at the ECB. Evidence on the importance of these bond characteristics is reported by Boermans and Vermeulen (2016a).

Finally, the international finance literature shows the importance of the international dimension (Lane and Milesi-Ferretti, 2008). Therefore, based on the CEPII database, we include the distance between the country of the investor and issuer, a dummy variable that indicates whether the country of the investor and issuer share a common border are included as characteristics relevant for international portfolio allocations.

Turning to the data on security specific characteristics, Table 1 shows that about 3% of the observations are PSPP-eligible bonds. PSPP-eligible bonds include the euro area sovereign bonds that the ECB purchases. Note that the holdings at market value in our sample are considerably larger than the unweighted 3% share. The mean market value of the amount outstanding of a bond is over EUR 80 million. Around 50% of the observations are investments in euro-denominated bonds. The average log residual maturity is 7.32, which amounts to a little over four years. Only a small fraction of all bonds (1%) are perpetuals. The majority of bonds pay a fixed coupon or are zero coupon bonds, as only 24% pay a floating coupon. The fraction of covered bonds (4%) is quite a bit smaller than the fraction of SPV issued bonds (13%), which consist mostly of mortgage-backed securities. Finally, about 22% of the bonds are eligible collateral for transactions at the ECB (see e.g. Nyborg, 2017, for details).

The average log distance between the investor and issuer is 6, which is around 400 kilometres.

We assume that the log distance between an investor and a bond issued by a domestic resident is zero. There is, therefore, a large variation in the distribution of this variable, especially because many holdings are located in relatively distant countries such as the United States and Japan. We include a dummy variable for domestic holdings, $Home$, to indicate whether the bond being invested in is issued by a resident. Around 20% of all the observations (unweighted) are holdings in domestic bonds. This proportion is even higher when the holdings are value weighted. About 15% of the holdings (unweighted) are in a neighboring country. Annex 1 presents a correlation matrix of the main variables.

## 2.2 Empirical methodology

We estimate bond demand functions using the widely used gravity model. A large numbers of papers in the international finance literature uses the gravity model to explain international asset allocations and flows (see e.g. Martin and Rey (2004), Lane and Milesi-Ferretti (2008) and Galstyan and Lane (2013) for some prominent examples. Formally, we estimate:

$$log(H_{i,j}) = \bar{\beta} * \mathbf{X_i} + \bar{\gamma} * \mathbf{Z_{i,j}} + isc_i + hc_j + \epsilon_{i,j}, \tag{1}$$

where $log(H)$ is the log value of the holdings of country $j$ investors in bond $i$. Bond specific characteristics $X$ cover the variables listed in Table 1 while $Z$ captures the bilateral variables specific for the investor's country and the issuer's country (see also Table 1). The vectors $\bar{\beta}$ and $\bar{\gamma}$ represent vectors that capture the coefficients on the variables in $X$ and $Z$. A set of fixed effect dummies is included for issuer sector $isc$ and holder countries $hs$ by country pairs.

We use Equation (1) to estimate the coefficients for bond demand at year-end 2013, 2014, 2015 and 2016. However, to assess whether investors changed their demand after the ECB started its quantitative easing programme in March 2015, we need to use a panel to test whether the coefficients changed after QE. To allow for a change in coefficients, we introduce a dummy QE that is equal to zero up to 2014:Q4 and one as of 2015:Q1.[4] Formally, we estimate:

[4]The ECB officially announced the PSPP in January 2015 and implemented it with the first purchases in March 2015, thus covering 2015Q1. For robustness purposes we also include an anticipation of the programme to cover potential market shifts earlier (i.e. signalling).

$$log(H_{i,j,t}) = \bar{\beta} * \mathbf{X_{i,t}} + \bar{\beta}^{QE} * QE_t * \mathbf{X_{i,t}} + \bar{\gamma} * \mathbf{Z_{i,j,t}} + \bar{\gamma}^{QE} * QE_t * \mathbf{Z_{i,j,t}} + isct_{i,t} + hct_{j,t} + \epsilon_{i,j,t}, \quad (2)$$

where the *t* subscript indicates time period and we include all the dummies each quarter. We argue that there is a significant change in the bond demand function when coefficients in $\bar{\beta}^{QE}$ and/or $\bar{\gamma}^{QE}$ are significantly different from zero. The fixed effects models in Equations (1) and (2) are estimated by ordinary least squares, with the standard errors clustered at the issuer-sector by issuer country level.

# 3 Results

## 3.1 The cross section of bond demand

Table 2 shows the results when estimating Equation (1) for four cross sections at year-end 2013 up to 2016. Our main interest is to obtain a first gauge of how QE may have shifted the main determinants of euro area investors' bond demand over time. First, we analyze the dummy for bonds that are or would have been eligible for the ECB to buy under the PSPP, which is the market segment directly targeted by the ECB. To start, euro area investors in general have a significantly positive preference to hold PSPP-eligible securities as the estimated bond demand coefficients range from 0.83 to 1.09. Interestingly, the coefficients do not seem to differ strongly in the periods before QE (2013Q4 and 2014Q4) and after QE (2015Q4 and 2016Q4). This suggests that QE may not have strongly pushed euro area investors out of the sovereign bonds targeted by the ECB's QE programme.

[Table 2 about here.]

Next, the coefficient on market value ranges from 0.378 in 2013Q4 up to 0.428 in 2016Q4, which we consider, although increasing, rather stable around 0.4 and significantly lower than the predicted CAPM value of one if investors would have held a (global) market bond portfolio as weighted by the size of the bonds. This implies that investors increase their holdings by about 4% if the size of the bond increases by 10%, ceteris paribus. So, while the size of bonds carries great importance for investment decisions, other factors play an important role as well.

We find a persistent very strong demand for euro-denominated bonds. Typically many bond investors such as banks, insurance companies and pension funds wish to avoid exchange rate risk. This is reflected by the large coefficient of around one, which implies that euro area investors invest double the amount in a euro-denominated bond, ceteris paribus. This coefficient is very stable across different time periods. It may also be considered as a lower bound for euro currency exposure because we do not account for currency swaps.

There is also a persistent, positive relationship between holdings and residual maturity, reflecting a demand for longer-term investments. However, most investors wish to receive the principal at some point in time. Therefore, investors hold 24% to 32% less in a bond if it is a perpetual. Demand for floating-rate bonds is less clear. The cross section at 2014Q4 suggests no relationship, while other periods suggest a positive demand for floating-rate bonds, although the magnitude is relatively small between 0.03 and 0.07.

Covered bonds attract a higher demand from investors, who value the extra security that the collateral offers. The magnitude of this extra demand varies slightly across periods. While the demand for covered bonds is always significantly positive, it seems to decline from 56.7% in 2014Q4 to 27.5% in 2016Q4. Two possible explanations are that, first, the ECB initiated its Covered Bond Purchase Programme 3 (CBPP3) in October 2014 and had purchased 204 billion covered bonds by December 2014.[5] This significantly raised the share of holdings by the ECB from 16% in 2014 to around 30% by the end of 2016 (see also European Banking Authority, 2016). Second, following a decline in issuance in 2012-2014, the supply of covered bonds has increased since 2015 (European Covered Bond Council, 2016).

Bonds issued by SPVs, usually mortgage-backed securities, do not attract extra demand from investors after QE. The coefficient on this variable is significantly negative across all cross sections, although also decreasingly over time. Thus, despite the ABSPP that the ECB announced together with the CBPP3, we find no significant shifts in the preference to hold bonds issued by SPVs by euro area investors since 2015Q1 up to 2016Q4.

When a bond is eligible collateral for liquidity transactions at the ECB investors hold 90% more of this bond, ceteris paribus. The strong demand for this type of bond may be surprising, because banks in particular can use these bonds for transactions at the ECB. However, banks are the largest

[5] Between 2011 and 2012, the ECB's CBPP2 led to cumulative purchases of only EUR 16 billion.

holders of bonds in the euro area. So, their preferences will translate to the aggregate demand, which also appears rather persistent over the different periods.

The coefficient on distance is significantly negative and around -0.4 across time periods, which implies that investors reduce their holdings in bonds that are issued by resident issuers further away from their home country. In fact, when distance doubles, investors reduce their holdings by about 40% ceteris paribus. This magnitude is stable across periods and the magnitude is comparable to findings in the international investment position literature (see e.g. Lane and Milesi-Ferretti, 2008). Note that we allow for two nonlinearities in the effect of distance as we include a home dummy and a neighboring country dummy. Both variables are naturally correlated with distance, so the negative coefficient on home does not imply that investors are not home biased. In fact, the mean distance is around 6, whereas the distance of home country bonds is zero. So, for a bond on average we obtain a value of -2.4 as distance effect and between -0.07 and -0.45 for a home bond because of the home dummy. Ceteris paribus, investors hold between 16% and 28% more in a bond issued by a neighboring country compared to a bond issued by a non-neighboring country with the same distance. Combined, while the distance and neighboring country effects appear stable over time, the home bias effect does not.

Taken together, these results are a first indication that on key bond characteristics euro area investor demand appears rather stable over the periods 2013-2016, although for some variables there may be some trends in the data, which we further analyze in the time series.

### 3.2 Did QE change bond demand?

We now formally investigate whether the bond demand coefficients differ before and after QE started by estimating Equation (2). Since the time sample is too short to endogenously estimate a break date we investigate two possible break dates. The first two Columns of Table 3 show the results when using 1 January 2015 as break date, and Columns (3) and (4) use 1 July 2014 as break date. The former date is chosen because the ECB officially announced to expand its quantitative easing programme to include sovereign bonds on 22 January 2015. The latter date is chosen because investors may have anticipated a QE programme, in particular following Mario Draghi's Jackson Hole speech in August 2014. Columns (1) and (3) show the main coefficients for all variables ($\bar{\beta}$ and $\bar{\gamma}$ in Equation (2), while Columns (2) and (4) show the coefficients of the variables interacted with the dummy variables

($\bar{\beta}^{QE}$ and $\bar{\gamma}^{QE}$ in Equation (2). So, a significant coefficient in Columns (2) and (4), our delta or differences columns, indicates a significant difference in the estimated coefficient before and after QE.

[Table 3 about here.]

Table 3 shows that virtually all of the coefficients exhibit no significant change after the QE programme started. Most importantly, the dummy variables for PSPP-eligible bonds have similar estimated coefficients before and after the QE implementation and announcements. The same holds for other bond characteristics. These results point out that the euro area investors exhibit persistent bond preferences that did not change strongly across time periods despite a large market shock, i.e. QE. It suggests that euro area investors acted as preferred habitat investors and thus that at least one condition for the ECB's QE programme under the portfolio rebalancing model to work has been fulfilled.

There are two variables that are significantly different at the 10% level in one of the regressions and worth mentioning. First, when considering 1 January 2015 as break date, the results suggest a decrease in demand for covered bonds. This outcome is comparable to the results from Table 2 and suggests that demand for covered bonds by euro area investors decreased after the ECB initiated its QE and CBPP3 programs. The size of the estimated coefficient suggests that demand fell by 20%. Note that this difference is not significant anymore when considering 1 July 2014 as break date. This indicates that the effect may be driven by the programme implementation, thus making investors willing to sell covered bonds after QE.

Second, Column (4) points to an increasing demand for longer residual maturities, but this increase is small in magnitude. When using 1 January 2015 as break date there is no evidence anymore of a significant change. However, this finding fits well with the results from Table 3 and may indicate that in 2014 euro area investors increased their demand for longer term bonds in anticipation of the QE programme. In the extensions of the model we further analyze these potential shifts in investor demand.

# 4 Extensions

## 4.1 Sectoral bond demand: Did certain euro area investors rebalance?

Table 3 shows the results when considering a representative investor in each of the 19 euro area countries. While the results show virtually no changes at this aggregate country level there can be potentially counteracting differences in how different actors in the bond market reacted to QE. Earlier research already showed that the cross-sectional determinants of holdings differ across investor sectors (Boermans and Vermeulen, 2016a; Galstyan et al., 2016). To investigate possible differences between investor sectors in our sample we estimate Equation (2) for the holdings of four different types of investors: 1) banks, 2) insurance companies and pension funds, 3) investment funds, and 4) households. So, instead of using the total holdings of all investors from a country, we only use those holdings of the respective sector from each country in the regressions. We use 1 January 2015 as the break date in the regressions.

[Table 4 about here.]

Table 4 present the results of these regressions. It has a similar set-up as Table 3, where Columns (1), (3), (5) and (7) show the estimated coefficients for all variables, while the $\Delta$ Columns show the coefficients of the variables interacted with the dummy variables to indicate the post QE periods. Again, a significant coefficient in the $\Delta$ columns indicates a significant change in the demand function of the respective investor sector.

First, for banks we find very stable demand functions with two exceptions. First, after QE, euro area banks decreased their demand for floating-coupon bonds. Second, they increased their demand for bonds issued by SPVs. This is somewhat surprising, as practically all bonds issued by SPVs are floating-rate bonds, suggesting that banks strongly decreased their demand for non-SPV floating-rate bonds after QE, although in general euro area banks still display the largest preference to hold floating-coupon bonds compared to other investors. The increase in SPVs may be related to supply-driven effects, as euro area banks tend to retain securitisations on their balance sheets and used SPV issuances more after 2015 as the market for securitisation was recovering.

Second, for insurance companies and pension funds overall bond demand after QE appears very stable. We only find lower demand for covered bonds, which is also present for investment funds. Hence, the overall decline in the preference for covered bonds as documented in Table 3 mainly stems

from shifts in demand from insurance companies, pension funds and investment funds. Moreover, investment funds seem to have a stronger demand for longer maturity bonds since the start of QE, while other factors for investment funds remained very stable after QE. This result suggests that investment funds for the euro area in particular increased their maturities of bond portfolios after QE.

Finally, for households the results show very stable bond demands, albeit a smaller demand for euro-denominated bonds. In general, even after drilling down to investor sector level we find stable bond demands for the market value, home, neighboring country, distance, perpetual, eligible collateral and, most importantly, PSPP eligibility. So, overall, the bond demand functions remained quite stable at the disaggregated sector holder level. This implies that none of the euro area investor sectors was induced to decrease their holdings of sovereign bonds eligible under the PSPP.

Another interesting result from these regressions is that even though bond demand remained largely unaffected by QE for the presented sectors, we observe large differences in preferred habitats across difference euro area investor sectors. In general we find that insurance companies, pension funds and investment funds have the largest coefficient on PSPP-eligible bonds (i.e. euro area sovereign debt). However, these investor sectors tend to have very different preferences in terms of other bond characteristics, including the tendency to hold euro-denominated bonds, long-term bonds, floating notes and bonds issued by SPVs.

Similarly, banks stand out for their dislike of perpetuals and have a strong inclination to hold floating-rate bonds, covered bonds, bonds issued by SPVs and eligible assets for ECB collateral compared to other investors. These bank preferences are motivated by regulatory treatment and hence explain their strong preferred habitat to hold such bonds. To match their assets and liabilities, insurance companies and pension funds display the strongest preference for euro-denominated debt and longer maturities compared to other investors. Investment funds show the greatest tendency to hold more bonds given an increased amount outstanding, while households are the only investors with a positive coefficient on perpetuals.

### 4.2 Vulnerable vs. non-vulnerable investors: Asymmetries in the euro area?

Countries in the euro area were hit very differently by the euro area sovereign debt crisis. Some countries, such as Germany and the Netherlands, did not experience increasing interest rates on their government bonds, while other countries, such as Italy and Spain, faced large increases in their bond

yields. In fact, problems were even larger in Ireland, Portugal and especially Greece as these countries needed bailout packages. So, investors in vulnerable countries may have reacted differently to QE than investors in non-vulnerable countries.[6]

[Table 5 about here.]

Table 5 suggests that this is not the case. While the pre-QE demand functions differ in some respects between both country groups, there seems to be no change due to QE for either of the country groups. This implies that the habit persistence of euro area bond market investors is uniform across countries. Overall, after accounting for issuer and country fixed effects, QE did not lead to asymmetric rebalancing within the euro area across vulnerable and non-vulnerable investors.

Some differences in the base coefficients are worth mentioning. First, demand for PSPP-eligible bonds is much stronger in vulnerable countries compared to non-vulnerable countries, ceteris paribus. Second, investors in vulnerable countries have a considerably smaller coefficient on residual maturity, indicating a lower demand for duration among investors in these countries. This effect is further emphasized by the strong demand for floating coupons in vulnerable countries, since floating-coupon bonds have a duration of zero. Finally, demand for covered bonds is stronger among investors in non-vulnerable countries compared to investors in vulnerable countries.

### 4.3 Only euro area bonds and only PSPP-eligible bonds

The previous analyzes consider the holdings of euro area investors in bonds issued by residents across the globe. This section zooms in on two subsets of the bond market. The first subset contains only bonds issued by euro area residents, while the second subset contains only PSPP-eligible bonds. Since the latter securities are the ones directly targeted by the ECB we may expect to find the largest, if any, change in bond demand since the start of QE. Note that all PSPP-eligible bonds are euro-denominated and exclude perpetuals. Hence, these variables are excluded from this regression.

[Table 6 about here.]

Columns (1) and (2) in Table 6 show no significant change in the coefficients for the euro area bond sample, except for covered bonds. This confirms our previous findings. The bond demand function did not significantly change for the euro area sample.

[6] We classify as vulnerable countries (Italy, Spain, Portugal, Ireland, Greece, Cyprus and Slovenia) and the other euro area countries as non-vulnerable in line with Koijen et al. (2017).

Turning to a restricted sample that contains only PSPP-eligible bonds, we again find no significant portfolio rebalancing. The results in Columns (3) and (4) indicate that even in the market in which the ECB buys large numbers of bonds we find no significant change in the coefficients of the bond demand function. The only exception is residual maturity, which suggests that investors have a higher demand for longer maturity bonds since the start of QE. As demand increases long term yields will decrease, thereby contributing to the effectiveness of QE. The finding that other bond demand coefficients show no significant differences before and after QE, even in the market where the ECB is most active, provides evidence in favor of the preferred habitats of euro area investors.[7]

# 5 Conclusion

In this study we analyze whether euro area investors acted as preferred habitat investors after the ECB had launched its sovereign debt purchase programme in early 2015. The presence of preferred habitat investors is important for large-scale asset purchase programmes by central banks to be effective, since their presence enhances the price impact of central bank asset purchases. Using granular data on bond holdings of different euro area investors our empirical results suggest that virtually all euro area investors have kept to a different degree a strong preferences for those bonds that were eligible under the sovereign debt purchase programme of the ECB. Most importantly, we show that euro area investors acted as preferred habitat investors between 2013 and 2016, as they practically did not change their bond demand functions, not even for those bonds targeted by the ECB's QE programme. These findings also hold among different investor types and investors from different countries, indicating that non-euro area investors more strongly responded to the ECB assets purchases than euro area investors.

Even though the results in this paper are robust, there are some limitations that need to be taken into account when interpreting the results. First, we only explore the investors' bond holdings and not investments in other asset classes. It could well be that the preferences within the bond market for certain types of bonds remained fixed after QE, however, investors may have changed their

[7] In unreported results we estimate regressions for the complement of Table 6. Therefore, this concerns a sample including non-euro area bonds only and a sample including euro area bonds that are not PSPP-eligible only. Also in these regressions we find no significant changes in the bond demand coefficients, which suggests that QE did not alter demand from investors in euro area countries in non-targeted segments of the bond market. The only exception is a significant decrease in the coefficient for covered bonds in the latter regression. This finding was already documented earlier.

composition of other assets, e.g. by selling money market paper and buying equities. For example, Hau and Lai (2016) find in a related study that investors from the euro area reallocated their investment fund portfolios in money markets to equities after ECB interest rate declines between 2003-2011 in a search-for-yield fashion. On the other hand, several scholars argue that portfolio rebalancing mainly occurs within asset classes and not between asset classes, see Joyce et al. (2014). Still, our results need to be interpreted as a partial equilibrium view. Thus, euro area investor's demand for PSPP eligible assets was not significantly affected by the ECB purchases.

Second, we only analyze the demand for bonds, but remain silent about compositional shifts in the supply of bonds (see Greenwood and Vayanos, 2014). However, suppose that the characteristics of outstanding bonds shifted strongly in our sample period. Since our estimated coefficients for bond characteristics did not change the supportive evidence for preferred habitat investors would become even stronger.

Third, we estimate bond demand functions for euro area investors, but not for non-euro area investors. The main reason for not including non-euro area investors is the incomplete coverage of their holdings. Taking the residual, i.e. subtracting euro area holdings from the market value of outstanding amounts, will not be very informative as this residual contains the holdings of both non-euro area private and official sector holdings and the holdings of the euro area central banks. However, ideally, researchers will be able to also investigate the behavior of these sectors in the bond market to have a more complete picture of which investors sold to the ECB. In particular, while researchers have shown that non-euro area investors sold bonds to the ECB (see e.g. Koijen et al., 2017), knowledge on the country and sector composition of these investors will be very insightful.

A remaining question is to what extent it matters which investor group is the preferred habitat in a specific market segment when conducting central bank purchases in this market. In other words, is QE effectiveness different if either domestic or foreign investors act as preferred habitat investors in the targeted market? Or does it matter if banks, pension funds or households have strong preferred habitats? These investors will benefit from the increasing asset prices. For example, Albertazzi et al. (2016) show that bank lending increased for those banks that benefited most from the ECB's asset purchases. Kabaca (2016) analyzes how the preference for home and foreign bonds affects the effectiveness of QE in the context of a small open economy with a portfolio rebalancing channel. Perhaps the mirror image is also interesting to answer these questions, i.e. to investigate how the

most price elastic investors behave during a quantitative easing programme. Intuitively, for spillover effects to other financial markets and the real economy this should be important. While beyond the scope of this paper, future research on how the transmission to other markets and the real economy of QE programmes changes when the preferred habitat investor differs will be very valuable.

Going forward, our findings have implications for the exit from unconventional monetary policy by scaling down the central bank's balance sheet. For example, Chen et al. (2016) argue that the Federal Reserve has several tools to normalize interest rates, and preferred habitats of investors influence the optimal choice of policy tools. Based on our results, euro area investors have strong and persistent preferred habitats. This implies that when the ECB scales down the purchases or seeks to reduce its balance sheet, non-euro area investors will most likely have to be persuaded to invest again in euro area sovereign bonds. As these investors sold their holdings when yields decreased, they will most likely only return when yields increase. So, a scaling down of the balance sheet will have important effects on bond yields and exchange rates, ceteris paribus. Since the sellers of bonds to the ECB are different from those that sold to the Fed, BoE and BoJ experiences from the US tapering cannot be projected one-to-one to the euro area. In particular, policymakers need to consider the crucial role of bond demand by non-euro area investors when deciding on tapering and the speed with which to decrease the ECB's balance sheet.

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Appendix

# A Correlation matrix

[Table 7 about here.]

**Table 1:** Summary statistics

| Variable | # Obs. | Mean | Std. Dev. | Skew. | Kurt. | p05 | p95 |
|---|---|---|---|---|---|---|---|
| log(holdings) | 4,605,646 | 14.38 | 2.81 | -0.57 | 4.28 | 9.50 | 18.55 |
| *security specific characteristics* | | | | | | | |
| PSPP-eligible | 4,656,734 | 0.03 | 0.17 | 5.41 | 30.28 | 0 | 0 |
| log(market value) | 4,495,538 | 18.20 | 3.19 | -1.73 | 10.08 | 13.25 | 21.75 |
| euro denominated | 4,656,734 | 0.52 | 0.50 | -0.06 | 1.00 | 0 | 1 |
| log(residual maturity) | 4,577,956 | 7.32 | 1.33 | -0.68 | 4.34 | 4.99 | 9.27 |
| perpetual | 4,656,734 | 0.01 | 0.12 | 8.22 | 68.64 | 0 | 0 |
| floating coupon | 4,656,734 | 0.24 | 0.42 | 1.25 | 2.56 | 0 | 1 |
| covered bond | 4,656,734 | 0.04 | 0.19 | 4.73 | 23.38 | 0 | 0 |
| spv | 4,656,734 | 0.13 | 0.34 | 2.18 | 5.73 | 0 | 1 |
| eligible collateral | 4,656,734 | 0.22 | 0.41 | 1.37 | 2.89 | 0 | 1 |
| *bilateral variables between investor and issuer countries* | | | | | | | |
| log(distance) | 4,656,734 | 6.01 | 3.24 | -1.05 | 2.62 | 0 | 9.13 |
| home | 4,656,734 | 0.20 | 0.40 | 1.48 | 3.18 | 0 | 1 |
| neighbouring country | 4,656,734 | 0.15 | 0.36 | 1.95 | 4.79 | 0 | 1 |

Note: This table presents summary statistics using data for the full period 2013:Q4-2016:Q4.

**Table 2:** Bond demand regressions (cross section)

| | 2013Q4 | 2014Q4 | 2015Q4 | 2016Q4 |
|---|---|---|---|---|
| PSPP-eligible | 1.091*** | 0.965*** | 1.041*** | 0.830*** |
| | (0.075) | (0.074) | (0.071) | (0.075) |
| log(market value) | 0.378*** | 0.380*** | 0.407*** | 0.428*** |
| | (0.006) | (0.005) | (0.006) | (0.005) |
| euro denominated | 1.105*** | 1.101*** | 1.145*** | 1.244*** |
| | (0.022) | (0.019) | (0.018) | (0.017) |
| log(residual maturity) | 0.050*** | 0.100*** | 0.109*** | 0.105*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| perpetual | -0.328*** | -0.283*** | -0.242*** | -0.265*** |
| | (0.060) | (0.058) | (0.055) | (0.058) |
| floating coupon | 0.072*** | -0.004 | 0.031** | 0.053*** |
| | (0.014) | (0.014) | (0.013) | (0.013) |
| covered bond | 0.555*** | 0.567*** | 0.386*** | 0.275*** |
| | (0.030) | (0.026) | (0.024) | (0.024) |
| spv | -0.482*** | -0.643*** | -0.654*** | -0.760*** |
| | (0.022) | (0.022) | (0.022) | (0.022) |
| eligible collateral | 0.919*** | 0.967*** | 0.983*** | 0.941*** |
| | (0.023) | (0.022) | (0.021) | (0.021) |
| log(distance) | -0.400*** | -0.429*** | -0.395*** | -0.398*** |
| | (0.014) | (0.013) | (0.013) | (0.013) |
| home | -0.070 | -0.449*** | -0.294*** | -0.452*** |
| | (0.098) | (0.093) | (0.090) | (0.088) |
| neighbouring country | 0.192*** | 0.159*** | 0.264*** | 0.282*** |
| | (0.019) | (0.018) | (0.018) | (0.018) |
| holder country FE | yes | yes | yes | yes |
| issuer country-sector FE | yes | yes | yes | yes |
| $R^2$ | 0.978 | 0.980 | 0.980 | 0.980 |
| Observations | 320,784 | 333,949 | 343,641 | 355,672 |

Note:

**Table 3:** Bond demand regressions (QE effect)

| | 2015Q1 break | | 2014Q3 break | |
|---|---|---|---|---|
| | base | Δ QE | base | Δ QE |
| PSPP-eligible | 1.023*** | -0.003 | 1.038*** | -0.023 |
| | (0.175) | (0.215) | (0.224) | (0.251) |
| log(market value) | 0.385*** | 0.021 | 0.384*** | 0.018 |
| | (0.031) | (0.039) | (0.039) | (0.045) |
| euro denominated | 1.096*** | 0.079 | 1.097*** | 0.064 |
| | (0.069) | (0.092) | (0.088) | (0.103) |
| log(residual maturity) | 0.087*** | 0.022 | 0.077*** | 0.030* |
| | (0.011) | (0.015) | (0.013) | (0.016) |
| perpetual | -0.321*** | 0.064 | -0.340*** | 0.072 |
| | (0.078) | (0.109) | (0.097) | (0.117) |
| floating coupon | 0.061 | -0.034 | 0.074 | -0.044 |
| | (0.074) | (0.091) | (0.097) | (0.108) |
| covered bond | 0.583*** | -0.194* | 0.581*** | -0.155 |
| | (0.095) | (0.115) | (0.125) | (0.139) |
| spv | -0.579*** | -0.153 | -0.549*** | -0.161 |
| | (0.104) | (0.144) | (0.119) | (0.148) |
| eligible collateral | 0.925*** | 0.036 | 0.918*** | 0.038 |
| | (0.106) | (0.128) | (0.139) | (0.154) |
| log(distance) | -0.439*** | 0.018 | -0.435*** | 0.009 |
| | (0.078) | (0.095) | (0.102) | (0.114) |
| home | -0.449 | -0.059 | -0.379 | -0.138 |
| | (0.499) | (0.608) | (0.657) | (0.730) |
| neighboring country | 0.166** | 0.099 | 0.174* | 0.068 |
| | (0.073) | (0.089) | (0.093) | (0.104) |
| holder country-time FE | yes | | yes | |
| issuer country-sector-time FE | yes | | yes | |
| $R^2$ | 0.334 | | 0.333 | |
| Observations | 4,433,000 | | 4,433,000 | |

Note: The table shows the regression results of estimating Equation ((2)) for the full sample. There are two potential break dates considered 1 January 2015 and 1 July 2014. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.

**Table 4:** Sector heterogeneity

| | banks | | ICPF | | inv funds | | households | |
|---|---|---|---|---|---|---|---|---|
| | base | Δ QE | base | Δ QE | base | Δ QE | base | Δ QE |
| PSPP-eligible | 0.464*** | -0.069 | 0.637*** | -0.077 | 0.609*** | -0.070 | -0.085 | 0.082 |
| | (0.103) | (0.138) | (0.051) | (0.067) | (0.105) | (0.134) | (0.068) | (0.093) |
| log(market value) | 0.321*** | 0.006 | 0.141*** | 0.013 | 0.358*** | 0.041 | 0.277*** | -0.006 |
| | (0.025) | (0.032) | (0.014) | (0.019) | (0.038) | (0.048) | (0.024) | (0.028) |
| euro denominated | 0.795*** | -0.087 | 1.576*** | -0.023 | 0.891*** | 0.085 | 0.860*** | -0.187*** |
| | (0.075) | (0.088) | (0.078) | (0.106) | (0.042) | (0.056) | (0.055) | (0.070) |
| log(residual maturity) | -0.016 | 0.012 | 0.119*** | 0.015 | 0.029*** | 0.048*** | -0.013* | -0.011 |
| | (0.014) | (0.021) | (0.013) | (0.017) | (0.011) | (0.019) | (0.007) | (0.010) |
| perpetual | -0.593*** | 0.009 | -0.441*** | -0.016 | -0.145* | -0.002 | 0.181*** | 0.106 |
| | (0.100) | (0.126) | (0.056) | (0.071) | (0.087) | (0.130) | (0.067) | (0.081) |
| floating coupon | 0.466*** | -0.192*** | -0.210*** | 0.014 | 0.253** | 0.011 | -0.024 | 0.031 |
| | (0.060) | (0.073) | (0.044) | (0.058) | (0.109) | (0.133) | (0.042) | (0.047) |
| covered bond | 0.694*** | -0.062 | 0.386*** | -0.148*** | 0.150** | -0.148** | -0.784*** | -0.048 |
| | (0.101) | (0.132) | (0.032) | (0.042) | (0.060) | (0.075) | (0.108) | (0.152) |
| spv | 1.095*** | 0.352*** | -0.430*** | -0.102 | -0.966*** | -0.142 | -0.214* | -0.090 |
| | (0.092) | (0.117) | (0.074) | (0.106) | (0.071) | (0.105) | (0.125) | (0.180) |
| eligible collateral | 1.300*** | -0.129 | 0.506*** | -0.038 | 0.370*** | -0.033 | 0.038 | 0.025 |
| | (0.082) | (0.099) | (0.064) | (0.078) | (0.066) | (0.085) | (0.050) | (0.064) |
| log(distance) | -0.133** | -0.027 | -0.245*** | 0.003 | 0.006 | 0.059 | -0.663*** | -0.033 |
| | (0.052) | (0.066) | (0.032) | (0.039) | (0.041) | (0.050) | (0.057) | (0.072) |
| home | 0.724** | -0.175 | -1.019*** | 0.085 | 0.620** | 0.560 | -1.218*** | -0.425 |
| | (0.345) | (0.442) | (0.221) | (0.276) | (0.282) | (0.345) | (0.440) | (0.552) |
| neighbouring country | 0.314*** | -0.011 | 0.158*** | 0.009 | 0.298*** | 0.109 | 0.170*** | -0.090 |
| | (0.058) | (0.074) | (0.050) | (0.068) | (0.066) | (0.084) | (0.064) | (0.082) |
| holder country-time FE | yes | | yes | | yes | | yes | |
| issuer country-sector-time FE | yes | | yes | | yes | | yes | |
| $R^2$ | 0.276 | | 0.334 | | 0.302 | | 0.350 | |
| Observations | 1,168,103 | | 1,119,920 | | 2,463,392 | | 1,572,307 | |

Note: The table shows the regression results of estimating Equation ((2)) for the holdings of only a single sector in each country: 1) banks, 2) insurance companies and pension funds, 3) investment funds and 4) households. We use 1 January 2015 as the break date in the regressions. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.

**Table 5:** Vulnerable vs. non-vulnerable investors

| | Non-vulnerable holder country | | Vulnerable holder country | |
|---|---|---|---|---|
| | base | Δ QE | base | Δ QE |
| PSPP-eligible | 0.762*** | 0.042 | 1.335*** | 0.074 |
| | (0.116) | (0.139) | (0.306) | (0.398) |
| log(market value) | 0.378*** | 0.019 | 0.412*** | 0.026 |
| | (0.030) | (0.037) | (0.044) | (0.055) |
| euro denominated | 1.146*** | 0.069 | 1.029*** | 0.046 |
| | (0.066) | (0.089) | (0.093) | (0.121) |
| log(residual maturity) | 0.124*** | 0.009 | 0.028** | 0.031* |
| | (0.012) | (0.017) | (0.012) | (0.019) |
| perpetual | -0.418*** | 0.121 | -0.327*** | 0.020 |
| | (0.071) | (0.100) | (0.102) | (0.146) |
| floating coupon | -0.004 | -0.053 | 0.260** | 0.026 |
| | (0.059) | (0.074) | (0.110) | (0.137) |
| covered bond | 0.681*** | -0.198 | 0.179* | -0.102 |
| | (0.113) | (0.137) | (0.104) | (0.122) |
| spv | -0.436*** | -0.043 | -0.917*** | -0.308 |
| | (0.087) | (0.113) | (0.144) | (0.217) |
| eligible collateral | 1.073*** | 0.041 | 0.607*** | 0.040 |
| | (0.100) | (0.122) | (0.144) | (0.176) |
| log(distance) | -0.403*** | -0.057 | -0.234*** | -0.027 |
| | (0.059) | (0.073) | (0.084) | (0.100) |
| home | -0.633 | -0.470 | 0.903 | -0.135 |
| | (0.454) | (0.552) | (0.843) | (0.991) |
| neighboring country | 0.058 | 0.095 | 0.160* | 0.037 |
| | (0.070) | (0.089) | (0.090) | (0.114) |
| holder country-time FE | yes | | yes | |
| issuer country-sector-time FE | yes | | yes | |
| $R^2$ | 0.340 | | 0.304 | |
| Observations | 3,036,994 | | 1,396,006 | |

Note: The table shows the regression results of estimating Equation ((2)) for either only investors from non-vulnerable or vulnerable countries. We use 1 January 2015 as the break date in the regressions. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.

**Table 6:** Euro area bonds

| | Euro area holdings only | | PSPP-eligible only | |
|---|---|---|---|---|
| | base | Δ QE | base | Δ QE |
| PSPP-eligible | 1.000*** | -0.023 | | |
| | (0.178) | (0.211) | | |
| log(market value) | 0.341*** | 0.016 | 0.161*** | 0.011 |
| | (0.035) | (0.043) | (0.006) | (0.008) |
| euro denominated | 0.643*** | 0.012 | | |
| | (0.076) | (0.092) | | |
| log(residual maturity) | 0.110*** | 0.024 | 0.433*** | -0.080 |
| | (0.013) | (0.019) | (0.077) | (0.104) |
| perpetual | -0.064 | 0.079 | | |
| | (0.094) | (0.119) | | |
| floating coupon | -0.115** | -0.042 | 0.016 | -0.204 |
| | (0.047) | (0.064) | (0.218) | (0.281) |
| covered bond | 0.783*** | -0.186** | 0.687*** | 0.130 |
| | (0.067) | (0.079) | (0.050) | (0.111) |
| spv | 0.029 | 0.016 | -0.269*** | 0.146 |
| | (0.065) | (0.087) | (0.096) | (0.181) |
| eligible collateral | 1.224*** | 0.017 | 3.898*** | -1.109 |
| | (0.131) | (0.157) | (0.565) | (0.691) |
| log(distance) | -0.740*** | 0.056 | -0.544*** | -0.078 |
| | (0.079) | (0.104) | (0.085) | (0.111) |
| home | -2.699*** | 0.219 | -1.204** | -0.598 |
| | (0.492) | (0.651) | (0.578) | (0.759) |
| neighboring country | -0.237*** | 0.111 | -0.255*** | 0.163* |
| | (0.067) | (0.083) | (0.067) | (0.089) |
| holder country-time FE | yes | | yes | |
| issuer country-sector-time FE | yes | | yes | |
| $R^2$ | 0.391 | | 0.453 | |
| Observations | 2,312,928 | | 141,030 | |

Note: The table shows the regression results of estimating Equation ((2)) for a restricted sample of only euro area bonds or only PSPP-eligible bonds. We use 1 January 2015 as the break date in the regressions. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.

**Table 7:** Correlations

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) log(holdings) | 1.00 | | | | | | | | | | | | |
| (2) PSPP-eligible | 0.12 | 1.00 | | | | | | | | | | | |
| (3) log(market value) | 0.34 | -0.03 | 1.00 | | | | | | | | | | |
| (4) euro denominated | 0.24 | 0.18 | -0.20 | 1.00 | | | | | | | | | |
| (5) log(residual maturity) | -0.01 | 0.08 | 0.07 | -0.21 | 1.00 | | | | | | | | |
| (6) perpetual | 0.00 | -0.02 | 0.05 | 0.01 | 0.24 | 1.00 | | | | | | | |
| (7) floating coupon | 0.00 | -0.05 | -0.21 | 0.26 | -0.03 | 0.09 | 1.00 | | | | | | |
| (8) covered bond | 0.10 | -0.01 | 0.08 | 0.09 | -0.03 | -0.02 | -0.03 | 1.00 | | | | | |
| (9) spv | -0.17 | -0.06 | -0.14 | -0.16 | 0.37 | -0.04 | 0.12 | -0.08 | 1.00 | | | | |
| (10) eligible collateral | 0.30 | 0.29 | 0.14 | 0.47 | -0.12 | -0.06 | 0.04 | 0.22 | -0.14 | 1.00 | | | |
| (11) log(distance) | -0.21 | -0.04 | 0.38 | -0.55 | 0.23 | 0.01 | -0.26 | -0.04 | 0.16 | -0.18 | 1.00 | | |
| (12) home | 0.19 | 0.01 | -0.35 | 0.41 | -0.17 | -0.03 | 0.21 | 0.01 | -0.11 | 0.08 | -0.93 | 1.00 | |
| (13) neighbouring country | 0.01 | 0.07 | -0.07 | 0.16 | -0.08 | 0.02 | 0.05 | 0.04 | -0.10 | 0.12 | -0.02 | -0.21 | 1.00 |

Note: This table presents the correlations between the variables.

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