

Discussion Paper No. 14-123

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Domestic Government Bonds?**

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Impact of Basel II and Basel III**

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Zentrum für Europäische
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What drives the demand of monetary financial institutions for domestic government bonds?

Empirical evidence on the impact of Basel II and Basel III

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Abstract

This paper examines the treatment of sovereign debt exposure within the Basel framework and measures the impact of bank regulation on the demand of Monetary Financial Institutions (MFI) for marketable sovereign debt. Our results suggest that bank regulation has a significant positive impact on MFI demand for domestic government securities. The results are representative for the MFI in the euro zone. They remain highly robust and significant after controlling for other influential factors and potential endogeneity.

Keywords

Monetary Financial Institutions; Financial sector regulation; Sovereign bond holdings; Investment incentives

JEL Classification

G11; G21; G28

1. Motivation

Recent monetary statistics provide evidence that euro zone banks have substantially increased their domestic marketable sovereign debt exposure. The accelerating public sector indebtedness might have significantly contributed to the growth of sovereign debt exposure across banks. Recent studies suggest that banks have changed their investment strategies following the global financial crisis. Yet, they leave aside the impact of banking sector regulation.

The demand for marketable sovereign debt might be strongly influenced by regulation, particularly the Basel II and Basel III framework. Banking sector regulation treats government debt denominated in domestic currency as “risk-free” and allows zero-risk weighting for them. It sets incentives for holding public debt rather than assets with non-zero risk weights. The global financial crisis revealed significant deficiencies of the existing regulatory framework. Thus, credit institutions needed to adopt a new framework and to meet stricter capital and additional liquidity requirements. The latter set further incentives for holding marketable sovereign debt. Some policy makers including Banque de France (Nouy 2012) and Deutsche Bundesbank (2013) have criticized the preferential treatment of sovereign debt within the Basel Accord.

Banks are important financiers of public households in the euro area holding 19% of total outstanding marketable public debt instruments. The relative share of domestic claims in the overall sovereign debt portfolio equals 71%. In Greece, Italy, Portugal and Spain, almost the entire public debt exposure of monetary financial institutions (MFI) is concentrated on the domestic public sector. Public interventions to support financial institutions increase the interdependence of public sector and financial industry. The links between banks and the public sector have been highlighted in recent research but literature on determinants of banks’ sovereign debt exposure in terms of volume is particularly limited (Buch et al. (2013)).

Hildebrand et al. (2012) utilize unique micro-level data and examine the holdings of securities across all German banks. Their results suggest that banks have re-balanced their portfolios following the collapse of Lehman Brothers towards securities which are accepted by central banks as eligible collateral for their credit operations. Moreover, the results provide strong evidence that German banks have increased the share of domestic securities in their overall portfolios. Buch et al. (2013) build upon the same database and examine the determinants of sovereign debt holdings. They confirm the shift

towards domestic government securities and find that banks with weak capitalisation and banks with small depositor base have higher sovereign debt exposures.

Both existing literature and recent empirical evidence suggest a significant increase of domestic marketable securities within the overall sovereign debt portfolio of MFI across euro countries. Yet, to the authors' knowledge, neither the drivers of banks' demand for sovereign debt nor the shift towards domestic claims on the public sector have been analysed so far. To bridge this gap, the focus of this paper will be the influence of banking sector regulation, particularly the Basel II and Basel III framework, on banks' demand for sovereign debt. We examine the treatment of sovereign debt exposure within the Basel framework and measure its impact on the demand of MFI for marketable sovereign debt.

Hildebrand et al. (2012) and Buch et al. (2013) focus on outstanding securities. This paper, in contrast, builds upon *flows* rather than *stocks*. Stocks remain relatively stable over time and reflect both past and current demand for marketable sovereign debt. Changes in stocks are not only driven by the amount of financial transactions, i.e. they are not always equal to flows, but also reflect reclassifications, exchange rate changes and other adjustments. In contrast, flows only include the amount of current financial transactions and exclude valuation effects. Hence, flows reveal more variation over time and provide a better measure of the MFI demand on marketable sovereign debt.

The analysis employs euro zone country level panel data and is done on a quarterly basis for the period between Q1 1999 and Q4 2013. Our results suggest that bank regulation has a significant positive impact on MFI demand for domestic government securities. The results are representative of the overall monetary union. They remain highly robust and significant after controlling for potential endogeneity.

The structure of our paper is as follows. This section is motivation. Section 2 highlights the treatment of public debt within the Basel framework. Section 3 explains empirical methodology and examines data. The results are summarized in section 4. A concluding section follows. Detailed description of data and sources is provided in the appendix.

2. The role of sovereign debt within the Basel framework

Sovereign debt plays a special role within the banking sector regulation. The *Basel Accord* (also known as Basel I, Basel II and Basel III) contains recommendations and

rules for regulation, supervision and risk management in the banking sector. It is transposed into European Union (EU) law through the *Capital Requirements Directive* (CRD)¹ and the *Capital Requirements Regulation* (CRR), the legal framework for banking sector regulation.

The treatment of sovereign debt within the Basel framework potentially influences the demand of MFI for marketable sovereign debt.

Table 1 and the following sections describe the treatment of investments in public debt instruments within the Basel framework and highlight those regulatory requirements that are significantly affected by sovereign debt treatment. The banking book sovereign exposure in the EU accounts for more than 80% of total public debt holdings, thus, significantly exceeding the trading book exposure (Blundell-Wignall and Slovik 2010; IMF 2011). Therefore, we mainly focus on credit risk and leave aside market risk requirements. The following sections 2.1 to 2.3 give a short description of those rules of Basel I, II, and III that particularly focus on investments in sovereign debt.

Table 1: Treatment of sovereign debt exposure and those regulatory requirements that are directly influenced by its treatment within the Basel framework

	Basel I	Basel II	Basel III
Sovereign risk weight	differentiation between OECD (0%) and non-OECD (100%)	based on Standardized Approach (SA) or on Internal Ratings-Based Approach (IRBA)	
Policy makers' discretion	0% risk weight for public debt denominated in domestic currency		
Capital Adequacy Ratio	at least 8.0%	at least 8.0%	at least 10.5% to 13.0%
Leverage Ratio	none	none	at least 3%
Liquidity requirements	none	none	Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR)
Large exposure	no requirements for sovereign debt with 0% risk weight under SA		

2.1. Basel I: single risk weight for claims belonging to the same asset class

The original Basel I framework was published in 1988 and enforced in 1992. It required the banks to maintain a *Capital Adequacy Ratio* (CAR) of at least 8%. The ratio is defined as regulatory capital expressed as percentage of total *Risk Weighted Assets* (RWA). Regulatory capital is the sum of core capital *Tier 1* and supplementary capital *Tier 2*. In order to calculate the RWA, assets were divided into different classes: claims on sovereigns, claims on corporates, claims on banks, claims on retail etc. They were then assigned different risk weights.

¹ CRD replaced the earlier *Capital Adequacy Directive* (CAD) and *Banking Consolidation Directive* (BCD) in 2006.

The risk weight for claims on sovereigns was either 0% if they were OECD members or 100% otherwise. In addition, national policy makers were allowed to assign zero risk weight for claims on domestic sovereign debt denominated in local currency. The CAD allowed zero risk weighting for public debt of both domestic government and any EU member state government denominated in local currency.

2.2. Basel II: risk weights within the same asset class driven by the default probability

The risk weights under Basel I were equal for claims belonging to the same asset class, regardless of the actual creditworthiness of the debtor. This issue was addressed by regulators and resulted in the revision of the framework. The subsequent Basel II framework was initially published in June 2004 and was implemented in the EU by January 2007. It accounts for different default probabilities across borrowers belonging to the same asset class. In the context of Basel II, counterparty risk weights are driven both by the asset class and the default probability of individual borrowers. Riskier assets have higher risk weights and require a higher capital backing than safer assets in the same class.

Credit institutions are allowed to choose between the *Standardized Approach* (SA) and the *Internal Ratings-Based Approach* (IRBA) for estimating the default probabilities of their counterparties. The risk weights under the SA are based on credit ratings of accepted *External Credit Assessment Institutions* (ECAI). Usually, these are the three leading rating agencies FitchRatings, Moody’s and Standard & Poor’s (S&P), and, in addition, Dominion Bond Rating Service (DBRS). External ratings are mapped to credit quality steps, a harmonized rating scale between 1 and 6 (see Table 2). High quality claims on sovereigns with an external credit rating between AAA and AA- have 0% risk weight (20% risk weight for A+ to A-). Usually, there is more than one external rating available from different ECAI. Where more than one external rating is available, the regulation refers to those two credit assessments which would yield the lowest risk weights and chooses the higher of the two.

Table 2: Mapping of external credit rating to credit quality steps and sovereign risk weights

credit quality step	1	2	3	4	5	6
DBRS	AAA to AAL	AH to AL	BBBH to BBBL	BBH to BBL	BH to BL	CCCH and below
FitchRatings	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ to B-	CCC and below
Moody’s	Aaa to Aa3	A1 to A3	Baa1 to Baa3	Ba1 to Ba3	B1 to B3	Caa1 and below
Standard & Poor’s	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ to B-	CCC and below
sovereign risk weight	0%	20%	50%	100%	100%	150%

The risk weights under the IRBA are based on sophisticated quantitative techniques and usually exceed 0%, even for high quality sovereigns claims. However, they can yield minor risk weights for lower rating classes and ease the strain on regulatory capital. In general, credit institutions that choose the IRBA have to apply it continuously to their credit portfolio. Notwithstanding, they are allowed to use a permanent carve-out and apply the SA for their sovereign debt exposure.

The national policy makers' discretion regarding zero risk weighting for claims on domestic sovereign debt remained particularly unchanged within Basel II: the CRD still allowed 0% risk weight under the SA for public debt of EU member states denominated in domestic currency regardless the actual sovereign default probability.

2.3. Basel III: more stringent capital requirements and additional liquidity requirements

The global financial crisis revealed significant deficiencies of the regulatory framework. Therefore, the framework has been revised in the aftermath to the crisis. Basel III was published in December 2010 and implemented in the EU gradually from January 2014, one year later than initially planned.

Basel III goes beyond the earlier framework and requires more stringent requirements for capital adequacy. It provides stricter rules on eligible regulatory capital and requires maintaining a higher CAR of at least 10.5%. National regulatory authorities are allowed to require an additional *Countercyclical Capital Buffer* (CCB) of up to another 2.5%, depending on macroeconomic conditions. The new capital requirements will be introduced gradually between 2014 and 2019. The risk weights for large financial institutions were increased but the risk weights for sovereign debt remained unchanged.

From 2018 on, the *Leverage Ratio* (LR) will complement the CAR. The ratio is defined as core capital *Tier 1* expressed as percentage of total bank assets and off-balance exposure. In contrast to CAR calculation, assets will be generally not risk-weighted. Banks will be required to maintain a ratio of at least 3%. In addition to the earlier framework, Basel III also requires credit institutions to maintain sufficient liquidity. It introduces the *Liquidity Coverage Ratio* (LCR) and the *Net Stable Funding Ratio* (NSFR).

The LCR requires banks to maintain a liquidity buffer, an adequate stock of *High-Quality Liquid Assets* (HQLA) for meeting their liquidity needs for a 30-days stress period. HQLA consist of cash holdings or assets convertible to cash with little transaction costs. The

framework differentiates between more liquid *level 1 assets* and less liquid *level 2 assets*. Level 1 assets mainly include marketable sovereign debt which qualifies for zero risk weight under the SA and have to account for at least 60% of total HQLA. Level 2 assets include marketable sovereign debt with 20% risk weight in the SA and are allowed to account for up to 40% of total HQLA. Marketable sovereign debt with risk weight exceeding 20% is not accepted as HQLA. The LCR will be introduced in 2015. First, banks will be required to maintain a ratio of at least 60%. The requirement will be increased gradually to 100% until 2019.

The LCR will be complemented by the NSFR. While the former ratio focuses on the 30-day period, the latter aims to ensure a sound funding structure over the one-year stress period. Its goal is to set incentives for stable funding sources and make banks less reliable on money market and central bank funding. The NSFR is defined as the ratio of *Available Amount of Stable Funding (ASF)* to *Required Amount of Stable Funding (RSF)*.

The ASF is the weighted book value of bank equity and liabilities. The weights vary between 100% for stable funding sources (mainly regulatory capital and liabilities with an effective maturity beyond one year) and 0% for unstable sources (including funding from central banks with residual maturity of less than six months). The RSF is the sum of bank assets and contingent liabilities. These are also assigned different weights between 0% for liquid assets (mainly cash and central bank reserves) and 100% for illiquid assets. The weights are 5% and 15% for level 1 and level 2 HQLA respectively with an effective maturity of at least one year. HQLA with an effective maturity below one year are assigned 100% weight. The treatment of HQLA for the NSFR calculation sets incentives for using liquid assets with more than one-year maturity rather than short-term assets for meeting the LCR requirements. The NSFR is to be introduced in 2018. Banks will be required to maintain a ratio of at least 100%.

2.4. Potentially false incentives arising from sovereign debt treatment within the Basel framework

Although various regulatory requirements were significantly increased, claims on the domestic public sector were granted special status within Basel I. This status remained unchanged in Basel II and has become even more important within the Basel III framework. Particularly before the euro debt crisis, public debt of EU member states denominated in local currency was widely regarded as “risk-free” by bank regulators. However, the recent default of Greece illustrates that a sovereign default of a euro

member state is a realistic scenario. Notwithstanding, the actual risk weight for claims on domestic sovereign debt is to a large extent based on national policy makers' discretion rather than affected by the sovereign default probability. In most cases, it is still treated as "risk-free".

Although larger banks tend to use the IRBA, a recent analysis of the European Banking Authority (EBA 2013) shows that most large banks apply the carve-out and use the SA for their central government portfolios. In a sample of 35 large banks from 13 EU countries, 23 were applying the carve-out. As larger banks apply the carve-out and smaller banks tend to use the SA, we estimate that the SA is applied to most sovereign debt exposure of the banking sector within the euro area in terms of volume.

Stricter requirements for capital adequacy for the banking sector as well as higher risk weights for claims on non-sovereigns require stronger capitalization of credit institutions. Stronger capitalization as well as the newly introduced NSFR and LCR potentially improve the solvency of credit institutions. However, the regulation could also provide false incentives and create new risks. Relatively high risk weights for claims on non-sovereigns compared to claims on sovereigns combined with stricter rules on eligible regulatory capital and higher minimum CAR require either higher capitalization or lower risk profile for credit institutions.

The new LR sets the upper limit for overall bank exposure, and thus specifically offsets the unlimited demand for assets with zero risk weight. Notwithstanding, claims on governments receive preferential treatment that potentially affects the MFI demand for marketable sovereign debt. In times of deteriorating capital ratios, the regulatory environment incentivises banks either to build up assets or to shift their asset allocation from non-zero weighted claims towards assets with zero risk weight, particularly claims on domestic general government. The new liquidity requirements force banks to hold more marketable sovereign debt with an effective maturity beyond a one-year horizon.

Although the CRR limits the risk exposure to a single counterparty, restrictions on large exposures do not apply for sovereign debt with 0% risk weight under SA. The regulatory incentives in conjunction with the missing restrictions on large exposures for sovereign debt could potentially result in higher risk concentration and make the banking sector more vulnerable towards domestic sovereign debt problems. The banking sector in Greece had to write down 29.9 bn euros on their domestic government securities

portfolio between August 2011 and April 2012. Following the sovereign default, Greek domestic banks required a significant recapitalization.

Our hypothesis is that there is a significant relationship between banking sector regulation and MFI demand for sovereign debt investments. Public debt treatment within the Basel framework should have a strong impact on MFI demand for government obligations. Our paper examines the influence of Basel II and Basel III relative to the regulatory framework that was in effect before.

3. Data and definitions

The analysis employs country panel data for *all euro member states* and is done on a quarterly basis for the period between Q1 1999 and Q4 2013. Those countries which have joined the monetary union after Q1 1999 have been considered following their entrance. All member states are exposed to the same banking supervision and regulatory environment. Thus, they are required to meet the same regulatory standards and are similarly exposed to both monetary policy and intervention of the ECB.

The following sections describe the data and introduce the variables. Section 3.1 examines the structure of public debt and MFI debt holdings across the sample countries. The descriptive analysis helps to identify an appropriate depending variable for measuring the MFI demand for domestic sovereign debt that is presented in section 3.2. The subsequent section 3.3 introduces potential demand determinants, including banking regulation and chosen control variables. In the following banks, credit institutions and MFI are used as synonyms. Detailed description of data and sources is provided in the appendix.

3.1. Descriptive statistics

In Europe, both public debt level and marketable sovereign debt exposure of MFI on domestic general government have significantly increased over the recent years. This section examines the structure of general government debt and sovereign debt portfolios across euro member states.

3.1.1. Public debt structure in the euro area

The absolute amount of public debt within the monetary union increased from 5,021 billion euros (73% of GDP) in Q1 1999 to 6,848 billion euros (79% of GDP) in Q3 2008 and peaked at 10,174 billion euros (119% of GDP) in Q4 2013. Table 8 compares the

level of public debt in percent of GDP across the member states. The reasons for accelerating public debt lie in the structural budget deficit of most countries and the negative impact of the recent financial crisis across the overall euro area. Eurostat estimates that public interventions to support financial institutions in the euro area have a cumulative impact of 481 billion euros on outstanding government liabilities and 503 billion euros on contingent liabilities as of December 2013.

Tables 9-12 summarize the overall structure of public debt across euro member states in terms of issuer, currency, residual maturity and financial instrument. Most public debt is issued by central governments. Except for Estonia and Germany, state and local government debt contribution is relatively low. General government debt is almost entirely denominated in domestic currency, which is euro. Three quarters of total government debt has residual maturity above one year. The public sector uses both marketable and non-marketable debt instruments to meet its financing needs. As the consequence of the EU and IMF emergency measures following the beginning of the euro zone debt crisis, the volume of loans in Greece, Ireland, Italy, Portugal and Spain increased significantly. These loans are neither marketable nor held by MFI. Debt securities are still the main source of financing for the general government in Europe accounting for over 80% of total outstanding public debt in the sample. Except for Estonia and Luxembourg who have low ratios, the proportion is similar across the sample countries. Estonia and Luxembourg have the lowest public debt level relative to GDP compared to other member states. Luxembourg had no marketable debt outstanding between Q2 2007 and Q3 2008.

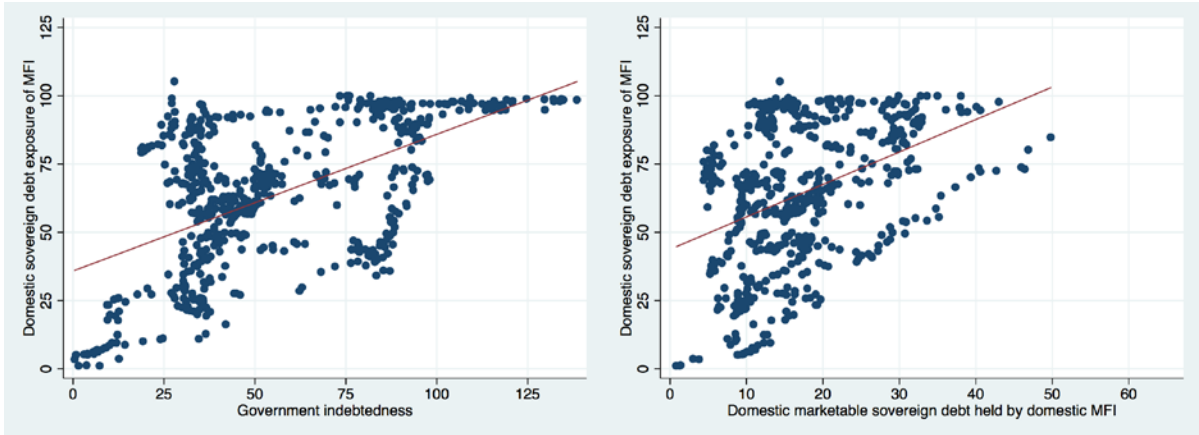
3.1.2. Structure of MFI marketable sovereign debt portfolios in the euro area

MFI are important financiers of the public sector in the euro area holding 19% of total outstanding marketable public debt instruments. Table 13 summarizes the share of total domestic marketable debt held by MFI across the member states. Banks' portfolios are strongly dominated by domestic claims. Between 1999 and September 2008, the overall amount of marketable claims on domestic public sector moderately declined from 866 billion euros to 630 billion euros. The outstanding amount doubled within five years following the collapse of Lehman Brothers in September 2008 and peaked at 1,313 billion euros in Q4 2013. In terms of total banks assets, the share increased from 3.8% to 5.6%. Table 14 reviews the ratio of domestic sovereign debt holdings to total MFI assets across the member states.

Table 15 summarizes the overall structure of marketable sovereign debt portfolios across the countries in terms of counterpart area. Notably, bank regulation in the EU provides an equal treatment of claims on domestic government and public sector of other member states. Thus, both are perfect substitutes. Still, the relative share of domestic claims in the overall sovereign debt portfolio increased from 45% to 71% within the last five years. The amount of domestic public debt varies across individual member states. Except for a few countries², domestic sovereign exposure exceeds foreign public debt holdings. In some economies where the public sector experienced the most severe problems following the global financial crisis – namely Greece, Italy, Portugal and Spain – the share of non-domestic public debt declined significantly. In these countries, almost the entire public debt exposure is recently concentrated on domestic public sector. At the same time as claims on domestic public sector increased, the share of claims on other euro member states considerably declined from 40% to 20%. Claims on non-euro public sector are of minor importance. They also declined by 5 percentage points to 9% relative to September 2008.

Figure 1 illustrates the relationships of the *domestic sovereign debt exposure* (defined as domestic general government securities held by the MFI relative to their overall marketable sovereign debt exposure) with (i) *government indebtedness* (general government net liabilities relative to GDP) and (ii) *domestic marketable sovereign debt held by domestic MFI* (domestic general government securities held by the MFI relative to the overall marketable sovereign debt issued by domestic general government).

Figure 1: Sovereign risk concentration across the euro zone MFI



² These are Estonia, Ireland, Luxembourg, and the Netherlands.

There seems to be a strong positive relationship between general government indebtedness and domestic holdings of domestic general government securities by the MFIs. Economies with low public debt-to-GDP ratios have relatively low default risk. Their government bonds are held by both domestic and foreign banks. The overall market volume for these instruments is relatively small since the government has little debt outstanding. Therefore, domestic MFI tend to invest some of their funds into foreign government bonds. On the other hand, economies with high public debt-to-GDP ratios have higher default risk. Given the higher default risk, it becomes more difficult to find foreign MFI who buy these debt instruments. Foreign MFI exposure gradually declines with total public debt-to-GDP ratios. At the same time domestic MFI gradually increase their domestic marketable sovereign debt exposure and reduce their foreign sovereign bond exposure. Significant risk concentration potentially makes the banking sector highly vulnerable to domestic sovereign debt problems.

3.2. Dependent variable: MFI demand for domestic marketable sovereign debt instruments

As we have shown above, securities comprise both most public debt instruments and sovereign debt exposures of MFI in the euro area. This aggregate comes closest to the definition of HQLA within the Basel III framework. Thus, we examine the demand of MFI for marketable sovereign debt instruments. The analysis builds upon *securities* issued by domestic general government. The volume of securities is not distorted by emergency loans which were provided by the international community. Focusing on domestic debt allows a direct link between endogenous domestic factors and the dependent variable.

We build upon *flows* rather than *stocks*. The dependent variable is the amount of financial transactions of MFI with securities issued by the domestic general government (*MFI_GGSec*). It is expressed as percentage of the GDP for the relevant period. In the following securities, marketable sovereign debt and bonds are used as synonyms. Next section introduces potential drivers of MFI demand for marketable sovereign debt.

3.3. Potential determinants of MFI demand for domestic marketable sovereign debt

Our ultimate goal is to measure the impact of the Basel framework on the MFI demand for marketable sovereign debt. Different effects going beyond banking sector regulation could also influence the MFI demand. Therefore, we add several control variables. Potential drivers have been grouped into four categories: (1) primary market supply of marketable sovereign debt, (2) banking sector regulation, (3) banking sector asset

allocation strategy and funding sources, and (4) policy makers' and public sector interventions.

3.3.1. Primary market supply

In order to meet their demand for marketable sovereign debt, MFI can use both the primary and the secondary markets. The net issue of general government securities drives the primary market (*GGSec*). We focus on the amount of financial transactions (*flows*) rather than on the outstanding amounts (*stocks*). The variable is expressed as percentage of the GDP for the relevant period.

The primary market supply should have a significant impact on the MFI demand. The secondary market, however, could be affected by numerous factors which are summarized below.

3.3.2. Banking sector regulation

We want to test whether banking sector regulation is one of the key drivers for MFI demand on marketable sovereign debt. The sample covers the period between 1999 and 2013, including three different episodes of banking sector regulation, particularly Basel I, Basel II and Basel III. MFI need certain time to meet the new requirements. Moreover, they have to disclose the ratios before their implementation date for information purposes. Banks begin adopting the requirements following their official announcement, long before the actual implementation date of the framework. Hence, the first announcement date should be more important than the enforcement date for measuring the effect of Basel II and Basel III on the demand of MFI for domestic marketable sovereign debt.

The analysis implements two dummy variables. The dummy variable *B2_Dummy* turns to one in Q3 2004 and remains so in the following periods. The dummy variable *B3_Dummy* is one from Q1 2011 on. The more recent Basel framework does not replace the earlier but reflects the stricter regulatory requirements relative to it. *B2_Dummy* captures the stricter requirements relative to Basel I (i.e. impact of credit default probability on risk weights) whereas *B3_Dummy* captures the stricter requirements relative to Basel II (i.e. enhanced capital and new liquidity requirements).

We believe that the regulatory environment has a substantial positive impact on MFI demand for government securities. Both dummy variables are expected to have a significantly positive effect on MFI demand for marketable sovereign debt.

3.3.3. Banking sector asset allocation strategy and funding sources

One important driver of the demand for government securities could be the MFI asset allocation strategy. The strategy reflects the MFI risk aversion and the risk-return profile of the different investments. Among others, the evaluation of asset prices as well as the level of interest rates might have an impact on the strategy. Equity prices reflect the fundamental environment and the investors' expectations. We control for the growth rate of real property prices (*RPP_Ch*) and the growth rate of stock market prices (*Equity_Ch*). Moreover, we employ the historical volatility (*Equity_Vola*) of stock markets in the respective period.³

We also control for the impact of long-term government bond yields (*GG_LTYield*) and credit assessment of domestic public sector. The latter is based on credit ratings provided by FitchRatings, Moody's, S&P, and DBRS that were converted to credit quality steps following the definition of CRR. Not only does credit assessment potentially affect the asset allocation strategy of credit institutions, it is also important for central bank funding of MFI. The Eurosystem provides credit on a collateralised basis. Until October 2008, the ECB only accepted securities with external ratings between AAA and A- (credit quality steps 1 and 2). As the consequence of rating deterioration following the crisis, it also accepts securities with external ratings between BBB+ and BBB- (credit quality step 3) from October 2008 on. Moreover, the ECB suspended the minimum credit rating threshold for Greece, Ireland and Portugal during the euro debt crisis. Dummy variables *CQS_1or2_Dummy* (credit quality step 1 or 2) and *CQS_3_Dummy* (credit quality step 3) are used to control for the impact of sovereign credit ratings on MFI demand for marketable public debt.

The asset allocation strategy affects the asset side of MFI. We also control for MFI funding sources. Buch et al. (2013) find that banks with weak capitalisation and banks with a small depositor base have higher sovereign debt exposure. Therefore, we also control for capital and reserves (*MFI_CapRes*) and retail deposits (*MFI_Deposits*). In addition, we control for total bank assets other than domestic marketable sovereign debt (*MFI_TotAssets*). We are using the flows. The variables are expressed as a percentage of GDP for the relevant period.

³ 60 trading days for quarterly or 260 trading days for annual analysis

We expect the banks potentially shifting towards safer investments in periods of deteriorating equity and property prices. The demand for marketable sovereign debt should be negatively correlated with asset prices. Volatility is negatively correlated with equity price growth rates, and therefore, should be positively linked with the MFI demand for marketable sovereign debt.

The demand for government debt should be positively related with long-term government yields in case that MFI purchase these assets for generating interest income. On the other hand the yield might be less important if the demand is particularly driven by regulatory requirements or even explicit policy makers stimulation to purchase government debt. We believe that credit quality has little effect on the MFI demand for marketable sovereign debt. First, those MFI that apply the SA assign zero-risk weights for their domestic sovereign debt portfolio independent of the rating. Second, the ECB has suspended the minimum credit rating threshold and also accepts lower quality debt instruments as collateral. Therefore, sovereign credit ratings should have little impact on both CAR for SA banks and MFI access to ECB credit.

3.3.4. Policy makers' and public sector and intervention

The effect of Basel III is potentially distorted by various events taking place in the aftermath of the global financial meltdown and in the cause of the subsequent euro zone debt crisis. We need to control both for a post-Lehman and a post-euro-crisis bias. Over the last few years the ECB and other central banks have provided sufficient short- and medium-term liquidity to credit institutions. Large amounts of this liquidity have been used to make overnight deposits under the ECB's deposit facility. Parts of this liquidity could be potentially used for buying government securities. We control for both the gross central bank funding *MFI_CBLia* and net central bank funding *MFI_CBNetClaims* (i.e. central bank funding less deposits at the central bank *MFI_CBClaims*). Both variables are expressed as percentage of GDP.

Besides the increased funding for the credit institutions, the ECB run its SMP between 10 May 2010 and 6 September 2012. First, the ECB was targeting Greece, Ireland and Portugal but extended the programme to Italy and Spain on 7 August 2011. It spent about 220bn euros for purchasing debt securities of these economies in the secondary market in the context of this programme (ECB 2014). The programme has potentially driven up the secondary prices for these securities and reduced government yields. The ECB did not provide the breakdown of the Eurosystem's SMP holdings per country of

issuer during the lifetime of the programme. It only provided the breakdown on 21 February 2013 as at 31 December 2012 following the termination of the programme. We use the dummy variable *SMP_Dummy* and account for the effect of the SMP programme. The dummy variable turns to one for Greece, Ireland and Portugal between Q2 2010 and Q3 2012 (for Italy and Spain between Q3 2011 and Q3 2012) and is zero otherwise.

Not only policy makers but also the public sector strongly intervened in the financial markets over the last few years. The public sector ran large-scale rescue operations during the crisis. Some banks have been nationalized. According to Eurostat, aggregated public interventions including both capital injections and guarantees to financial institutions in the euro area peaked at 1.111 billion euros in 2012 and accounted for 984 billion euros at the end of 2013. Becoming a significant shareholder, lender or guarantor, the government could have influenced the banks' investment strategy and forced them to take a larger stake in the overall public sector financing.

We control for public interventions and employ two different data sources: the earlier mentioned Eurostat statistics and state aid information from the European Commission. Eurostat summarizes the potential effect of intervention on public debt including both outstanding liabilities (*GGLia*) and contingent liabilities (*GGContLia*) since 2007. The European Commission provides data from 2008 on. It differentiates between four different instruments: recapitalization measures (*GGRecap*), asset relief measures (*GGAssetRelief*), guarantees on liabilities (*GGGuarant*) and other liquidity measures (*GGLiqMeas*). In contrast to Eurostat that summarizes the outstanding amounts, the Commission does not collect information on repayments of these instruments. It reports the provided aid measures in the consecutive period and summarizes the outstanding amount of guarantees at the period-end. Both sources only provide annual data. We have to sum up earlier indicators to annual aggregates when we control for public sector interventions. Public sector interventions are expressed as percentage of GDP.

As the sample only includes euro zone member states, the key interest rate is the same for all countries in the sample. Therefore, we do not control for its effect separately.

The excessive central bank funding is expected to have a positive effect on the MFI demand for marketable sovereign debt. The potential effect of the SMP is unclear. The programme is expected to have a negative effect on MFI demand if banks have sold their

holdings to the ECB. However, the effect could also be positive either because they might be forced to support the programme and keep their holdings or simply believed in the non-default of their domestic government following the intervention of the ECB and took a higher stake in domestic government bonds. The effect of public interventions is expected to be positive.

4. Results

This section presents our results and derives implications of impact of public debt treatment within the banking sector regulation on financial sector vulnerability. Tables 3-6 summarize results of the estimations. We use random effects panel models for all estimations.⁴

4.1. Impact of banking sector regulation on MFI demand for marketable sovereign debt

Tables 3 and 4 summarize our main results. First, we control for the net primary market supply in column (1). The coefficient of *GGSec* is positive and highly significant. In the next step, we introduce the Basel II and Basel III dummy variables. Both dummy variables suggest that bank regulation has a significant positive impact on MFI demand for domestic government securities. Adding both dummies yields a substantially higher R-Squared between the countries. Thus, we conclude the bank regulation helps explain variation across the individual euro member states. Further control variables are introduced in the subsequent specifications and examined one-by-one below.

In columns (3)-(5), we control for the impact of asset prices. *Equity_Vola*, *Equity_Ch* and *RHPI_Ch* have the expected signs. Equity markets volatility and property prices are highly significant. We control for risk and return characteristics of marketable sovereign debt in specifications (6) and (7). The results suggest a positive relationship between banks' demand for marketable sovereign debt and long-term government bond yields. Credit quality assessment is not significant.

Column (8) examines the impact of bank funding. Capital and reserves variable has a positive sign and is significant at the 5% level. The coefficient of retail deposits is negative but not significant. The results do not contradict the findings of Buch et al. (2013) who find that banks with weak capitalisation and banks with small depositor base have higher sovereign debt exposure. Buch et al. (2013) focus on stocks whereas

⁴ The Hausman test suggests to prefer a random effects model for our dataset.

our analysis builds upon flows. Obviously, weakly capitalised MFI need substantial capital injections. Therefore, there should be a high correlation between weak capitalisation and inflow of capital and reserves. Variation of other bank assets beyond domestic marketable sovereign debt has no impact on the dependent variable. Its coefficient is close to zero and not significant either indicating that the demand for government securities does not go hand in hand with increasing business volume and growing asset base. The effect is potentially driven by the high leveraging of credit institutions in the run-up to the global financial crisis.

In specifications (10)-(12), we control for the effect of policy makers' interventions. The results suggest that banks partly use central bank funds to buy domestic government bonds. *MFI_NetLiaCB*, *MFI_LiaCB* and *MFI_CICB* have the expected signs. Central bank funding is significant and robust. The *SMP_Dummy* has a positive coefficient and is highly significant. It indicates an increased demand of MFI for distressed domestic government securities. The *B3_Dummy* remains positive but is not significant in column (12). Notably, those member states that were targeted by the SMP had high long-term government bond yields. The government yields are not significant any more if we add them to specification (13). Although MFI demand for domestic government bonds was high in low-yield member states over the last years, the highest demand was observed in the SMP countries. The results imply that the MFI demand is not necessarily determined by attractive yields but was significantly influenced by the SMP.

Specifications (14)-(18) control for the impact of public sector interventions for rescuing the financial sector. Data on interventions are only available on an annual basis. To make the results comparable to earlier observations, we replicate specification (12) on an annual basis in column (14). In column (15), we utilize the aforementioned Eurostat data. Columns (16)-(18) employ European Commission statistics. First, we control for used aid amounts granted for recapitalization and asset relief measures in column (16). In specification (17), we control for outstanding amounts for guarantees and other liquidity measures and in column (18) for all alternative aid instruments. Except for asset relief, public sector interventions are not significant. Our earlier results remain robust if we add these intervention data into the regression.

Interestingly, both Basel dummies are significant and robust in all specifications. They remain highly robust if we control for a post-Lehman and a post-euro-debt-crisis bias by adding public sector and policy makers' interventions as well as deteriorating asset

prices. The following section examines the representativeness of our results for the overall euro area.

Table 3: Impact of primary market supply, banking sector regulation, and banking sector asset allocation strategy and funding sources

Unbalanced country level panel, estimated by a random effects model; dependent variable: demand of MFI for marketable sovereign debt instruments (*MFI_GGSec*); t-statistics in parentheses (robust standard errors).

	Pr. mkt.	Regulation	Banking sector asset allocation strategy and funding sources						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GGSec	0.247** (2.273)	0.245** (2.235)	0.243** (2.198)	0.244** (2.209)	0.241** (2.242)	0.258** (2.259)	0.251** (2.155)	0.245** (2.190)	0.244** (2.196)
B2_Dummy		0.947*** (2.625)	0.942*** (2.685)	0.944*** (2.617)	0.664 (1.533)	1.170*** (3.893)	0.910*** (2.634)	0.923*** (2.683)	0.942*** (2.707)
B3_Dummy		0.780** (2.264)	0.830*** (2.831)	0.779** (2.286)	0.577** (2.220)	0.536** (2.437)	0.492* (1.795)	0.893*** (3.490)	0.896** (2.574)
Equity_Vola			0.032** (2.290)			0.016 (1.101)	0.024* (1.772)	0.026 (1.618)	0.033** (2.352)
Equity_Ch				-0.011 (-0.603)					
RPHI_Ch					-0.235** (-2.269)				
GG_LTYield						0.352** (2.399)			
CQS1or2							-2.080 (-1.605)		
CQS3							-1.603 (-0.813)		
MFI_CapRes								0.046** (2.558)	
MFI_Deposits								-0.011 (-1.458)	
MFI_TotAssets									0.002 (0.938)
Constant	-0.437 (-1.478)	-1.279*** (-3.324)	-2.003*** (-3.831)	-1.275*** (-3.291)	-0.935*** (-2.717)	-3.347*** (-4.191)	0.233 (0.184)	-1.966*** (-4.040)	-2.064*** (-3.867)
Random Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	820	820	820	820	814	808	820	820	820
Number of countries	17	17	17	17	17	16	17	17	17
R-Squared within	0.213	0.226	0.232	0.226	0.233	0.251	0.237	0.244	0.233
R-Squared between	0.251	0.410	0.433	0.433	0.481	0.345	0.424	0.457	0.443
R-Squared overall	0.213	0.229	0.234	0.229	0.237	0.248	0.239	0.247	0.235
p(Chi-Squared)	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
p(Hausman test)	0.830	0.928	0.948	0.932	0.979	0.326	0.619	0.962	0.920

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

Table 4: Impact of policy makers' and public sector interventions

Unbalanced country level panel, estimated by a random effects model; dependent variable: demand of MFI for marketable sovereign debt instruments (*MFI_GGSec*); t-statistics in parentheses (robust standard errors).

	Policy makers' interventions					Public sector interventions			
	(10)	(10)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
GGSec	0.247** (2.280)	0.247** (2.313)	0.259** (2.474)	0.261** (2.411)	0.213*** (3.402)	0.224*** (3.521)	0.184*** (3.016)	0.202*** (2.796)	0.191*** (2.628)
B2_Dummy	0.958*** (2.857)	0.940*** (2.816)	0.817** (2.566)	0.883*** (3.370)	0.870*** (2.971)	0.796*** (2.649)	0.901*** (2.854)	0.954*** (3.204)	0.933*** (3.214)
B3_Dummy	0.936*** (2.789)	0.957*** (2.651)	0.400 (1.297)	0.371 (1.309)	0.734*** (3.013)	0.715*** (3.184)	1.112*** (2.598)	1.105** (2.546)	1.078** (2.522)
Equity_Vola	0.030** (1.999)	0.024 (1.459)	0.010 (0.773)	0.008 (0.487)	0.028** (2.382)	0.025*** (2.664)	0.034** (2.526)	0.035*** (2.690)	0.037*** (2.905)
GG_LTYield				0.086 (0.583)					
MFI_NetLiaCB	0.034 (1.556)								
MFI_LiaCB		0.050** (2.063)	0.046** (1.967)	0.046* (1.937)	0.016** (2.165)	0.016** (1.988)	0.011 (1.206)	0.012 (1.396)	0.012* (1.658)
MFI_CICB		-0.022* (-1.725)	-0.019 (-1.623)	-0.020 (-1.609)	-0.006 (-1.246)	-0.007 (-1.346)	-0.007 (-1.316)	-0.008* (-1.704)	-0.007* (-1.734)
SMP_Dummy			4.241*** (6.016)	3.793*** (4.786)	2.548*** (2.961)	2.309** (2.197)	2.085** (2.455)	2.144* (1.892)	2.008** (2.038)
GGIntLia						0.088 (0.801)			
GGIntContLia						-0.009 (-1.321)			
GGRecap							-0.014 (-0.403)		-0.030 (-0.583)
GGAssetRelief							0.639** (2.440)		0.644*** (2.654)
GGGaurant								-0.010 (-0.705)	-0.010 (-0.652)
GGLiQMeas								-0.101 (-0.373)	-0.108 (-0.325)
Constant	-2.031*** (-4.094)	-1.901*** (-3.804)	-1.611*** (-3.715)	-1.968** (-2.483)	-1.907*** (-3.742)	-1.850*** (-4.615)	-2.008*** (-3.734)	-2.065*** (-4.128)	-2.104*** (-4.226)
Random Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	809	809	809	797	198	198	181	181	181
Number of countries	17	17	17	16	17	17	17	17	17
R-Squared within	0.271	0.283	0.311	0.313	0.414	0.435	0.432	0.410	0.433
R-Squared between	0.438	0.468	0.386	0.360	0.418	0.408	0.467	0.503	0.485
R-Squared overall	0.272	0.285	0.311	0.311	0.407	0.424	0.421	0.410	0.424
p(Chi-Squared)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
p(Hausman test)	0.960	0.860	0.985	0.035	0.989	0.999	0.370	1.000	0.064

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

4.2. Representativeness for the overall euro area

The sample covers both core euro member states and those member states which have joined the monetary union later. Core members are widely recognized as mature economies and have highly developed financial markets, thus providing a relatively homogeneous sample. They account for 99% of both securities issued by general government and MFI assets in the euro zone. Therefore, core member states are highly representative of the overall monetary union. Moreover they yield an almost balanced panel. Those economies which have launched the euro later, are either classified as emerging markets (Estonia, Slovakia, Slovenia) or are relatively small compared to the original members (Cyprus, Malta). They have joined the euro significantly later than core member states and still have less developed financial markets compared to original member states. Therefore, those countries only add up limited observations but would change our panel to be significantly unbalanced. In columns (19)-(21), we therefore exclude Cyprus, Estonia, Malta, Slovakia and Slovenia from the sample. The overall results remain robust.

In columns (22)-(24), we drop those member states which had most severe sovereign debt problems and have been targeted by the ECB's Securities Markets Programme. The results remain robust. The Basel dummy variables have a positive signs and are highly significant. This is also true if we include only SMP countries and exclude all other member states.⁵

Obviously, member states of the euro area vary by size. On the one hand, there are large economies with huge banking sector, particularly France, Germany, Italy and Spain. On the other hand there are relatively small countries like Cyprus, Estonia, Malta and Slovenia. Some smaller and medium sized countries have an extremely large banking sector, particularly Cyprus, Ireland and Luxembourg. The number of smaller countries exceeds the number of larger economies. Still, these large countries are more representative of the overall euro zone in terms of total bank assets. Treating all sample countries equally could create a bias towards countries with less pronounced banking sector even though they are less representative of the overall monetary union. Therefore, we estimate a weighted fixed-effects model and summarize its results in specifications (25)-(27).⁶ We assign constant weights to all sample countries. The weights are based on total outstanding MFI assets in

⁵ These extended results are available from the authors on request.

⁶ Weights are not allowed for the random-effects model.

the observation period (for those countries which have joined the euro after 1999, only for their membership period). Again, our main results remain robust.

Table 5: Representativeness for the overall euro area

Unbalanced country level panel, estimated by a random effects model; dependent variable: demand of MFI for marketable sovereign debt instruments (*MFI_GGSec*); t-statistics in parentheses (robust standard errors).

	w/o CYP, EST, MLT, SVK, SVN			w/o ESP, GRC, IRL, ITA, PRT			weighted by total MFI assets		
	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
GGSec	0.112*** (3.396)	0.130*** (3.956)	0.122** (2.185)	0.349** (2.316)	0.350** (2.374)	0.341*** (3.797)	0.173*** (3.390)	0.185*** (3.865)	0.204*** (3.454)
B2_Dummy	1.080*** (3.615)	0.967*** (4.205)	0.891*** (3.009)	0.661 (1.486)	0.720* (1.859)	0.757*** (2.610)	0.476* (1.837)	0.508** (2.180)	0.446 (1.455)
B3_Dummy	0.676** (2.561)	0.027 (0.111)	0.815** (2.278)	0.317 (1.167)	0.340* (1.743)	0.566 (1.327)	0.803** (2.394)	0.306 (1.397)	0.992* (1.980)
Equity_Vola		0.011 (1.464)	0.024** (2.086)		0.013 (1.007)	0.035** (2.280)		0.008 (1.039)	0.019 (1.315)
MFI_LiaCB		0.025* (1.866)	0.008 (0.929)		0.037 (1.307)	0.019 (1.642)		0.025* (1.882)	0.010 (1.137)
MFI_CICB		-0.010* (-1.699)	-0.006 (-1.283)		-0.016 (-1.263)	-0.004 (-1.258)		-0.012 (-1.698)	-0.012 (-1.533)
SMP_Dummy		4.061*** (6.204)	2.361** (2.460)					4.177*** (6.074)	0.456 (0.386)
GGRecap			-0.019 (-0.603)			-0.401 (-1.605)			-0.019 (-0.413)
GGAssetRelief			0.782*** (2.769)			0.484 (1.632)			0.897*** (6.667)
GGGaurant			0.003 (0.294)			0.060 (0.587)			-0.013 (-0.923)
GGliqMeas			0.054 (0.118)			-0.401*** (-6.135)			-0.106 (-0.343)
Constant	-1.024*** (-3.180)	-1.369*** (-4.450)	-1.670*** (-3.442)	-1.400*** (-2.783)	-1.748*** (-3.443)	-2.248*** (-2.963)	-0.769*** (-3.071)	-1.048*** (-3.799)	-1.367** (-2.707)
Random-Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Fixed-Effects	No	No	No	No	No	No	Yes	Yes	Yes
Number of observations	712	701	159	528	523	115	820	809	181
Number of countries	12	12	12	12	12	12	17	17	17
R-Squared within	0.110	0.207	0.471	0.359	0.387	0.462	0.170	0.247	0.451
R-Squared between	0.092	0.185	0.077	0.373	0.471	0.563	0.396	0.310	0.409
R-Squared overall	0.109	0.205	0.432	0.357	0.387	0.461	0.228	0.305	0.379
p(Chi-Squared)	0.000	0.000	0.000	0.005	0.000	0.000	0.005	0.000	0.000
p(Hausman test)	0.860	0.996	1.000	0.001	1.000	0.996	---	---	---

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

4.3. Potential endogeneity

Our results in Tables 3-5 are highly significant and robust. Yet, we cannot fully exclude potential endogeneity. Reverse causality is the issue of our major concern. The results suggest that MFI demand for marketable sovereign debt is strongly driven by general government's net issue of securities but the observed relationship could also reflect reverse causality. The potential supply is substantially determined by the government's financing needs. However, the appetite of investors also determines the actual issue volume of bonds. Banks are significant sovereign bondholders. Therefore, the public sector potentially takes their appetite into account when it issues new securities. The public sector may issue more bonds to cover its financing requirements or refinance existing debt when financing conditions are favourable and the MFI demand is high. Under these circumstances, the government might be inclined to issue more securities than it currently needs, and thus build up liquid assets. In this case, gross government liabilities would increase but net financial debt would remain stable. If the demand for bonds is low, the government can use its liquid assets or financial instruments other than securities or wait for a later window of opportunity. A primary market supply aggregate which only accounts for net issue of securities does not capture all these effects. Thus, we have to consider alternative financial instruments and the variation of liquid assets.

Therefore, we replace the net issue of general government securities (*GGSec*) by the net financial transactions of general government (*GGNetLia*) in specifications (28)-(30). This variable reflects the flows of total financial assets and liabilities. Financial liabilities are not limited to securities but also contain alternative debt instruments. Including financial assets allows eliminating the effect of increase and reduction in liquidity. The coefficient of *GGNetLia* is positive and highly significant. *GGNetLia* includes different financial instruments and provides a wider supply definition of net primary market supply with government debt than *GGSec*. Thus, the magnitude of its coefficient is lower than for *GGSec*.

Having both the overall net financial transactions of general government and the net issue of general government securities, we are able to separate the impact of government financial transactions going beyond their net issuance of securities. *GGSec* and the difference between *GGNetLia* and *GGSec* are highly correlated. Adding both variables to our model simultaneously creates multicollinearity. Therefore, we regress

GGSec on *GGNetLia* first and then add the *error term* to our model in specifications (31)-(33). The error term is not correlated with *GGSec* by definition. *GGSec* remains robust and significant. The *error term* is neither significant nor robust. Finally, we use the one-period lagging *GGSec* (i.e. three-month lag on a quarterly basis and twelve-month lag on an annual basis), the results are shown in columns (34)-(36). Its coefficient is positive and highly significant but the magnitude is lower than for the instantaneous *GGSec* variable.

We cannot fully exclude potential endogeneity for all variables on the right-hand side. Strong MFI demand for marketable sovereign debt possibly reduces long-term government bond yields and influences asset prices if banks re-allocate their investments. However, the results remain highly robust if we exclude *Equity_Vola*, *Equity_Ch*, *RHPI_Ch* and *GG_LTYield*. Thus, these factors are not the issue of our major concerns.

Our results remain highly robust and significant after controlling for potential endogeneity. The coefficients of Basel II and Basel III dummy variables remain positive and significant in all specifications. These findings alleviate our concerns of endogeneity, and particularly reverse causality.

Table 6: Considering potential endogeneity

Unbalanced country level panel, estimated by a random effects model; dependent variable: demand of MFI for marketable sovereign debt instruments (*MFI_GGSec*); t-statistics in parentheses (robust standard errors).

	Net financial liabilities			Other financing sources			One-period Lag		
	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)
GGNetLia	0.121*** (3.405)	0.103*** (2.635)	0.070 (1.468)						
GGSec				0.245** (2.236)	0.259** (2.474)	0.171** (2.349)			
Error_Term				0.017 (0.225)	-0.013 (-0.189)	0.205*** (2.677)			
lag(GGSec)							0.016 (0.973)	0.030** (2.087)	0.076* (1.794)
B2_Dummy	1.042*** (3.293)	1.050*** (3.781)	1.251*** (3.463)	0.911*** (2.883)	0.841*** (3.209)	0.774*** (3.470)	1.376*** (4.463)	1.268*** (4.693)	1.383*** (4.062)
B3_Dummy	0.325 (1.099)	0.268 (0.774)	0.834** (2.061)	0.757* (1.864)	0.410 (1.190)	0.848** (2.175)	0.489 (1.460)	0.328 (0.900)	0.904** (2.436)
Equity_Vola		0.020 (1.640)	0.038*** (2.839)		0.011 (0.854)	0.037*** (3.660)		0.023* (1.906)	0.054** (2.335)
MFI_LiaCB		0.047* (1.719)	0.013 (1.542)		0.046** (2.005)	0.014** (1.967)		0.047* (1.694)	0.034* (1.908)
MFI_CICB		-0.018 (-1.328)	-0.002 (-0.356)		-0.019 (-1.635)	-0.003 (-0.609)		-0.018 (-1.327)	-0.017* (-1.818)
SMP_Dummy		1.874*** (2.687)	1.722** (2.127)		4.302*** (5.142)	1.274 (1.468)		2.639*** (4.224)	1.128 (1.215)
GGRecap			-0.140*** (-3.328)			-0.185*** (-3.221)			-0.147** (-2.394)
GGAssetRelief			0.781** (2.395)			0.423 (1.550)			0.789** (2.298)
GGGaurant			0.005 (0.816)			-0.007 (-0.433)			-0.008 (-0.589)
GGliqMeas			0.170 (0.333)			-0.138 (-0.533)			0.087 (0.160)
Constant	-0.898*** (-2.845)	-1.429*** (-4.419)	-1.981*** (-3.692)	-1.248*** (-2.651)	-1.642*** (-3.469)	-1.762*** (-4.311)	-0.850*** (-2.894)	-1.471*** (-4.440)	-2.354*** (-3.202)
Random Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	820	809	181	820	809	181	813	806	169
Number of countries	17	17	17	17	17	17	17	17	17
R-Squared within	0.036	0.097	0.344	0.226	0.311	0.474	0.017	0.083	0.379
R-Squared between	0.284	0.214	0.442	0.409	0.389	0.545	0.303	0.274	0.490
R-Squared overall	0.039	0.096	0.346	0.229	0.311	0.465	0.021	0.086	0.363
p(Chi-Squared)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
p(Chi-Squared)	0.434	0.168	0.830	0.971	1.000	0.928	0.539	0.700	1.000

*** Significant at 1%, ** Significant at 5%, * Significant at 10%

5. Summary and concluding remarks

The overall domestic marketable sovereign debt exposure of banks has significantly increased across euro member states during the last years. We employ country panel data and examine the demand of MFI for these instruments. We are particularly interested in the impact of banking sector regulation on the demand of MFI for marketable sovereign debt. These are our main findings:

- The demand is substantially driven by government net issue of securities.
- Both Basel II (i.e. impact of credit default probability on risk weights) and Basel III (i.e. enhanced capital and new liquidity requirements) have a strong positive impact on MFI demand for domestic marketable sovereign debt.
- Banks shift their asset allocation towards domestic sovereign bonds when stock markets are volatile and asset prices deteriorate.
- Public sector and policy maker interventions, in particular the liquidity injections of ECB during the crisis as well as its interventions in bond markets under the Securities Market Programme, also have a positive impact on demand for domestic sovereign bonds.
- The results are representative of the overall euro area and remain robust if we control for potential endogeneity.

The primary goal of the Basel framework is to improve the capitalization of the MFI and to increase liquidity buffers. Existing bank regulation incentivises MFI to purchase more government debt for meeting the requirements.

Securities issued by the domestic government and those issued by other euro zone member governments are perfect substitutes within the Basel framework. Notably, restrictions on large exposures do not apply for sovereign debt with 0% risk weight under the Standard Approach. As a consequence, marketable sovereign debt portfolios of banks are strongly dominated by domestic claims. Under these circumstances, significant risk concentration makes the banking sector highly vulnerable to domestic sovereign debt problems. Sizable amounts of liquid assets in the form of domestic marketable sovereign debt holdings do not necessarily result in a more stable banking sector. Appropriate restrictions on large exposures to sovereign debt might help to mitigate these risks.

Appendix

A. Sample: euro member states

Table 7: Country sample

The analysis employs quarterly country panel data for euro member states and is done for the period between Q1 1999 and Q4 2013. Those countries which have joined the monetary union after Q1 1999 have been considered following their entrance. Latvia has launched the euro in 2014 and is not included. We refer to the original eleven member states and Greece as to euro core members. The table also indicates those states which have been targeted by the ECB's Securities Markets Programme (SMP).

Countries	Euro membership	Observations	Core euro member	Targeted by the SMP
Austria (AUT)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	
Belgium (BEL)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	
Cyprus (CYP)	Q1 2008 – Q4 2013	24		
Germany (DEU)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	
Estonia (EST)	Q1 2011 – Q4 2013	12		
Finland (FIN)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	
France (FRA)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	
Greece (GRC)	Q1 2001 – Q4 2013	52	<input type="checkbox"/>	<input type="checkbox"/>
Ireland (IRL)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	<input type="checkbox"/>
Italy (ITA)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	<input type="checkbox"/>
Luxembourg (LUX)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	
Malta (MLT)	Q1 2008 – Q4 2013	24		
Netherlands (NDL)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	
Portugal (POR)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	<input type="checkbox"/>
Slovakia (SVK)	Q1 2009 – Q4 2013	20		
Slovenia (SVN)	Q1 2007 – Q4 2013	28		
Spain (ESP)	Q1 1999 – Q4 2013	60	<input type="checkbox"/>	<input type="checkbox"/>
17 euro member states		820	12	5

B. Consolidated gross government debt

The following tables build upon government debt statistics provided by Eurostat and the European Central Bank (ECB). Eurostat provides consolidated gross government debt for each member state of the European Union (EU) as well as the breakdown by issuer and financial instrument on quarterly basis. The ECB provides the breakdown by currency and residual maturity at the general government on annual basis.

The tables provide descriptive statistics for the sample countries for the fifteen-year period between 1999 and 2013. The last column of each table reports the aggregated statistics for the overall euro zone.

Table 8: Total general government debt in percent of GDP

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	76.5	106.0	82.8	72.4	17.1	62.0	53.0	87.3	133.0	55.8	127.5	19.2	96.6	65.9	83.7	53.1	52.5	85.3
Std. Dev.	10.2	9.3	22.9	12.6	2.5	19.1	10.0	20.6	28.6	34.0	19.1	10.6	10.8	12.1	28.0	10.4	16.6	15.7
Min.	64.6	92.1	54.0	56.3	13.4	43.8	38.2	63.8	100.1	29.1	104.9	10.5	78.6	52.5	50.9	35.6	31.2	68.7
Max.	99.0	127.3	133.0	95.8	20.7	115.5	78.0	128.7	204.9	135.1	172.3	47.2	114.8	92.6	149.8	69.8	93.3	119.6

Table 9: Central government debt in percent of total general government debt

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	93.4	91.8	159.3	63.1	73.0	81.1	92.3	79.2	106.6	98.4	94.3	83.9	99.6	86.2	96.5	95.7	95.0	82.5
Std. Dev.	1.2	1.5	9.3	1.4	3.8	1.7	11.7	1.1	4.1	0.7	2.9	3.6	0.1	3.6	0.9	1.0	1.0	1.1
Min.	91.1	88.5	141.4	60.8	66.6	76.8	79.8	76.9	98.5	96.4	91.0	75.0	99.5	79.8	93.8	93.9	93.6	80.6
Max.	95.5	93.8	173.0	66.1	78.1	85.4	121.7	81.1	113.0	100.3	99.4	93.1	99.7	92.3	98.3	97.2	97.3	84.3

In some member states, social security funds hold substantial amounts of marketable central government debt instruments (i.e. intergovernmental lending). In Cyprus, Greece, Finland and Ireland, central government debt contribution exceeds the consolidated general government debt and yields a ratio above 100% for some observation periods.

Table 10: Domestic currency denominated government debt in percent of total general government debt

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	93.7	98.9	99.6	98.9	100.0	98.7	94.3	98.2	97.9	n.a.	98.7	99.3	100.0	97.6	n.a.	97.3	96.1	97.2
Std. Dev.	4.2	1.2	0.5	1.1	0.0	0.9	6.8	0.9	1.5	n.a.	1.3	1.1	0.0	2.3	n.a.	3.4	6.7	7.0
Min.	87.4	96.4	98.6	96.7	100.0	97.2	80.1	96.8	94.4	n.a.	96.5	97.6	99.9	93.6	n.a.	92.9	82.8	93.6
Max.	99.4	100.0	99.9	100.0	100.0	99.7	98.5	99.5	99.6	n.a.	99.9	100.0	100.0	99.4	n.a.	99.7	99.8	122.2

Table 11: Government debt with residual maturity above one year in percent of total general government debt

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	89.5	80.1	80.8	79.9	91.1	80.1	79.9	78.8	87.5	n.a.	72.4	83.2	84.4	76.9	73.9	86.1	87.0	78.0
Std. Dev.	2.2	2.9	5.1	4.6	2.2	1.7	4.5	4.4	2.4	n.a.	2.3	9.6	2.4	6.5	5.0	1.9	3.7	2.1
Min.	87.0	75.6	75.0	70.5	88.5	76.4	74.2	72.0	82.7	n.a.	66.4	67.0	81.4	59.2	65.6	83.4	81.6	74.1
Max.	94.3	83.4	88.8	86.6	92.4	82.3	88.7	86.4	90.1	n.a.	75.0	93.9	86.6	85.5	83.8	87.6	91.2	81.1

Table 12: Securities other than shares in percent of total general government debt

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	81.6	85.0	63.1	68.9	12.0	77.2	76.5	73.4	68.7	68.5	77.2	21.8	81.9	72.7	64.6	82.0	74.7	74.0
Std. Dev.	2.0	1.1	9.4	4.7	2.1	3.0	3.9	3.6	20.9	9.9	2.9	15.2	1.5	2.4	7.1	1.1	3.4	1.3
Min.	76.6	82.6	41.2	59.9	9.4	70.7	67.2	66.2	19.2	45.0	72.4	0.0	78.3	67.8	47.2	79.1	67.2	71.4
Max.	84.1	86.6	72.6	75.2	15.5	81.6	83.2	78.3	84.2	83.2	82.1	52.0	83.9	76.1	72.4	84.3	79.3	76.5

In contrast to most other euro member states, state governments have a large contribution to overall general government in Germany. German state governments issue less marketable sovereign debt than its central government. Therefore, the percentage of securities other than shares in percentage of total general government debt is below other countries in the sample. It is between 83.0% and 94.5% if we consider only central government data (Mean: 89.3% / Std. Dev.: 3.2%).

C. Claims of monetary financial institutions on public sector

The following tables build upon monetary statistics provided by the European Central Bank (ECB). The ECB provides consolidated assets of monetary financial institutions (MFI) for each member state of the European Union (EU), including but not limited to claims on general government. The latter contain securities other than shares, loans and deposit liabilities. Securities other than shares are broken down by counterpart area to domestic and other euro area member states (no breakdown for loans, and therefore no breakdown for overall claims on public sector). The exposure to non-euro countries is not broken down at country level and is only available for the whole monetary union. For individual countries, the breakdown is only available at the general government level. Claims on public sector are not broken down by currency. The data is reported on monthly basis.

The tables provide descriptive statistics for the sample countries for the fifteen-year period between 1999 and 2013. The last column of each table reports the aggregated statistics for the overall euro zone.

Table 13: Domestic general government securities other than shares held by the MFI in percent of total securities other than shares issued by the domestic general government

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	8.6	22.4	34.8	10.3	4.0	4.7	11.8	4.7	14.0	8.2	11.2	6.7	31.8	7.9	7.6	35.9	18.0	12.3
Std. Dev.	3.1	7.8	6.0	1.1	0.6	3.5	3.5	3.5	6.5	3.2	2.4	6.0	2.5	1.9	4.5	7.5	2.3	1.9
Min.	4.3	14.3	23.9	7.7	3.1	1.9	7.0	1.9	3.9	0.7	8.6	0.0	26.4	4.4	3.0	25.2	14.0	9.1
Max.	17.6	42.8	47.8	12.5	4.9	12.7	21.1	12.7	30.9	13.5	18.1	45.3	35.4	12.7	16.4	46.1	22.2	17.2

The amount of total securities other than shares issued by the domestic general government is only available on quarterly basis (see Table 12). Therefore, this table summarizes quarterly statistics.

Table 14: Domestic general government securities other than shares in percent of total MFI assets

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	3.5	13.7	7.1	3.9	1.6	6.9	2.5	5.1	10.9	4.8	7.7	5.7	4.6	5.0	2.9	20.5	9.4	5.5
Std. Dev.	0.7	4.8	2.6	0.4	0.9	2.6	2.1	1.3	5.6	1.2	1.7	1.0	1.0	1.3	1.8	1.5	1.3	1.0
Min.	2.0	7.6	3.5	2.9	0.7	2.8	0.7	2.5	3.2	2.7	4.6	3.0	2.7	2.8	1.1	15.0	7.5	3.6
Max.	5.5	21.7	12.2	5.6	3.2	11.6	8.2	7.9	24.4	7.3	12.2	7.3	6.5	7.9	8.0	23.7	14.0	7.6

Table 15: Domestic general government securities other than shares in percent of total general government securities other than shares issued by euro area member states held by MFI

	AUT	BEL	CYP	DEU	EST	ESP	FIN	FRA	GRC	IRL	ITA	LUX	MLT	NDL	POR	SVK	SVN	Total
Mean	61.9	55.2	54.9	62.1	35.0	84.3	60.8	58.0	96.6	17.5	93.9	0.7	78.7	31.4	79.6	95.8	62.4	62.8
Std. Dev.	16.9	12.5	23.0	5.3	17.6	9.2	16.8	10.4	1.9	12.3	4.0	0.6	12.6	9.8	10.0	2.6	13.8	8.8
Min.	32.6	39.1	22.3	53.9	12.7	59.2	27.8	42.1	91.3	0.9	86.0	0.0	54.8	19.2	55.2	91.7	41.4	50.0
Max.	93.2	87.7	85.6	74.7	65.1	96.9	98.9	75.3	99.9	45.5	98.8	3.4	97.9	50.4	106.2	99.9	84.6	78.1

In Portugal, the amount of domestic marketable sovereign debt holdings exceeds the overall amount of euro area sovereign debt holdings between 04/2000 and 08/2000. The issue has been addressed but was not explained by the ECB.

D. The indicators

Sources: European Central Bank (ECB); Eurostat; European Commission (EC); International Financial Statistics (IFS), International Monetary Fund (IMF); International House Price Database, Federal Reserve Bank of Dallas (Fed Dallas); credit ratings of FitchRatings, Moody's, Standard & Poor's (S&P) and Dominion Bond Rating Service (DBRS); MSCI; Dow Jones (DJ); Bloomberg. The analysis builds upon flows. If flows are not available, they were derived as change in stocks relative to previous period. Absolute flow amounts were expressed as percentage of the neither seasonally nor working day adjusted GDP for the consecutive period (Source: ECB).

<i>B2_Dummy</i>	<i>post Announcement of Basel II: dummy variable.</i>
<i>B3_Dummy</i>	<i>post Announcement of Basel III: dummy variable.</i>
<i>CQS_1or2_Dummy</i>	<i>Credit quality step 1 or 2 with 0% or 20% risk weight under SA: dummy variable based on credit ratings.</i>
<i>CQS_3_Dummy</i>	<i>Credit quality step 3 with 50% risk weight under SA: dummy variable based on credit ratings.</i>
<i>GGNetLia</i>	<i>General government debt: net financial liabilities financial flows at market value in percent of GDP (Source: Eurostat).</i>
<i>GGSec</i>	<i>General government debt: securities other than shares financial flows at market value in percent of GDP (Source: Eurostat).</i>
<i>GGLTYield</i>	<i>Long-term government bond yield with maturity close to 10 years in percentage points (Source: IFS); no long-term securities or proxy indicator that were compliant with the definition of long-term interest rates available for Estonia (ECB 2014b).</i>
<i>GGLia_BS</i>	<i>Impact of public interventions on government liabilities change versus previous period in percent of GDP (Source: Eurostat).</i>
<i>GGContLia</i>	<i>Impact of public interventions on contingent government liabilities change versus previous period in percent of GDP (Source: Eurostat).</i>
<i>GGRecap</i>	<i>Recapitalisation measures to the financial sector granted by the government change versus previous period in percent of GDP (Source: EC).</i>
<i>GGAssetRelief</i>	<i>Asset relief measures to the financial sector granted by the government</i>

	change versus previous period in percent of GDP (Source: EC).
<i>GGGuarant</i>	<i>Guarantees to the financial sector provided by the government</i> change versus previous period in percent of GDP (Source: EC).
<i>GGLiQMeas</i>	<i>Other liquidity measures to the financial sector provided by the government</i> change versus previous period in percent of GDP (Source: EC).
<i>MFI_CB_Claims</i>	<i>MFI assets: claims on central bank</i> change versus previous period in percent of GDP (Source: IFS).
<i>MFI_CB_Fund</i>	<i>MFI funds: liabilities to central bank</i> change versus previous period in percent of GDP (Source: IFS).
<i>MFI_CB_NetFund</i>	<i>MFI_CB_Fund less MFI_CB_Claims</i>
<i>MFI_Deposits</i>	<i>MFI funds: overnight deposits from non-MFI excluding general government</i> financial transactions (<i>flows</i>) in percent of GDP (Source: ECB).
<i>MFI_Capital</i>	<i>MFI funds: Capital and reserves</i> financial transactions (<i>flows</i>) in percent of GDP (Source: ECB).
<i>MFI_GGSec</i>	<i>MFI assets: securities other than shares of domestic general government</i> financial transactions (<i>flows</i>) in percent of GDP (Source: ECB).
<i>MFI_TA</i>	<i>MFI assets, total assets less claims on domestic general government</i> <i>(securities other than shares and loans) and on central bank</i> financial transactions in percent of GDP (Source: ECB).
<i>Equity_Ch</i>	<i>Growth rate of stock market prices:</i> period-to-period %-change (Source: MSCI); where no MSCI price indices were available, alternative indices have been used (DJ Cyprus Titans 10 Index for Cyprus; DJ Wilshire for Estonia, Malta, Slovakia and Slovenia; LuxX for Luxembourg).
<i>Equity_Vola</i>	<i>Historical volatility of stock market prices:</i> 60 trading days for quarterly or 260 trading days for annual analysis (Underlying indices: same as for <i>Equity_Ch</i> ; Source: Bloomberg).
<i>RPP_Ch</i>	<i>Real growth rate of property prices</i> period-to-period %-change (Source: Fed Dallas); where no data was available, residual property indices (Source: ECB) and the personal

consumption expenditure deflator (Source: Eurostat) of the corresponding country were used for estimating the real growth rates (particularly for Austria, Cyprus, Estonia, Greece, Malta, Portugal, Slovakia, Slovenia).

SMP_Dummy *Securities Market Programme of the Eurosystem*: dummy variable.

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