BANCA D'ITALIA

EUROSISTEMA

Temi di discussione

(Working Papers)

Banks' holdings of and trading in government bonds

by Michele Manna and Stefano Nobili

March 2018

Number 1166

BANCA D'ITALIA
EUROSISTEMA

Temi di discussione

(Working Papers)

Banks' holdings of and trading in government bonds

by Michele Manna and Stefano Nobili

Number 1166 - March 2018

The papers published in the Temi di discussione *series describe preliminary results and are made available to the public to encourage discussion and elicit comments.*

The views expressed in the articles are those of the authors and do not involve the responsibility of the Bank.

ISSN 1594-7939 (print)
ISSN 2281-3950 (online)

Printed by the Printing and Publishing Division of the Bank of Italy

BANKS' HOLDINGS OF AND TRADING IN GOVERNMENT BONDS

by Michele Manna* and Stefano Nobili*

Abstract

In this paper we examine the holdings of government securities by domestic banks along with those of five other sectors: foreign banks, foreign non-banks, the official foreign sector, the domestic central bank and domestic non-banks. We use data for 21 advanced economies from 2004 Q1 to 2016 Q2. The results offer four main insights. First, banks are reluctant to undertake major changes in their holdings of domestic bonds but do accept frequent changes of more intermediate size. Second, the foreign official sector emerges as the clearest example of a contrarian investor, buying when prices fall and selling when prices rise. Third, the greater the holdings by domestic and foreign banks, the lower the yields tend to be on 10-year benchmark sovereign bonds. Finally, in all countries included in the sample we find a positive home bias in banks' sovereign holdings while foreign banks hold fewer bonds than predicted by a neutral portfolio measure. These results suggest that banks regard domestic government bonds as a special asset class (hence the positive bias and avoidance of major changes in inventories) which they manage in a flexible manner (hence the frequent intermediate changes and lack of systematic timing of transactions), in all likelihood to meet requests from their customers. All in all, this behaviour by domestic banks provides a positive contribution to the liquidity of the market.

JEL Classification: C23, E43, G11, G12, G15, G21.
Keywords: government bond yields, investor holdings, panel cointegration.

Contents

1. Introduction 5
2. The literature 6
3. Descriptive statistics 8
4. The Home and Foreign Bias Indexes 14
5. Matching changes in inventories with changes in interest rates 17
6. The panel model 20
7. Thoughts on the future government bond market 28
8. Concluding remarks 29
References 31
Annex 35
Additional tables and charts 39

* Bank of Italy, Market Operations Department.
E-mail: michele.manna@bancaditalia.it; stefano.nobili@bancaditalia.it

1. Introduction[1]

An enquiry on the liquidity of government bond markets almost unavoidably runs into the role played by banks, as large owners and influential traders of these bonds. However, banks' leadership is under threat on a number of counts and a list of usual suspects could include changes in regulation, the process known as electronification of markets, the legacy of the crisis started in 2007, the ample deleveraging undertaken by banks as well as the current monetary policy stance and purchase programs by central banks (BIS, 2014, 2016a and 2016b).

It should thus be of no surprise that large efforts are being deployed by both the academia and official institutions to assess the current state of markets' liquidity with a focus on the contribution banks can offer.[2] A fair summary of this body of research could describe liquidity, compared to pre-crisis standards, as adequate but also less resilient to the arrival of significant news and large orders.[3] Moreover, banks are perceived to be decreasingly willing and capable to offer inventory services to customers (including, but not limited to, for government bonds) and increasingly inclined to provide 'search services' instead.[4] The role of electronic platforms adds to this pattern, especially of most liquid bonds.

The core input of the analysis is an IMF dataset (Arslanalp and Tsuda, 2012) – which we expand with data from ECB, BIS and Bruegel, a think tank – on bond holdings by six sectors of investors, measured as end-quarter stocks in 2004Q1 through 2016Q2, for 21 advanced economies.[5] The six sectors are: (i) foreign official sector, (ii) foreign banks, (iii) foreign non-banks, (iv) domestic central banks, (v) domestic banks and (vi) domestic non-banks.

The objective of this paper is to offer a comprehensive analysis of styles of management of bonds' holdings by different groups of investors, banks but not only. By style of management, we mean the preference displayed by the investor to keep holdings stable or let them vary over time. And, in the latter case, whether such changes tend to occur piecemeal or also in large amounts. The style of management means also the timing of the transactions, namely whether the investor tends 'to follow the market' or rather 'leans against the wind'. The way the investor implements her / his trading choices does contribute to the liquidity of the bond market and in the econometric part of the paper we study the relationship between the bonds' yields and the holdings estimating a panel model.[6]

---

[1] The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Italy. The authors wish to thank participants in seminar held at the Bank of Italy as well as two anonymous referees for a number of helpful suggestions. Thanks go also to Daniela Pizzuto that read carefully the text.

[2] Possible references include Adrian, Fleming, Shachar and Vogt (2016), Trebbi and Xiao (2015), Bao, O'Hara and Zhou (2016); as for analyses undertaken by official institutions, virtually any recent bulletin and financial stability report from central banks deals with developments in market liquidity.

[3] Probably, most commentators would also agree that liquidity is not as easy a concept to measure exactly.

[4] The bank provides an 'inventory service' when it acts as direct counterpart of its customer, so that the transactions changes the bank's inventories. Conversely, in the 'search service' the bank effectively acts as a broker searching for a suitable counterpart of its customer to close the deal.

[5] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and USA.

[6] Due to data limitations we could run this part of the analysis on 16 of the 21 countries only. For a more limited subset of 9 countries we could extend the analysis to a seventh sector, obtained the breakdown of domestic non-banks in insurance firms and pension and mutual funds on the one hand

This paper builds on different streams of literature on portfolio choices, surveyed in section 2. Its element of novelty is the systematic approach adopted in the analysis: we look at management styles in a large number of countries, tackling all holdings of the outstanding government bonds, and benefitting from a relatively long sample.[7]

Anticipating the main result of the research, we find that banks display a unique style of management in respect to their domestic holdings of government bonds (that is, the bonds issued by their own national Treasury). Noticeably, these banks are reluctant to undertake large changes in their holdings but do accept frequent changes of more intermediate size, a cautious-but-flexible approach which is probably meant to meet trading requests from their customers. Furthermore, as shown by the panel model, in so doing domestic banks provide a positive contribution to the liquidity of the market as a whole.

The rest of the paper is organized as follows. Section 2 review the relevant literature. Section 3 sets out the results of the descriptive statistics, whereas section 4 presents some results on home and foreign bias indexes. An exercise of cross-checking the timing of changes in inventories with changes in interest rates is shown in the Section 5 and is preliminary to the panel analysis, which is in section 6. In the light of the results of the work, section 7 presents some clues on the future microstructure of the government bond markets. Section 8 draws the conclusions. Annex 1 adds a description of the data sources while Annexes 2, 3 and 4 deal the technical aspects of the research.

2. The literature

Our paper builds on a number of different strands of academic research and reports from the relevant authorities. In the introduction we referred to three reports authored by central banks' committees. BIS (2014) discusses trends in market-making and proprietary trading and identifies signs of increased liquidity bifurcation and fragility, with market activity concentrating in the most liquid instruments and deteriorating in the less liquid ones. That report also stresses the decline in (banks) dealer risk-taking capacity and/or willingness. Touching a similar chord, BIS (2016a) highlights that fixed income markets are in state of transition: while dealers have continued to cut back their market-making capacity in many jurisdictions, demand for market-making services, in turn, continues to grow. BIS (2016b) tackles electronification, a term referring to the traction that electronic communication networks are gaining in inter-dealer markets for liquid sovereign bonds. Market liquidity and market-making is the subject of ESRB (2016). In the US, the "Joint Staff Report on October 15, 2014"[8] argued that primary dealers no longer account for most trading volume on the interdealer brokerage platforms. It fits well into this first list of references the work by Benos and Zikes (2016) on the liquidity of UK Gilts and that by Kurosaki, Kumano, Okabe and Nagano (2015) on the Japanese government bonds.

At the intersection between the topics of market liquidity and the role of banks in the market, we find the banks' home bias. The existence of a positive bias is ubiquitous in

---

and all other domestic non-banks on the other. The panel is estimated both on levels of the 10-year government bonds yields and their first differences. Besides holdings of these bonds by the different sectors, the explanatory variables include short-term interest rates, expectation of inflation, expectation of GDP growth (as proxy of the real interest rate) and public finance ratios.

7 Studies that are more directly comparable close to ours are Andritzky (2012) and Arslanalp and Poghosyan (2014), who deal with the relationship between the investor base and sovereign yields.

8 Joint report from the U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, U.S. Commodity Futures Trading Commission (2015). A summary of the report is in Fleming, Keane and Schaumburg (2016).

finance – it can be found in virtually any category of investors and on any type of financial instruments – and we can thus refer our reader to a broad literature which encompasses but is certainly not confined to government bonds. A subjective list of contributions could include Lewis (1999), Chan, Covrig and Ng (2005), Fidora, Fratzscher and Thimann (2006), Chen and Yuan (2011), Levy and Levy (2014), Park and Mercado (2014).[9] As to how to detect the bias, the basic idea is to compare actual banks' holdings with a neutral portfolio allocation (Cooper and Kaplanis, 1994, Brealey, Cooper and Kaplanis, 1999, Chan, Covrig and Ng, 2005, Chen and Yuan, 2011, and Vanpée and De Moor, 2012).[10]

On a different line of research, the question arises whether the holdings of government bonds (notably domestic bonds, due to the marked positive bias) crowd in or crowd out other banks' assets. To sketch the main elements of this debate, a preliminary observation is about the money-like properties of securities issued by established Treasuries. Grinblatt (2001) and Krishnamurthy and Vissing-Jorgensen (2012) show that investors are willing to underwrite these securities at yields lower than those required for other instruments, after controlling for various factors, where this premium is declining in the total supply of Treasuries. In a later paper, Krishnamurthy and Vissing-Jorgensen (2015) – building on works *à la* Diamond and Dybvig (1983) – recall the special role of banks in creating liquidity and conclude that supply of Treasury bonds crowds out financial sector short-term debt via effects on the equilibrium prices. On the other hand, Weymuller (2013) argues that banks hold public debt as an input to their safety production function. Notably, this author establishes a link between the supply of Treasuries, which is generally welfare improving because it is endowed with negative beta, the level of safe assets in the economy, the dimension of banks' balance sheets and their lending to the economy.[11]

Results such as those put forward by Krishnamurthy and Vissing-Jorgensen (2012) tell us something about the level of the yields of government bonds (compared to yields of other financial instruments). When it comes to the changes in these yields, a number of authors show that increases in the share of outstanding debt held by non-residents are associated with a reduction in yields.[12] However, a moot point is about the direction of causality, namely whether it is the demand by foreign investors that brings yields down (commonly known as push factor) or these investors step in the market when prices are expected to rise and yield to go down (pull factor).

Given the objectives of our work, we ought to retain also at least one key result of the literature on market microstructure (two ample surveys are Madhavan, 2000, and Biais, Glosten and Spatt, 2005): market makers tend to adjust their quoted prices when, as a

---

9 Overall, this literature identifies three broad drivers of the home bias in financial markets: (i) information and transaction costs, (ii) asset-liability management, as economic agents tend to select assets originated in their own country to match the bulk of their liabilities; (iii) a basket of other factors of less tangible nature such as moral suasion by the authorities and the tendency to replicate what neighboring investors do.

10 Cross-country comparisons are often limited by lack of adequate data on holdings, while data on supply of securities are usually readily available and of good quality. Perhaps, this is the reason why ESRB (2015) infers a strong home bias through the sheer comparison of country ratios of banks' holding of domestic sovereign debt to their holdings of all sovereign debt issued by euro area Treasuries.

11 Weymuller (2013) acknowledged that this process is not without boundaries: a greater supply of government bonds is beneficial up to the point where the bonds lose their safe-asset status.

12 A selective list of references on the role of foreign investors include De Santis and Gérard (2006), Warnock and Warnock (2009), Andritzky (2012), Beltran, Kretchmer, Marquez and Thomas (2012), Battistini, Pagano and Simonelli (2013), Arslanalp and Poghosyan (2014).

result of the execution of a buy or sell order, their inventories deviate from a target or desired level (Kyle, 1985, and Glosten and Milgrom, 1985, among others). This finding allows to rationalize the bid-ask spread, as a form of remuneration against the risk that the steering of inventories back to their desired level implies capital losses. Hence, the progress in electronification notwithstanding, the bid-ask spread quoted by market makers ought to stay in the future, even when the physical costs of trading were negligible.

3. **Descriptive statistics**

Our dataset counts 6,300 data points in terms of level of inventories, as a result of 50 quarters times 21 countries times 6 holding sectors (see Annex A.1). Hence, across all sectors we count 294 quarterly changes of inventories per country (49 times 6). A number of our statistics revolve around what we define as 'large changes' in the inventories, complemented by statistics on 'intermediate changes'. By 'large' we mean a quarterly change which falls in the top or bottom 5% of all changes per country. Overall, we identify 630 'large changes', equally split between 315 'large increases' and 315 'large decreases' with obvious meaning.[13] By intermediate we mean a change comprised between the 10^{th} and 40^{th} percentile or between the 60^{th} and 90^{th} percentile of all quarterly changes per country.

3.1 The weights of inventories

Chart 1 overleaf shows the distribution of weights of holdings of government bonds by sector along the entire time span of our sample, using the IMF (Arslanalp and Tsuda, 2012) dataset.[14] In most quarters domestic investors held 50 to 60% of governments bonds with marginally lower values in 2009-2010. Across the foreign sectors, the weight of the foreign official sector increased from levels close to 5% in 2004 to above 20% in 2016 mainly at the expense of foreign non-banks. Focusing on foreign banks, their weight moved in a roller-coaster clearly associated to the unfolding of the crisis, falling from levels of 13-15% until 2010 to 5% in 2013, to gain back part of the lost ground towards the very end of the sample. By contrast, and this is one the main subjects discussed in this paper, remarkably stable is the share of bonds held by domestic banks, confined in a narrow range from 15% to 18%. Finally, the impact of purchase programs emerges visibly from the chart in the widening of the weight associated to domestic central banks in recent years.

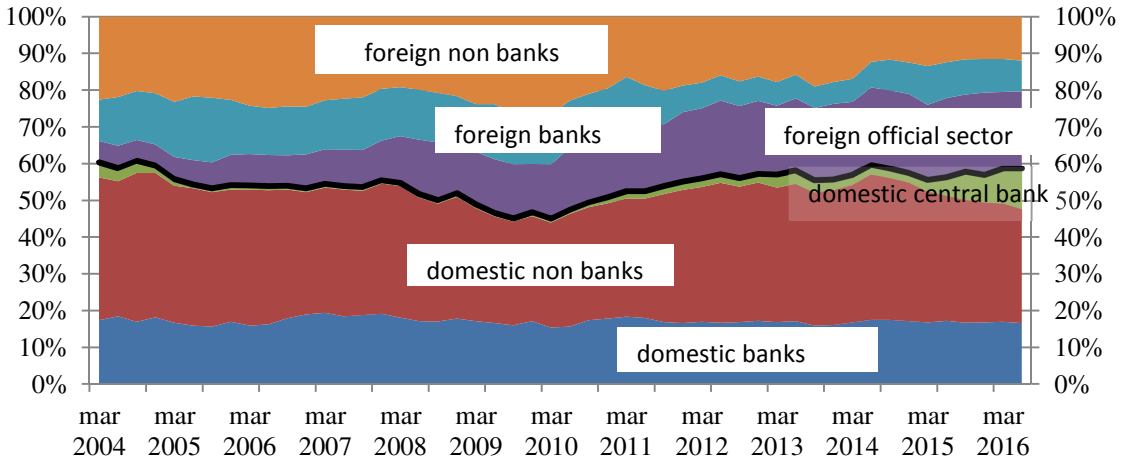
---

[13] 315 is the result of 15 'large increases' per country times 21 countries. In turn, 15 is the closest integer of 5% times 294 (the exact result being 14.7).

[14] The weight of each sector per quarter is the median of the corresponding weights across all 21 countries; more details are presented in Chart 2 and in Table A.1 (Tables and Charts coded A.1, A.2, etc. are shown at the end of this paper). We did not opt for select a weighted average of country weights based on GDP / outstanding stock of public debt coherently with the selected broad-based approach (any such weighted average would have de facto singled out the patterns in just 2 countries or at most 5 ones, bearing in mind that USA and Japan alone account for 64% of all outstanding public debt securities across the entire sample, a share rising to 82% adding Italy, Germany and Japan). Nor we picked an unweighted average, too sensitive to outliers (possibly driven by small countries).

Chart 1 **Holdings of government debt securities, by sector (1)**

(weights over a sample of 21 countries)

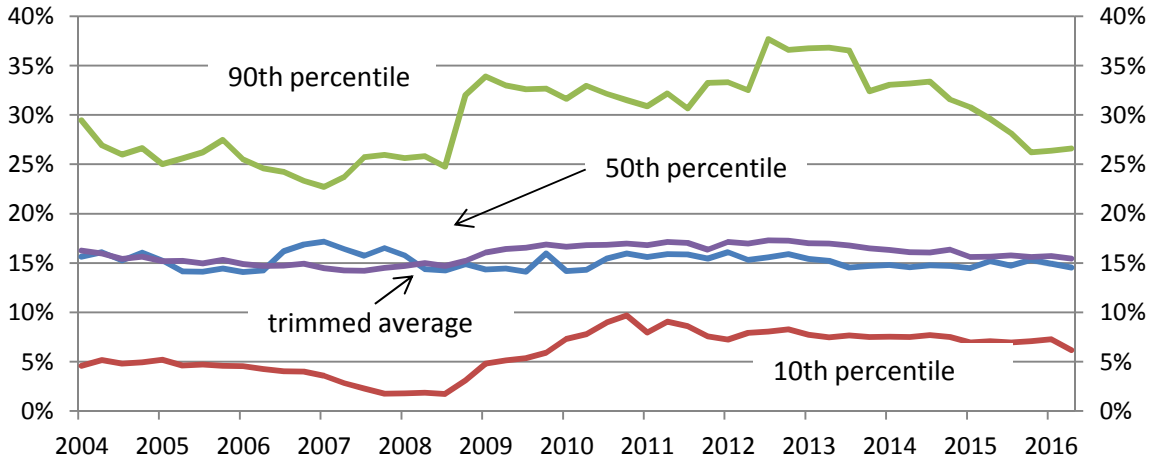


Source: IMF (Arslanalp and Tsuda, 2012). (1) The weight in each sector / quarter is obtained as median of the weights across the 21 countries of our sample (see footnote 5).

In Chart 2 we plot the 50th percentile (the median) of domestic banks' quarterly holdings, the 10th and 90th percentiles as well as a trimmed average, which excludes the highest and lowest 10% of the weights across the 21 countries. Two findings emerge. Firstly, the trimmed average and the median are very much alike, signaling that the stability in the weights associated to domestic banks is robust to the specific metrics being used. Secondly, the width of the "corridor" drawn by the 90th and 10th percentiles is also fairly stable over time, namely while there is natural heterogeneity in weights across countries, relative positions tend to change little over time. All in all, we gauge from these findings that the share of domestic banks' holdings owes to structural elements, which stand solid through the years of great moderation, the banking crisis and the European sovereign debt crisis.

Chart 2 **Government debt securities held by domestic banks**

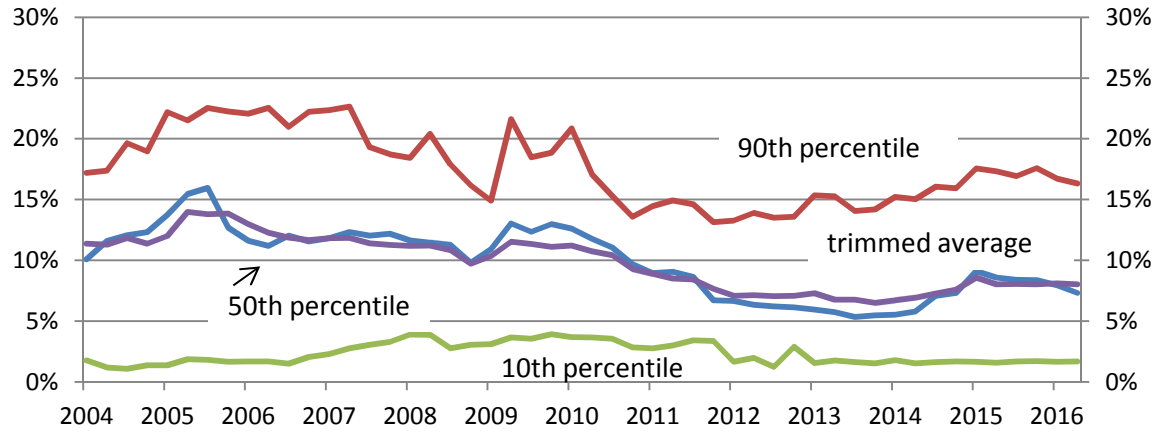
(percentiles over a sample of 21 countries)



Source: IMF (Arslanalp and Tsuda, 2012).

Some lessons can be learnt by the corresponding statistics on holdings by foreign banks. In this case, the median and the trimmed average display a downward trend – which compares with the aforementioned stability for domestic banks – as weights went from levels in the order of 10-15% to below 10% (Chart 3). Simultaneously, the 90th-10th corridor widened markedly in recent years, probably a reflect of flight-to-quality purchases by foreign banks towards a few sovereign issuers.

Chart 3 **Government debt securities held by foreign banks**
(percentiles over a sample of 21 countries)



Source: IMF (Arslanalp and Tsuda, 2012).

3.2 The changes in the weight of inventories

We now turn to the changes in inventories, to highlight how domestic banks kept their inventories of domestic govies broadly stable over time by, on the one hand, limiting large quarterly changes and, on the other hand, being flexible enough to undertake many intermediate changes (we introduced the notions of large and intermediate at the beginning of this section).

Out of a total of 630 large changes in inventories, we count 215 occurrences among foreign non-banks only (Table 1). Dividing this number by 19.4%, the average weight of holdings of this sector, we obtain a ratio of 11.1, which is around three times as large as the corresponding ratios for the foreign official sector, domestic banks and domestic non-banks (respectively, 4.5, 3.8 and 4.6). That is, foreign non-bank investors are much more prone, in absolute and relative terms, to undertake massive changes of their holdings compared to other groups of investors. The fact that a ratio above 11 is found also for the central bank should not mislead: as already pointed when discussing Chart 1, such changes occurred only in recent years in the backdrop of purchase programs.

Differences emerge across sectors also in terms of the sign of the large changes. In the two non-bank sectors, the 'large decreases' outnumber the 'large decreases', that is within these sectors the offload of inventories tend to occur in bulk size while the opposite accumulation tends to happen in a more granular way. We read in these statistics a sign of occasional panic selling. The opposite approach – more 'large increases' than 'large decreases' – is pursued by the foreign official sector and the domestic central bank: in the former case, this relative proportion is a first hint of a contrarian approach on

which we shall see more later, while in the latter case no general lesson can be drawn as the statistics reflect choices clustered in the latest years only, as already noted. To cut a long story short, we gauge from these statistics that the nature of large changes in inventories tends to be associated with what you do as a profession, not on your country of residency.

Table 1 **Large changes in inventories (1)**

Sector	(a) No. large increases	(a) No. large decreases	(c) = (a)+(b)	(d) share	(c) / (d) ×100
Foreign official sector	52	13	65	14.4%	4.5
Foreign banks	36	39	75	10.1%	7.4
Foreign non-banks	92	123	215	19.4%	11.1
Domestic central bank	39	14	53	4.7%	11.3
Domestic banks	32	30	62	16.4%	3.8
Domestic non-banks	64	96	160	35.0%	4.6
Total	315	315	630	100%	

(1) Changes measured on end-quarter stocks, 2004Q1-2016Q2. 'No. large increases' / 'No. large decreases': number of times the weights associated to the specified sector fall in the top or bottom 5% of all changes per country. 'share' average weight of the specified sector across the 21 countries.

In the second step of the analysis, we counted which combinations of 'large increases' and 'large decreases' occur more frequently (the ten most frequent combinations are shown in Table 2). A few facts emerge from this bean counting. Firstly, more often than not when one sector undertakes a large change of a given sign, another sector does the opposite.[15] This behavior suggests that large deals bring about a marked reallocation of weights between pairs of sectors. In turn this reallocation may be non-neutral on market dynamics as a whole if the two sectors involved adopt different trading styles. Secondly, only 2 out of the 10 most frequent combinations see the juxtaposition of a domestic and a foreign sector. As we have already observed above, this finding confirms that, over the entire panel, there is not a split along national lines in trading choices. Moreover, domestic banks are conspicuously absent from this list, confirming that they rarely undertake large changes.

[15] Consider the example of a large increase in holdings by foreign non-banks: the aim is to buy bonds and it ought to be irrelevant in this move who is selling them. Accordingly, it could have been expected to be the norm that when one given group undertakes a large change, the offsetting pattern is dispersed in a number of small changes by other sectors. In fact, we find as mentioned in the text more a one-to-one trading pattern.

Table 2 Most frequent combinations of 'large increases'/'large decreases' (1)

	Sectors with large changes in inventories		No. of occurrences
	Increase	Decrease	
(i)	Foreign non-banks	Foreign official sector	38
(ii)	-	Foreign non-banks	32
(iii)	-	Domestic non-banks	29
(iv)	Domestic non-banks	Foreign non-banks	25
(v)	Domestic non-banks	-	23
(vi)	Foreign official sector	Foreign non-banks	23
(viii)	Foreign non-banks	Domestic non-banks	19
(viii)	Domestic central bank	Domestic non-banks	15
(ix)	Foreign official sector	-	12
(x)	Foreign non-banks	Foreign banks	11

(1) In rows where either side of the transaction is blank, no sector undertook a 'large change' in inventories.

The results gathered thus far prove unambiguously that banks manage their inventories of domestic government bonds in a prudent way. However, banks do not enforce a strict targeting either and as a result do not qualify as brokers: as a matter of fact, banks do accept to alter their inventories, but avoid large jumps. This tendency emerges neatly if one compares the frequency associated to domestic banks in respect to large changes (above 95th and below 5th percentile) with the frequency in respect to intermediate ones (between 10th and 40th percentile or 60th and 90th percentile). As noted in Table 1 domestic banks are the sector with the second lowest number of occurrences of large changes, 62 out of 630 or 9.8%. However, the situation is reversed if we take into consideration intermediate changes: in this bracket, domestic banks stand out as the sector with the highest number of changes: 727 out of 3626 or 19.7%, marking the largest increase among the six sectors with 9.9 percentage points (Table 3). However, domestic banks are not alone in upholding this behavior as comparable results are obtained for the foreign official sector and foreign banks.

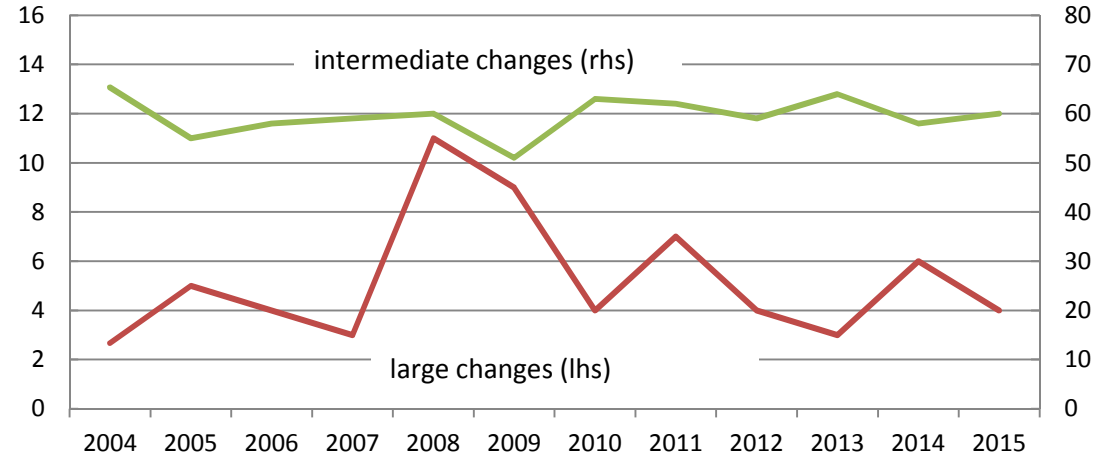
Table 3 Large and intermediate changes in inventories

	Large changes (1)		Intermediate changes (2)		Δ% (3)
	number	%	number	%	
Foreign official sector	65	10.3%	699	18.9%	+8.6
Foreign banks	75	11.9%	695	18.8%	+6.9
Foreign non-banks	215	34.1%	593	16.0%	-18.1
Domestic central bank	53	8.4%	340	9.2%	+0.8
Domestic banks	62	9.8%	727	19.7%	+9.9
Domestic non-banks	160	25.4%	642	17.4%	-8.0
Total	630	100%	3696	100%	

(1) Changes which fall in the top or bottom 5% of all quarterly changes per country. (2) Changes which fall between the 10th and 40th percentile of all quarterly changes per country or between the 60th and 90th percentile. (3) Difference between the percentages associated to large and intermediate changes.

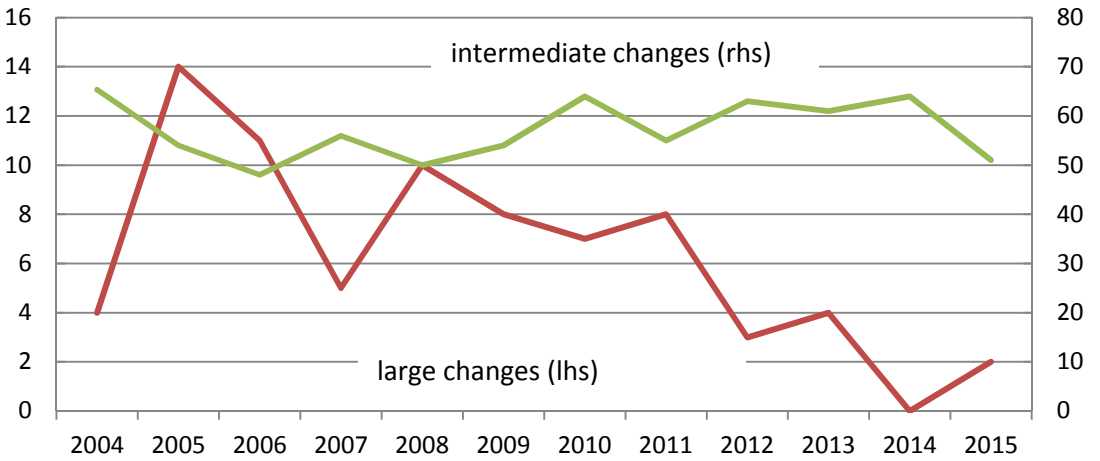
We complete this analysis of changes in inventories by examining the time dimension of these statistics: Chart 4a shows the yearly number of large and intermediate changes for domestic banks, while Chart 4b presents the corresponding results for foreign banks. The number of intermediate changes is remarkably stable in both sectors, even in problematic years such as those covered by our sample. Conversely, substantial more dynamics emerge in respect to large changes, e.g. the noticeable jump in the series relating to domestic banks in 2008, followed by another high level in 2009. Clearly this proves that banks tend to stick to a preferred pattern in their holdings of domestic government bonds – many intermediate changes and few large ones – but could not help from yielding to pressure under the exceptional circumstances of the banking crisis in 2008-2009.

Chart 4a Number of domestic banks' large and intermediate changes (1)



(1) Total per year. Data for 2004 are annualized; data for 2016 are not shown.

Chart 4b Number of foreign banks' large and intermediate changes (1)



(1) Total per year. Data for 2004 are annualized; data for 2016 are not shown.

4. The Home and Foreign Bias Indexes

Following Manna (2004) and Manna, Signoretti, Tommasino (2016), we elaborate a Home Bias Index (HBI) which compares the holdings by bank located in *i* and issued by the Treasury of country *j* against a neutral measure of these holdings, proportional to both the total bonds' holdings by *i* banks and the total holdings by all (worldwide) banks of bonds issued by *j*. We introduce the following symbols:

V_t(i,W) - stock of bonds held by banks resident in *i*, no matter what is the country of issuance (or, equivalently, the bond is issued in the world, W), as of time t;
V_t(W,i) - stock of bonds held by all banks, irrespective of the country of residence, and issued in *i*;
V_t(i,i) - stock of bonds held by *i* banks and issued in *i*, these are the domestic holdings
V_t(W,W) - stock of bonds held by all banks and issued globally.

The algebra of the HBI is

$$[1] \quad HBI_{i,i} = \left\{ V_t(i,i) - \frac{V_t(i,W) \times V_t(W,i)}{V_t(W,W)} \right\} / V_t(i,W) \qquad i = 1, \ldots, n$$

where the denominator outside the curly bracket is a scaling factor so that [1] yields a dimensionless number, ranging (approximately) between -1/n and (n-1)/n.[16] We emphasize that the level of the index corresponding to neutrality (no bias) is country-dependent.[17] Details of the procedure we follow to derive the inputs in (1) are in Annex A.3.

While equation [1] broadly is conceptually close to similar results laid down in the literature surveyed in section 2, what is innovative of this paper is our proposal of a foreign bias index (FBI), measuring whether foreign banks hold more or less bonds issued in country *i* than a neutral portfolio measure. The algebra of this latter index is :

$$[2] \quad FBI_{i,t} = \left\{ V_t(RWi,i) - \frac{V_t(RWi,W) \times V_t(W,RWi)}{V_t(W,W)} \right\} / V_t(RWi,W) \qquad i = 1, \ldots, n$$

where we introduced the additional symbols

V_t(RWi, W) - stock of bonds held by banks *not* resident in *i*, issued globally;
V_t(RWi, i) - stock of bonds held by banks *not* resident in *i*, issued in *i*;
V_t(W, RWi) - stock of bonds held by all banks in *i*, issued outside *i*.

We conclude this introduction to the bias indices noting that, especially the HBI, could be regarded as unfair to banks from non-euro countries in our sample. Indeed, non-euro based banks are subject to an exchange rate risk on all foreign bonds, whereas banks from the area may invest in bonds issued by Treasuries of other euro area countries (hence, still foreign bonds) without incurring in this risk. Hence, we work out a variant of [1] which adjusts for the fact that for euro area banks there are two levels of "foreign-ness": foreign

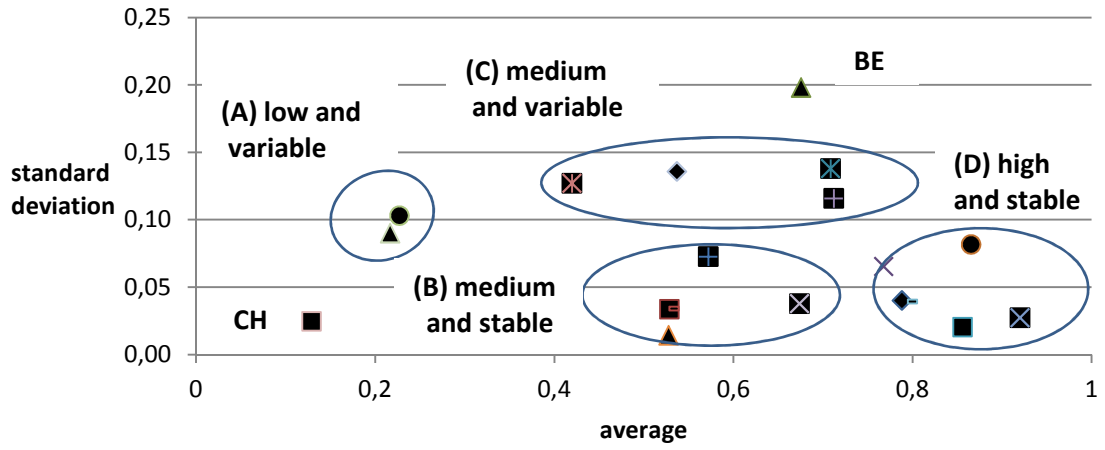
[16] The exact boundaries are –V(W, i) / V(W, W), omitting the time index, if banks in *i* hold only foreign bonds and [1 – V(W, i) / V(W, W)] if they hold only domestic bonds.

[17] This is because the neutral, no-bias quota of domestic banks is a function of the total demand for bonds by the banks resident in any given country (compared to the demand from other banking systems) and the supply by the national Treasury (compared to the supply from other Treasuries. Hence, the problem of finding a non-bias portfolio must be solved separately for each country / banking system; a numerical example is in Annex A.2. Incidentally, this rules out one-size-fits-all solutions where the 'neutral measure' is obtained as a weighted average (GDP is a usual candidate for the weights) of the bonds' portfolios of all national banking systems.

bonds issued from other countries of the area and foreign bonds issued from countries outside the area (details in Annex A.3). In what follows measures of the home bias of euro area banking systems are based on this variant.

Results for the HBI are shown in Chart 5 (full time series of this index for each country in the sample are in Charts A.1 and A.2). Moving from left to right in the Chart 5, the dots corresponding to the different countries mainly cluster in four groups. A first group is formed by two banking systems displaying a HBI with a low average but intermediate volatility (Norway and United Kingdom). Next, there are two groups of banking systems whose results take both intermediate values in terms of average levels where the standard deviation is low in one case (Austria, France, Germany, Japan and United States)[18] whereas it take more intermediate values in the other (Denmark, Netherlands, Portugal and Sweden). Final, there is a group whose HBI is as stable as that of the second group but displays a distinctly higher average (Australia, Canada, Finland, Italy, Korea and Spain).

Chart 5 **Home Bias Index (1)**



(1) Average and standard deviation of country time series of (1). Groups: (A) Norway and UK; (B) Austria, France, Germany, Japan, USA; (C) Denmark, Netherlands, Portugal, Sweden; (D) Australia, Canada, Finland, Italy, Korea, Spain. Greece and Ireland have standard deviation outside scale and are not shown in the scatter.

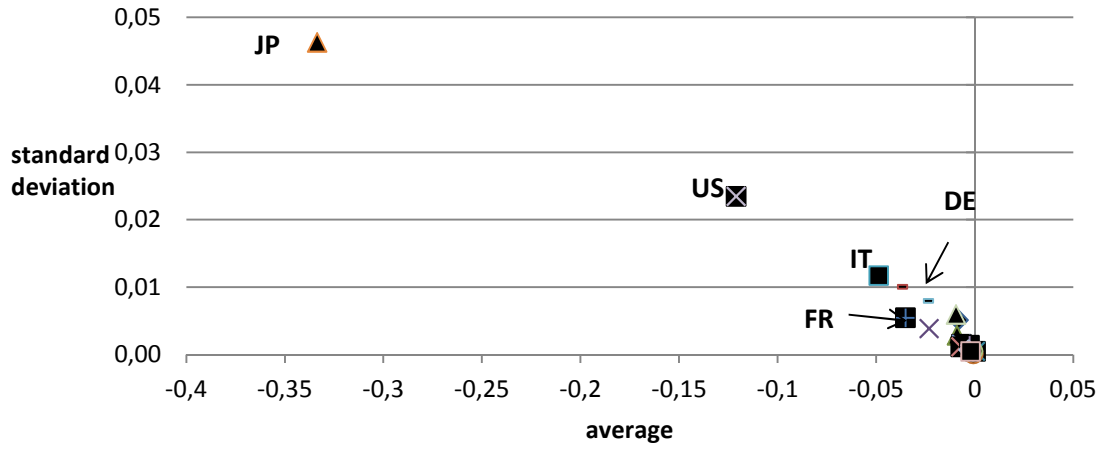
Belgium and Switzerland are two outliers while the dots for Ireland and Greece are conspicuously absent from Chart 5, as their standard deviation exceeds the selected vertical scale. One might gauge from this finding a link between patterns in home bias and the impact of the banking-turned-sovereign crisis. However, the crisis argument cannot explain it all. The events in Greece and Ireland are only partly comparable as the former country suffered from a fundamental economic imbalance while the latter experienced a banking crisis although starting from 'right' fundamentals. Hence, it is difficult to draw any common lesson. Moreover, it speaks volume that the dots for Italy and Spain lie in the same cluster as those for Australia, Canada and Finland, all countries which have either benefited from the commodity boom or have weathered well the peak

[18] Only four dots are visible in this cluster as those of Germany and Austria lie almost exactly one on top of the other.

of the sovereign crisis in 2010-2011.[19] All combined, our intuition is that the degree of home bias, as measured through the HBI statistics [1], owes in most countries to structural factors specific to each country and banking system.

The corresponding results about the Foreign Bias Index (FBI) are shown in Chart 6. Note that for all 21 countries of our sample this bias turns out to be negative: this means that for each country *i*, foreign banks hold less bonds issued by the i-th Treasury than it ought to be based on considerations of equal distribution. As a rule of thumb, countries with largest outstanding public debt feature more negative foreign bias. An ample gap emerges in the FBI measure for the two largest economies, as the dot for Japan lies far to the left of that of United States, suggesting that there is relatively less demand by foreign banks for Japanese bonds compared to US ones. As to the three largest euro area economies, there is not much difference in the degree of foreign bias, though it should be noted that this piece of data is more negative for the Italian debt, relatively less for France and places Germany in an intermediate position.

Chart 6 **Foreign Bias Index (1)**



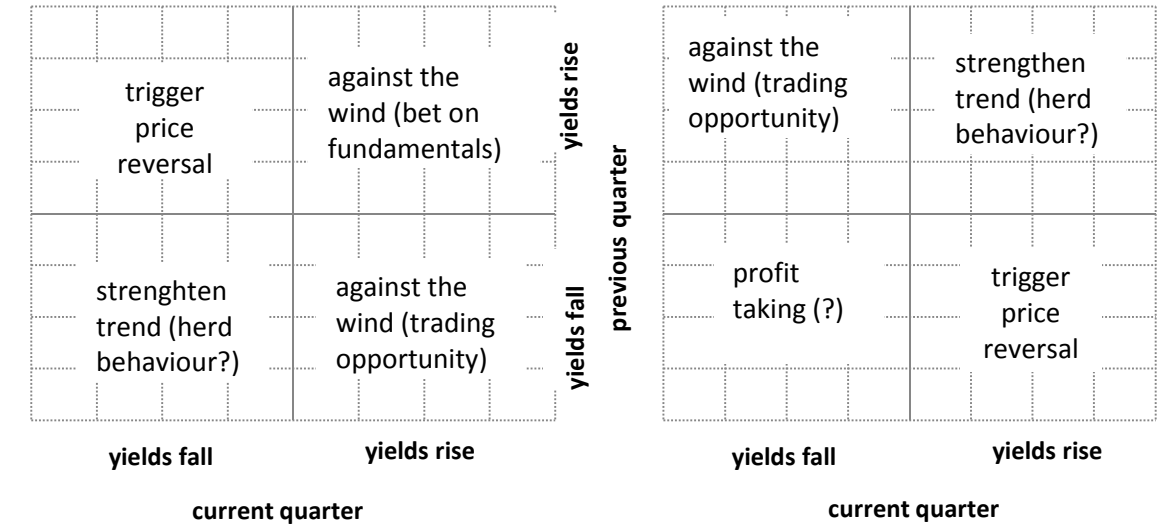
(1) The scatter shows along the X-axis the average and along the Y-axis the standard deviation of the country time series of equation (2).

[19] It is also notable the stability of the quarterly time series for Italy and Spain (Chart A.2) in the home bias measure through the sovereign debt crisis. Indeed, this reflects a more widespread pattern, as in most countries the standard deviation of the quarterly results for the HBI is a fraction of the average, again with the exception of Greece and Ireland (with Belgium being an intermediate case).

5. Matching changes in inventories with changes in interest rates

Cross-checking the timing of large changes in inventories with market rate conditions may provide insights about the style of market participation. For instance, if an investor purchases bonds (increasing his inventories) when yields rise (price fall), he is leaning against the wind. Or, if he sells (decreasing his inventories) when yields have been falling (price rising) since the previous quarter, he may be taking profits. A full taxonomy is in Chart 7.

Chart 7 A taxonomy of changes in yields and changes in inventories



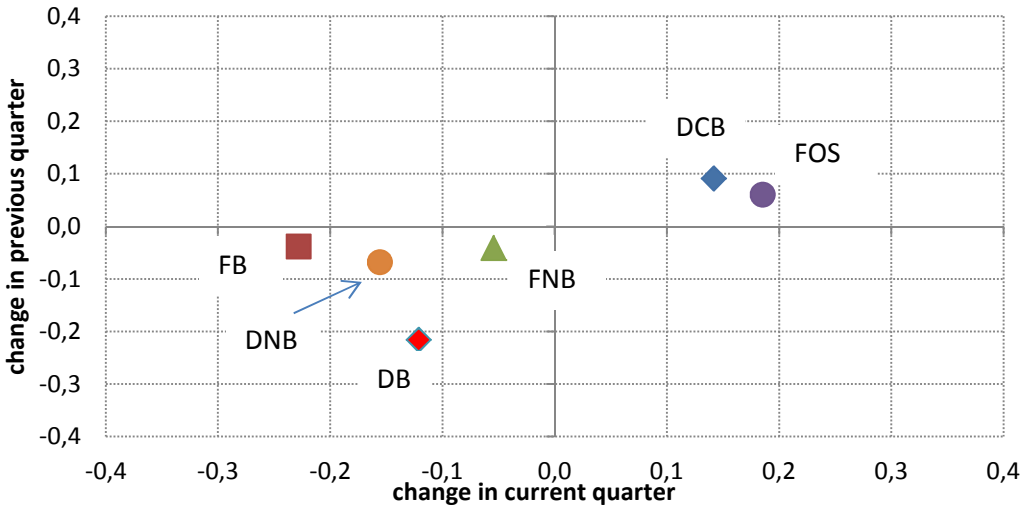
The results of an exercise along these lines are shown in Charts 8 and 9, for respectively the quarters up to 2010Q2 and from 2010Q3 onwards.[20] In the first sub-sample, the dots relating to the foreign official sector (FOS) and domestic central bank (DCB) lie in the top-right region in quarters of large increases in inventories: these two groups were buying in quarters of price falls, leaning against the wind. Note that the foreign official sector offloads its inventories in the opposite circumstances when prices rise, signaling a profit taking action. A different result is observed for the domestic central bank, which tends to avoid large reductions in its stock likely to prevent unwanted price volatility.[21] In the second sub-sample the dot of the foreign official sector are again in the top-right region but close to zero along both coordinates. One could conjecture that in times of exceptional uncertainty, even this sector balked at taking a contrarian position to the market. What about the domestic banks? We find them close to the bottom-left region in quarters when they reduce their inventories in the first sub-sample, which could be read as a profit-taking action, and are otherwise close to zero.

[20] Statistics based on a sample excluding Greece, Ireland and Portugal.

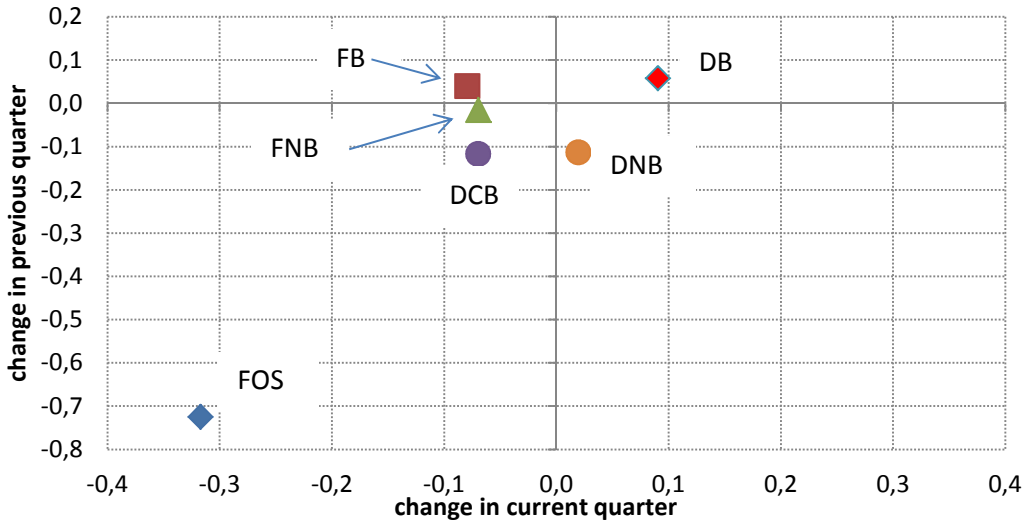
[21] Of course, a cluster in sales could be observed should the central bank undertake the sale right to exert downward pressure on prices rather than to achieve a leaner balance sheet only.

Chart 8 Changes in inventories and changes in yields, 10-year bonds, 2004-2009 (1)

Large increases



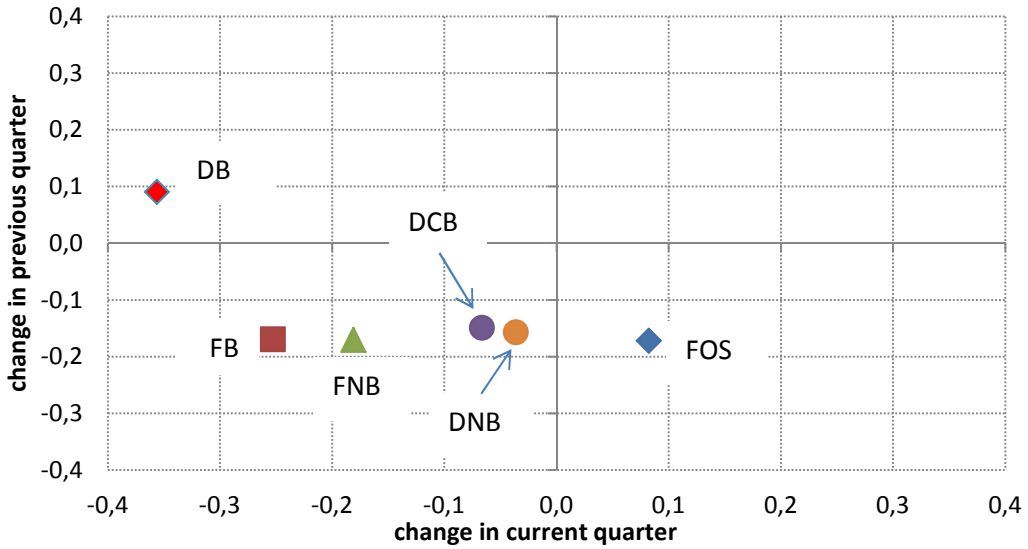
Large decreases



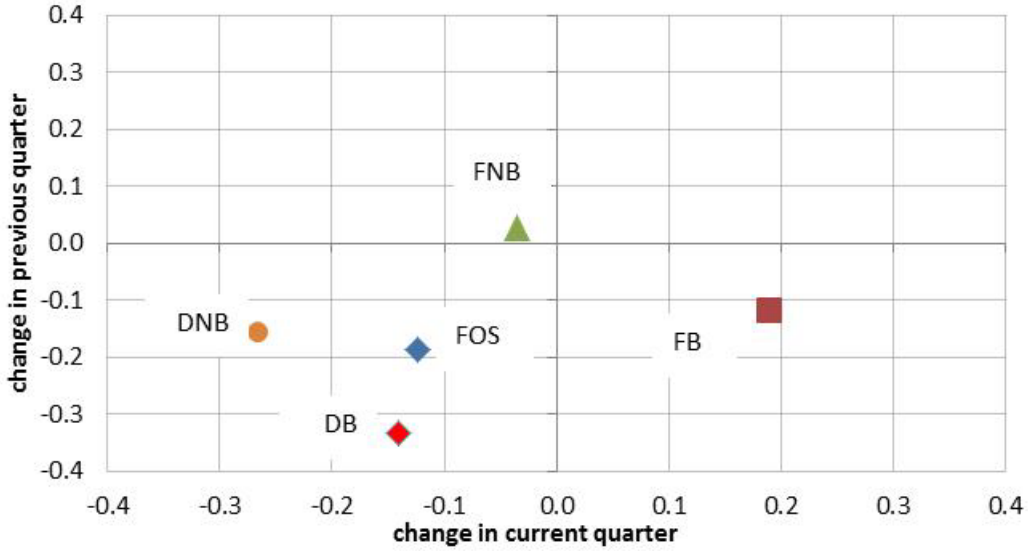
(1) FOS: foreign official sector. FB: foreign banks. FNB: foreign non-banks. DCB: domestic central bank. DB: domestic banks. DNB: domestic non-banks.

Chart 9 Changes in inventories and changes in yields, 10-year bonds, 2010-2016 (1)

Large increases



Large decreases



(1) FOS: foreign official sector. FB: foreign banks. FNB: foreign non-banks. DCB: domestic central bank. DB: domestic banks. DNB: domestic non-banks.

It is beyond the scope of this paper a thorough discussion of the purchase programs undertaken in recent years by a number of central banks. These programs deserve nonetheless some attention within this research since they offer a real-life experiment of how banks handle their inventories of domestic bonds. In Table 4 we break down for six jurisdictions the holdings in sovereign governments between the domestic central bank, the domestic banks and a residual group ("Others") which include all other investors; the start and the end dates are selected so as to single out the period when the central undertook the (bulk of its) purchases. With the exception of Japan, the large increase in holdings by the domestic central bank is offset entirely by a decrease in the holdings by the Other investors, while the weight associated to domestic banks stayed put or even increased, even if marginally.

Table 4 Bonds holdings in times of central banks' purchase programs (1)

	Japan			USA			UK		
	2012Q2	2016Q2	Δ	2010Q3	2016Q2	Δ	2009Q1	2012Q3	Δ
Domestic central bank	10%	33%	+23	6%	14%	+8	3%	27%	+24
Domestic banks	42%	27%	-15	10%	10%	=	4%	6%	+2
Others	48%	40%	-8	84%	76%	-8	93%	67%	-26%
	Germany			France			Italy		
	2015Q1	2016Q2	Δ	2015Q1	2016Q2	Δ	2015Q1	2016Q2	Δ
Domestic central bank	1%	9%	+8	3%	9%	+6	6%	10%	+4
Domestic banks	14%	15%	+1	14%	14%	=	26%	26%	=
Others	85%	76%	-9	83%	77%	-6	68%	62%	-6

Source: IMF (Arslanalp and Tsuda, 2012).
(1) Weights of holdings out of outstanding national public debt securities, in specified quarters and countries.

6. The panel model

6.1 Some background to the model

The literature on market microstructure (Madhavan, 2000, and Biais, Glosten and Spatt, 2005) argues that the breakdown of the holdings among different groups of investors is non-neutral on the yield of a long-term bond. At the same time, according to a tenet in finance, the yield can be decomposed onto the sum of three components: expected inflation over the term of the security; expected short-term real interest rates, usually proxied by real rates of growth in GDP; and a residual component that embeds the compensation for several risk premia.[22] In turn, the premia may be broken down, at least in conceptual terms, in the product of a 'quantity of risk' times the 'price per unit of risk'. While the former should be an objective measure the latter should be rather subjective, namely it should vary with the subjects holding the bonds and participating in the market. Moreover, the literature on microstructure proves that the arrival of large orders in the market does affect the yield of the bond, and not necessarily over a short interval only.[23]

Carvalho and Fidora (2015) set out a taxonomy of the theoretical contributions on the impact of asset demand on long-term interest rates, between portfolio balance theories and preferred habitat models. In portfolio balance theories, purchases of long-term securities reduce the risk premium through a decrease in the duration available in the market (Gagnon et al., 2010, Neely, 2010, and Bauer and Neely, 2012). This may take place either because the marginal buyer of the specific duration risk is willing to pay a

[22] The premia owe in the first place to the uncertainty over the realization of the said expectations. In addition, the holder of the bond will seek compensation for a range of risks: credit, liquidity, operational, legal, and so forth. The literature offers fairly established approaches to conduct the empirical decomposition of the yield (Bernanke, 2013).

[23] See the literature cited in footnote 12.

higher price for it or because the average buyer decreases exposure to the specific duration risk and therefore demands a lower compensation to hold it.

Conversely, in preferred habitat models, the focus is on heterogeneous investor preferences and imperfect substitutability between maturities and asset classes (Vayanos and Vila, 2009). This approach relies on the preliminary identification of two types of investors: arbitrageurs and investors with preferred horizons. Faced with a demand shock in a given maturity that decreases yields, arbitrageurs move along the yield curve looking for alternative (higher yielding) investment opportunities, while other investors tend to stay put. While in general it is the movement undertaken by arbitrageurs to spread the shock from a single maturity bucket along the entire yield curve, the extent to which this contagion happens depends on the risk aversion of arbitrageurs themselves. The higher is their risk aversion, the lower is the spreading of the shock.

We try to encompass these approaches, using the following very general model:

$$[3] \quad i_t^L = function\left\{ i_t^S, E_t\left(Z_{t+k}\right), S_{t,j} \right\}$$

where i_t^L and i_t^S denote respectively the long- and short-term interest rate as of time t, $E_t(Z_{t+k})$, is the current expectation of macroeconomic variables Z, and, finally, $S_{t,j}$ is the stock of inventories held by sector j of investors. The actual panel model used in the fits is:

$$[4] \quad i_{t,c}^L = \beta_0 + \beta_1 i_{t,c}^S + \beta_2 E_t\left(y_{t+k,c}\right) + \beta_3 E_t\left(\pi_{t+k,c}\right) + \sum_{j=1}^{n} \beta_{4,j} S_{t,j,c} + error\ term$$

where, on top of aforementioned symbols, the pedix 'c' signals that the equation refers to variables for country c, $E_t(y_{t+k,c})$ is the expected real rate of GDP change of that country, $E_t(\pi_{t+k,c})$ its expected inflation rate and $S_{t,j,c}$ is the stock of inventories held by sector j of investors.

We assess the short- and long-run determinants of long-term government bond yields employing a panel error correction model (PECM). We also take into account the cross-country dependences regarding this segment of the capital markets. More specifically, we apply the pooled mean group (PMG) estimator of Pesaran et al. (1999), a panel data version of the error-correction model. Indeed, this approach addresses the unit roots in the panel data and allows for short-run versus long-run analyses of sovereign bond yields in the same specification. Besides, similar to the fixed effects (FE) estimator, the PMG estimator pools coefficients of long-run factors to improve the statistical inference and comply with theoretical predictions (which are general and should not wary from country to country). However, unlike the FE estimator, the PMG is flexible enough to allow country-specific variations in short-run coefficients. In turn, this allows a differentiated response to changes in short-term factors.

In order to take account the common factors in the cross equation covariance, the long-run parameters are obtained with Common Correlated Effect (CCE) estimator (Pesaran, 2006). This is consistent under various types of cross-section dependence, including single or multiple common factors, which might be stationary or non-stationary, and even when the idiosyncratic errors are cross-sectionally correlated (Kapetanios, Pesaran, and Yamagata, 2011; Pesaran and Tosetti, 2011).

We estimate the complete PECM described by the following equation:

$$[5] \quad \Delta i_{t,c}^{L} = \sum_{j=0}^{k} \varphi_{j,c} \Delta X_{t-j,c} + \lambda_c \left[i_{t-1,c}^{L} - \beta_0 - \beta_i X_{t-1,c} \right] + \nu_{t,c}$$

where Δ is the difference operator, $i_{t,c}^{L}$ the long-term government bond interest rate, $v_{t,c}$ the disturbances, X includes a set of explanatory variables. The index c denotes the country, t the period and λ_c is the speed of adjustment towards the long-run level.

6.2 The results of the model

Due to data limitations we run this part of the analysis on 16 of the 21 countries considered in the previous sections.[24] In particular, Australia and Korea are excluded for lack of data about Consensus Economics expectations either on inflation rate and on gross domestic product. Market data for expectations on 10-year inflation are not available for Greece, Ireland and Portugal; for these countries, data issues arise also in the interest rate series.

Based on a preliminary ordinary inspection, tests show that all the variables considered in the long run estimate (10-year nominal interest rate, 12-month real interest rate, 10-year inflation rate expectation, domestic banks holdings/ GDP, foreign banks holdings/ GDP, foreign official sector holdings/ GDP) contain a unit root (Tables A.2 and A.3). We used both first and second generations of panel unit root tests (an introduction on these models is in Annex A.4). The use of second-generation panel unit root tests is desirable provided the panel is subject to a significant degree of error cross-section dependence (CD) as confirmed by the Pesaran test (2004, Table A.4).[25] Between the variables considered in the short run equation turn out to be stationary: i) the real GDP growth; ii) the standard deviation of 10 year nominal interest rate and iii) the level of risk aversion in global capital markets, measured by the VIX Index.[26] The deficit / GDP is stationary with the first generation tests. On the other hand, domestic central banks holdings are integrated of order 2.

Against these results, firstly we test the existence of co-integration between nominal long-term interest rates and its potential determinants. To this end, we used the test by Banerjee and Carrion-i-Silvestre (2017), which runs a panel unit root test on residuals from a Common Correlated Effect Pooled (CCEP) procedure.[27] Secondly, we estimate a

---

[24] Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom and USA. Comparing to the previous sections, the econometric analysis has not run for Australia, Greece, Ireland, Korea and Portugal.

[25] The test is based on a simple average of all pair-wise correlation coefficients of the OLS residuals obtained from standard augmented Dickey–Fuller regressions for each individual in the panel. All the variable used in the long run estimates show cross-section dependence. Between the variables considered in the short run equation, one exception is the series of Foreign Non-Financial Sector Holdings.

[26] In this instance, a DF-GLS unit root test shows that the null hypothesis of a unit root can be rejected at 5 percent significance level (test statistics = -2.972). The stationarity of the time-varying degree of international risk aversion indicates that it is a phenomenon influencing short-run variations in sovereign yield spreads (Attinasi et al., 2010, find it to be relevant during the financial crisis) but not long-run fluctuations.

[27] In the testing phase, Banerjee and Carrion-i-Silvestre test (2017) is our first choice but we have run also the tests put forward by Gengenbach, Urbain and Westerlund (2008) and Pedroni (1999) for the sake of robustness. This ranking mainly owe to the fact that Banerjee and Carrion-i-Silvestre (2017) is a test specifically geared to assess co-integration on a Common Correlated Effect Pooled (CCEP) model, and thus is well suited to our application. The Gengenbach, Urbain, Westerlund test is regarded as especially suited to CCE Mean Group model, while Pedroni has a limited allowance for

panel error correction model (PECM). In what follows we consider the following sets of variables[28]:

X = (12-month real interest rate, 10-year inflation rate expectation, Domestic banks Holdings/ GDP, Foreign banks Holdings/ GDP, Foreign Official Sector Holdings/ GDP)

We estimate the long-run determinants of sovereign yields using the cross-section augmented co-integrating regression, based on the CCEP procedure:

[6] $$i_{t,c}^{10Y} = \alpha + \beta_1 r_{t,c}^{12M} + \beta_2 \pi_{t,c}^{t+k} + \beta_3 S_{t,c}^{DB} / GDP_{t,c} + \beta_4 S_{t,c}^{FB} / GDP_{t,c}$$

$$+ \beta_5 S_{t,c}^{FOS} / GDP_{t,c} + \mu_1 \overline{i_{t,c}^{10Y}} + \mu_2 \overline{X_t} + u_{it}$$

The co-integrating regression is augmented with the cross-section averages of the dependent variable and the observed regressors as proxies for the unobserved factors. Accordingly, $\overline{i_{t,c}^{10Y}}$ and $\overline{X_t}$ denote respectively the cross-section averages of the long term sovereign yield and the independent variables in the year t. Note that the coefficients of the cross section averages do not need to carry a specific economic interpretation as their inclusion simply aims to improve the estimates of the coefficients of interest.

Nominal 10-year interest rate is found to be statistically and positively related to the 12-month real interest rate and 10-year inflation expectation, and negatively to the holdings by domestic banks, by foreign banks and by the foreign official sector (Table 5A). In details, the estimates show that across the sixteen countries of the panel, the ratio of bonds' holdings by domestic banks to GDP exerts a negative and significant influence on the level of the yields. Likewise, a negative and significant coefficient is associated to the holdings by foreign banks and by the foreign official sector.

---

cross-section dependence unless you assume that the unobservable variables are identical in their impact across countries.

28 We tested the existence of co-integration between different set of combinations of the variables: i) 10-year nominal interest rate, 12-month real interest rate, 10-year inflation expectation, Domestic Banks Holdings/ GDP; ii) 10-year nominal interest rate, 12-month real interest rate, 10-year inflation expectation, Foreign banks holdings / GDP; iii) 10-year nominal interest rate, 12-month real interest rate, 10-year inflation expectation, Official Foreign sector holdings / GDP; iv) 10-year nominal interest rate, 12-month real interest rate, 10-year inflation expectation, Domestic banks holdings / GDP, Foreign banks holdings/ GDP, Foreign official sector holdings / GDP; v) 10-year nominal interest rate, 12-month real interest rate, 10-year inflation expectation, Domestic banks Holdings/ GDP, Foreign holdings (the sum of inventories by foreign banks and the foreign official sector /GDP).The results of the Banerjee and Carrion-i-Silvestre test (2017) support the existence of co-integration; these outcomes have also been confirmed by the Gengenbach, Urbain and Westerlund (2008) and Pedroni (1999) tests. Results are available on request.

Table 5 CCEP (long-run) and PMG (short-run) estimations, 2004Q1- 2016Q2

	(1)	(2)	(3)	(4)	(5)	(6)
(A) Long-run coefficients						
12-m real interest rate	0.31***	0.22***	0.28***	0.23***	0.29***	0.29***
	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
10-y inflation expectation	0.41***	0.26***	0.44***	0.21***	0.43***	0.43***
	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Domestic banks' holdings / GDP	-0.02**			-0.03***	-0.02***	-0.02***
	(0.01)			(0.01)	(0.01)	(0.01)
Foreign banks' holdings/GDP		-0.04***		-0.04**		
		(0.02)		(0.02)		
Foreign official sector hold. / GDP			-0.02**	-0.03**		
			(0.01)	(0.01)		
(Foreign banks &off. sector) / GDP					-0.07***	-0.07***
					(0.01)	(0.01)
Constant	0.85	1.75**	0.32	3.05**	1.41	1.41
	(0.86)	(0.86)	(0.62)	(1.29)	(0.91)	(0.91)
	(1)	(2)	(3)	(4)	(5)	(6)
(B) Short-run coefficients						
Error Correction term	-0.16***	-0.14***	-0.15***	-0.11***	-0.12***	-0.12***
	(0.02)	(0.019)	(0.03)	(0.02)	(0.02)	(0.02)
Δ 12-m real interest rate	0.22***	0.22***	0.23***	0.26***	0.24***	0.24***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Δ 10-y inflation expectation	0.63***	0.65***	0.61***	0.71***	0.70***	0.72***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
Δ Domestic banks' holdings / GDP	0.02			0.00	-0.01	-0.01
	(0.04)			(0.05)	(0.05)	(0.05)
Δ Foreign banks holdings / GDP		-0.10***		-0.09***		
		(0.02)		(0.02)		
Δ Foreign official holdings / GDP			0.04	0.05		
			(0.04)	(0.03)		
Δ Foreign banks &off. sector/ GDP					-0.01	-0.03*
					(0.02)	(0.02)
Deficit/ GDP	0.06**	0.07***	0.08**	0.06**	0.07**	0.08**
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
Δ Foreign non banks / GDP						-0.04**
						(0.02)
Constant	-0.41***	-0.97***	-0.13**	-0.91***	-0.10	-0.11
	(0.09)	(0.14)	(0.05)	(0.17)	(0.07)	(0.07)
Number of countries	16	16	16	16	16	16
Observations	784	784	784	784	784	784

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In a nutshell, the more banks (both domestic and foreign ones) hold a given bond, the lower is the yield of this bond, ceteris paribus. A possible intuition behind this result is that because banks 'make the market', larger holdings of a given bond by their side are associated to more liquidity. In turn, this could justify a lower headline yield required by investors to underwrite the bond in the first place. Moreover, as highlighted above, banks hold large and relatively stable holdings of government bonds. In this way, banks do decrease the duration risk available in the market and other investors as well may be appreciative of such contribution by accepting a lower yield, ceteris paribus.[29] Indeed, we

[29] Duration risk denotes the exposure of long-term bonds to unexpected changes in policy interest rates, where the monetary value of this risk increases with the stock of long-term bonds. One could thus

find that a one percentage point increase in the share of government debt held by domestic banks is associated to a lower yield in the 10-year government bond by 2-3 basis points.

We also find a larger impact, in the order of 6-7 basis points of reduction, when foreign investors (banks and official sector) increase their share by one percentage point. This result is comparable with previous studies on the impact of the foreign investor base on long-term sovereign bond yields in a cross-country context (Andritzky, 2012 and Arslanalp and Poghosyan, 2014) as well as with the estimate of 5-6 basis points put forward by Beltran et al. (2012) in a work US Treasuries.

Having proven a long-run relationship in our panel, we estimate the error correction model using the following PMG equation:

$$[7] \quad \Delta i_{t,c}^{10Y} = \gamma + \sum_{j=0}^{k} \varphi_{j,c} \Delta X_{t-j,c} + \lambda \, [error\ correction\ term] + \nu_{t,c}$$

In the equations on first differences, the estimated coefficients of the co-integration equation linking the nominal 10-year, the real 12-month interest rates, the expected 10-year inflation rate with the holdings by domestic banks and foreign sector are significant and show the expected negative coefficient: bar any news, the market corrects itself when yields deviate from a long-term equilibrium (Tables 5B). The speed of adjustment towards the long-run level is around -0.13, namely the adjustments completes in 7 quarters or so.[30]

The deficit-to-GDP ratio contributes to the fit with a significant positive coefficient: ceteris paribus, the higher this ratio the more costly is for a country to refinance its public debt, as it should be expected. In the short run, changes in holdings by foreign banks exert a negative and significant influence in the change of long-term yields; conversely, the coefficient of domestic banks is not significant. The coefficient of foreign official sector exerts a positive influence and confirms the results of the exercise of matching changes in inventories with changes in interest rates, shown in the section 5. In other words, the foreign official sector bought government bonds in quarters of price falls (yield increases) and sold them in quarters of price rises (yield decreases).[31] The coefficient of the level of risk aversion in global capital markets, measured by the VIX Index, is not significant and not reported in Table 5.

To test for coefficients stability, we repeated the regressions on a reduced sample. On March 2015, the ECB began its public sector purchase programme (PSPP) and around the same time the Bank of Japan increased the size of its government bond purchases. As these drivers of change could have affected the coefficients of the regressions, we have considered the sample until the end of 2014. The results for the long- and short-run equations are shown in Tables 6.

---

conjecture that the larger and more stable the banks' holdings of these bonds, the lesser is the monetary value of this risk for other market participants.

30 Before considering Equation 7, we used a Hausman statistic to test for common parameters across countries (i.e. $\lambda_c = \lambda$, for c = 1,…,N): data did not reject the null hypothesis $\lambda_c = \lambda$ on the speed of adjustment. The results commented in the text are based on the co-integration between nominal long-term interest rate, 12-month real interest rate, long-term inflation expectation, domestic banks holdings/ GDP, the sum of inventories by foreign banks and the official foreign sector /GDP. Results are robust with respect of selection of regressors. More precisely, results are extremely similar if we substitute the sum of inventories by foreign banks and the official foreign sector /GDP with the single components (Table 5B).

31 The same result is obtained for the domestic central banks.

Table 6 CCEP (long-run) and PMG (short-run) estimations, 2004Q1- 2014Q4

	(1)	(2)	(3)	(4)	(5)	(6)
(A) Long-run coefficients						
12-m real interest rate	0.32***	0.22***	0.28***	0.24***	0.30***	0.30***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
10-y inflation expectation	0.43***	0.28***	0.49***	0.19**	0.44***	0.44***
	(0.08)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)
Domestic banks' holdings / GDP	-0.02***			-0.05***	-0.04***	-0.04***
	(0.01)			(0.01)	(0.01)	(0.01)
Foreign banks' holdings/GDP		-0.05***		-0.06***		
		(0.02)		(0.02)		
Foreign official sector hold. / GDP			-0.01	-0.04**		
			(0.02)	(0.02)		
(Foreign banks &off. Sector)/ GDP					-0.08***	-0.08***
					(0.01)	(0.01)
Constant	0.99	1.66*	0.18	3.48**	1.54	1.54
	(1.19)	(0.93)	(0.73)	(1.40)	(1.15)	(1.15)

	(1)	(2)	(3)	(4)	(5)	(6)
(B) Short-run coefficients						
Error Correction term	-0.17***	-0.18***	-0.17***	-0.08***	-0.10***	-0.10***
	(0.028)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Δ 12-m real interest rate	0.24***	0.23***	0.25***	0.31***	0.29***	0.28***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Δ 10-y inflation expectation	0.66***	0.67***	0.63***	0.76***	0.73***	0.75***
	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)
Δ Domestic banks' holdings / GDP	0.03			0.00	-0.00	-0.01
	(0.04)			(0.05)	(0.05)	(0.04)
Δ Foreign banks holdings / GDP		-0.07***		-0.06***		
		(0.02)		(0.02)		
Δ Foreign official holdings / GDP			0.05	0.06		
			(0.04)	(0.04)		
Δ Foreign banks &off. sector/ GDP					-0.00	-0.02
					(0.02)	(0.02)
Deficit/ GDP	0.05**	0.04***	0.03*	0.07	0.09*	0.08**
	(0.02)	(0.01)	(0.02)	(0.04)	(0.05)	(0.04)
Δ Foreign non banks / GDP						-0.03
						(0.02)
Constant	-0.34***	-0.81***	-0.05	-0.67***	-0.05	-0.04
	(0.08)	(0.14)	(0.05)	(0.17)	(0.06)	(0.06)
Number of countries	16	16	16	16	16	16
Observations	688	688	688	688	688	688

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

These results confirm the stability of the coefficients, a finding which emerged also in further estimates run when dividing the sample in two sub-periods: the first goes from 2004Q1 to 2010Q4; the second from 2011Q1 to 2016Q2 (results available on request).

Table 7	**CCEP (long-run) and PMG (short-run), subset of 9 countries**						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(A) Long-run coefficients							
12-m real interest rate	0.33***	0.27***	0.36***	0.26***	0.36***	0.36***	0.36***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)
10-y inflation expectation	0.39***	0.30***	0.43***	0.20**	0.33***	0.37***	0.33***
	(0.09)	(0.09)	(0.08)	(0.11)	(0.10)	(0.10)	(0.10)
Domestic banks' holdings / GDP	-0.01			-0.03***	-0.03***	-0.03***	-0.03***
	(0.01)			(0.01)	(0.01)	(0.01)	(0.01)
Foreign banks' holdings/GDP		-0.06***		-0.00			
		(0.02)		(0.02)			
Foreign official sector hold. / GDP			-0.02	-0.03*			
			(0.02)	(0.02)			
(Foreign banks &off. Sector)/ GDP					-0.05***	-0.05***	-0.05***
					(0.01)	(0.01)	(0.01)
Other domestic financial corp. holdings/GDP						-0.003	
						(0.01)	
Constant	1.59**	1.54**	1.26*	1.86***	1.66***	3.46***	1.66***
	(0.74)	(0.77)	(0.65)	(0.50)	(0.37)	(0.97)	(0.37)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(B) Short-run coefficients							
Error Correction term	-0.17***	-0.16***	-0.15***	-0.12***	-0.13***	-0.14***	-0.13***
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Δ 12-m real interest rate	0.17***	0.18***	0.19***	0.21***	0.20***	0.19***	0.19***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Δ 10-y inflation expectation	0.70***	0.70***	0.73***	0.7***	0.77***	0.75***	0.79***
	(0.07)	(0.08)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)
Δ Domestic banks' holdings / GDP	-0.04			-0.07*	-0.05	-0.06	-0.06*
	(0.04)			(0.03)	(0.04)	(0.04)	(0.03)
Δ Foreign banks holdings / GDP		-0.12***		-0.13***			
		(0.03)		(0.05)			
Δ Foreign official holdings / GDP			0.05	0.07			
			(0.05)	(0.04)			
Δ Foreign banks &off. Sector/GDP					-0.01	-0.01	-0.02
					(0.03)	(0.03)	(0.03)
Δ Other domestic financial corp. holdings/GDP				0.01	0.01	0.01	0.01
					(0.04)	(0.04)	(0.04)
Deficit/ GDP	0.04***	0.05***	0.04***	0.03***	0.04***	0.04***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ Foreign non banks / GDP							-0.05***
							(0.01)
Constant	-0.77***	-0.60***	-0.37***	-0.99***	-0.54***	-0.57***	-0.54***
	(0.17)	(0.14)	(0.08)	(0.19)	(0.15)	(0.15)	(0.14)
Number of countries	9	9	9	9	9	9	9
Observations	441	441	441	441	441	441	441

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A further exercise we undertook was to run the fits, for the whole time sample but splitting the domestic non-bank group in two sub-sectors: (i) financial corporations other than banks (i.e. insurance companies and pension and mutual funds) and (ii) others. This exercise is relevant in terms of the debate of the role entities (i) could play in the market along banks or in their substitution. However, this cannot be our baseline fit since we availed of suitable data only for 9 countries.[32] Results are shown in Tables 7. The estimates show that across the nine countries of this panel, the ratio of bonds' holdings to

[32] Belgium, France, Germany, Italy, Japan, the Netherlands, Spain, the United Kingdom and USA.

GDP either by domestic banks and foreign banks exert a negative and significant influence on the level of yields. In the long-run regression, the coefficient of other financial corporations' holdings (i.e. insurance companies and pension funds) to GDP is negative but not significant: across the nine countries of this panel these investors exerts a non-significant influence on the level of the yields. A significant role of foreign banks' holdings is also detected in the fit of the model whose dependent variable is the first difference of the 10-year government bond yields. The role played by other financial corporations' holdings in the short run dynamics is again not significant.

7. Thoughts on the future government bond market

Do the results gathered in this research offer any hint on the future microstructure of the government bond markets? We believe that the answer should be a cautious yes which we gather from comparing three scenarios: (a) banks effectively stop acting as market makers and the market evolves into an order driven one, largely operated through electronic platforms; (b) banks partly dismiss their market-making function and the void is filled by other non-bank financial intermediaries; (c) fewer banks act as market-makers with no other significant development.

As to scenario (a), simply enough we do not find in our results any clear sign of a retrenching by the banking system as a whole from established patterns in terms of management of inventories. Accordingly, our intuition is that trading on government bonds will continue to be based on the offer of quotes by intermediaries who 'make the market'. However, it remains to be discussed who will offer the market-making services. Incidentally, note that such a microstructure fits well a theoretical result of the literature: markets for which the arrival rate of new orders reasonably outweighs that of new information – and reasonably this is the case of the government bond market[33] – suit better forms of continuous trading vs. the alternative of call auctions (Biais, Glosten and Spatt, 2005).[34]

Turning to scenario (b), Duffie (2012) argued that due to changes in banking regulation, "Some of the lost market-making capacity might be filled by existing non-bank firms such as hedge funds or insurance companies". The intuition is that once a market maker has limited capacity to warehouse risk on its balance sheet, then it would avoid meeting requests for immediacy services to keep actual inventories in a narrow range around the target.[35]

To examine whether this will actually prompt non-banks to turn up as market makers, let's follow BIS (2014) which identifies five common features in this business: (i) a sufficiently large client base to get a good view of the flow of orders; (ii) the capacity to take on large principal positions; (iii) continuous access to multiple markets, including funding and hedging markets; (iv) the ability to manage risk, especially the risk of

[33] To cut a long story short, there is a huge effort by market participants and institutions to analyse the fundamentals on government bonds' yields (inflation and real growth) and fiscal variables. Hence, there is limited scope for high-frequency surprises in data.

[34] This should be seen only as a criterion of compatibility, in the sense that while market makers tend to be found in continuous markets, one may have continuous markets also without market makers.

[35] The regulatory regime could affect the banks' market making capacity even when the holdings of sovereign bonds as such would be treated fairly leniently. It would be enough for regulation to enhance the cost of trading in a key segment for the market-making activity such as the repo market.

holding assets in inventory; and (v) market expertise in providing competitive quotes for a range of securities (see also Fender and Lewrick, 2015).

Criteria (iv) and (v) do not seem too demanding, in the sense that non-banks such as insurance firms and hedge funds may well stock adequate market expertise and capability to manage risk. As to criterion (iii), commercial banks avail of a large customers' basis, but so could do insurance firms and investment and pension funds. Given the question we laid down above, it is crucial however that only domestic banks have, as a rule, direct to central bank liquidity. This offers them a full access to the different market segments, in a way that other financial intermediaries do not enjoy.[36]

As to the empirical results we have been able to gather, both descriptive statistics and the econometric analysis do not offer hints to a market-making role of non-bank investors. Hence, in our view, although non-banks may possibly have some role in market making they are not fit to replace the banks fully.

Hence, we place our bet with scenario (c) with banks playing (most of) the market-making function in the government market even in the foreseeable future. However, this statement needs to be qualified however in different ways. Firstly, when we say "banks" we refer to the banking system as a whole; namely, we accept that some individual banks do take a different course of action by halting their market-making function. Secondly, it is also true that liquidity tends to cluster: traders place their orders when they see others doing the same, to take advantage of that public good called liquidity (Admati and Pfleiderer, 1988, Pagano, 1989, Foster and Viswanathan, 1990). Hence, a pattern of bifurcation could emerge across bonds: some bonds could attract increasingly flows in transactions throughout the whole business day also supported by the readiness by banks to offer inventory services while on other bonds competing quotes would be on offer only in peak hours with banks offering mostly 'search services'. On both counts, a different type of analysis, on micro data, could shed more light on these patterns at the level of individual intermediaries and securities. Finally, developments in technology may be a double-edged sword: technology may lead to an increase in competition from less traditional sectors (with platforms taking traction) but it may also serve well the banks in many ways (BIS, 2016b).

8. Concluding remarks

In this paper we analyze patterns in holdings of government bonds by six groups of investors, covering 21 advanced economies from 2004Q1 to 2016Q2. The research is organized around three questions: whether banks hold a different approach in the management of government bonds' inventories compared to other groups of investors; under which market conditions large changes in inventories by both banks and non-banks take place; whether levels and changes in yields of 10-year benchmark government bonds are driven by banks' (and other sectors) holdings besides the usual fundamentals.

As to the first question, we find that banks adopt a unique style of 'loose targeting' of their inventories of domestic bonds: banks emerge as the sector less prone to undertake

[36] In the euro area in 2016 special repo rates have often been quoted well below the Eurosystem's deposit facility. This apparently odd result has often been interpreted by noting that while banks can park their excess liquidity with their domestic central bank within the euro area, other financial intermediaries do not have this option and are forced to accept even more negative rates of interest on their deposits.

large changes but at the same time are quite ready to undertake changes of more intermediate size. By comparison, we find many large changes for both foreign banks and domestic central banks (compared to the size of their average holdings) while, at the other end of the spectrum, domestic non-banks skip both large and intermediate changes. In this ranking, the foreign official sector is the one that comes closest to domestic banks.

Where differences emerge between the foreign official sector and domestic banks – which brings us to the second question – is about the timing of the changes. The former sector has proved to be a cunning investor able to lean against the wind, by buying when prices fall and selling when prices rise (noticeably prior to the onset of the great financial crisis). By contrast, we do not observe this pattern for domestic banks, which in our view is not necessarily a sign of limited capability in exploiting market trends as it may rather reflect the banks' availability in using their inventories to serve customers' orders. This is reflected in the banks' willingness to undertake many intermediate changes, as outlined above.

As to the third question, the econometric analysis shows that the larger are the holdings by domestic and foreign banks, the lower the yields of 10-year benchmark sovereign bonds, after controlling for the usual fundamental factors. One interpretation is that investors are willing to underwrite bonds at relatively low yields when banks are significant holders because of the liquidity services they offer.

All in all, the results of this econometric analysis and the descriptive statistics we worked out to answer the first two questions suggest that the provision of liquidity to the market as a whole is an important by-product of the services domestic banks offer to their customers.

Two final points are worth highlighting. Firstly, each of the 21 national banking systems displays a positive (home) bias in respect to bonds issued by their own Treasury – where the 'positive' means that they hold more bonds than a neutral distribution would suggest – and at the same time a negative (foreign) bias in respect to bonds issued by foreign Treasuries. The result on the home bias adds to an ample extant literature in finance while the one on the foreign bias is novel (we are not aware of similar empirical systematic research). On the whole, these results clearly indicate that the nature of the bias is not country-dependent and reinforce the view that banks regard domestic government bonds as a special class of assets.

Secondly, both descriptive statistics and econometric fits prove to be robust to the unfolding of the financial crisis; accordingly, we tend to see the aforementioned domestic banks' "loose targeting" style as a structural feature. Noticeably, we do not find evidence of any broad-based, system-wide change in attitude by banks in the management of their inventories of bonds. In turn, this suggests that caution should be exercised in predicting any major short-term transformation in the pivotal role played by banks in government bond markets.

References

Admati, A.R. and Pfleiderer, P. (1988). A Theory of Intraday Patterns: Volume and Price Variability. Review of Financial Studies, 1, 3-40.

Adrian T., M. Fleming, O. Shachar and E. Vogt (2016). Market Liquidity after the Financial Crisis. Federal Reserve Bank of New York Staff Reports, no. 796.

Afonso A. and C. Rault (2015). Short- and long-run behaviour of long-term sovereign bond yields. Applied Economics, 47:37, 3971-3993

Andritzky J.R. (2012). Government Bonds and Their Investors: What Are the Facts and Do They Matter? IMF Working Paper, no. 158.

Arslanalp S. and T. Tsuda (2012). Tracking Global Demand for Advanced Economy Sovereign Debt. IMF Working Paper, no. 284.

Arslanalp S. and T. Poghosyan (2014). Foreign Investor Flows and Sovereign Bond Yields in Advanced Economies. IMF Working Paper, no, 27.

Attinasi, M.G., Checherita, C. and C. Nickel (2010). What explains the surge in euro area sovereign spreads during the Financial Crisis 2007-2009? Public Finance and Management, 10, 595-645.

Bao J., M. O'Hara and X. Zhou (2016). The Volcker Rule and Market-Making in Times of Stress. Mimeo

Banerjee, A., Marcellino, M. and Osbat, C. (2005). Testing for PPP: should we use panel methods? Empirical Economics, 30,7 7 –91.

Banerjee, A. and Carrion-I-Silvestre, J. L. (2017). Testing for Panel Cointegration Using Common Correlated Effects Estimators. Journal of Time Series Analysis, Vol. 38, Issue 4, pp. 610-636, 2017.

Battistini, Pagano and Simonelli (2013). Systemic Risk and Home Bias in the Euro Area. European Commission Economic Papers, no. 494.

Bauer, M. D. and C. J. Neely (2012). International Channels of the Feds Unconventional Monetary Policy. Federal Reserve Bank of St. Louis, Working Paper No. 2012-028A

Beltran D.O., M. Kretchmer, J. Marquez and C.P. Thomas (2012). Foreign Holdings of U.S. Treasuries and U.S. Treasury Yields.

Benos E. and F. Zikes (2016). Liquidity determinants in the UK gilt market. Bank of England Staff Working Paper, no. 600.

Bernanke, B. (2013). Long-Term Interest Rates, Speech at the Annual Monetary/Macroeconomics Conference: The Past and Future of Monetary Policy.

Biais B., L. Glosten and C. Spatt (2005). Market microstructure: A survey of microfoundations, empirical results, and policy implications. Journal of Financial Markets, 8, 217-264.

BIS (2014). Market-making and proprietary trading: industry trends, drivers and policy implications. Report by the Committee on the Global Financial System. Available at www.bis.org.

BIS (2016a). Fixed income market liquidity. Report by the Committee on the Global Financial System. Available at www.bis.org.

BIS (2016b). Electronic trading in fixed income markets. Report by the Markets Committee. Available at www.bis.org.

Brealey R.A., I. Cooper and E. Kaplanis (1999). What is the International Dimension of International Finance? European Finance Review, 3, pp. 103-119.

Canova F., M. Ciccarelli and E. Ortega (2007). Similarities and Convergence in G-7 Cycles, Journal of Monetary Economics, 54 (3), 850-878, 2007.

Canova F. and M. Ciccarelli (2009). Estimating Multi-country VAR Models. International Economic Review, 50 (3), 929-961, 2009.

Carvalho D. and M. Fidora (2015). Capital inflows and euro area long-term interest rates. ECB Working Paper Series No 1798 / June 2015.

Chan K., V. Covrig and L. Ng (2005). What Determines the Domestic Bias and Foreign Bias? Evidence from Mutual Fund Equity Allocations Worldwide. The Journal of Finance, 60:3, pp. 1495-1534.

Chen S. and C.-D. Yuan (2011). Home Bias and the International Cost of Equity: Global Evidence from CAPM Perspective. International Research Journal of Finance and Economics, 74, 152-168.

Claessens, S., Kose, A., Laeven, L. and Valencia, F. (2013). Understanding Financial Crises: Causes, Consequences, and Policy Responses. CEPR Discussion Papers 9310.

Cooper I. and E. Kaplanis (1994). Home Bias in Equity Portfolios, Inflation Hedging, and International Capital Market Equilibrium. The Review of Financial Studies, 7:1, pp. 45-60.

De Santis R.A. and B. Gérard (2006). Financial integration, international portfolio choice and the European Monetary Union. ECB Working Paper, no. 626.

Diamond, D. and P. Dybvig (1983). Bank runs, deposit insurance, and liquidity. Journal of Political Economy, 91, pp. 401-419.

Duffie D. (2012). Market Making Under the Proposed Volcker Rule.

ESRB (2015). Report on the regulatory treatment of sovereign exposures.

ESRB (2016). Market liquidity and market-making.

Fender I. and U. Lewrick (2015). Shifting tides – market liquidity and market-making in fixed income instruments. BIS Quarterly Review.

Fidora M., M. Fratzscher and C. Thimann (2006). Home bias in global bond and equity markets – The role of real exchange rate volatility. ECB Working Paper, no. 685.

Fleming M, F. Keane and E. Schaumburg (2016). Primary Dealer Participation in the Secondary U.S. Treasury Market. Liberty Street Economic Blog.

Foster, F.D. and S. Viswanathan (1990). A Theory of the Interday Variations in Volume, Variance, and Trading Costs in Securities Markets. The Review of Financial Studies, Vol. 3, No. 4, (1990).

Gagnon, J., M. Raskin, J. Remache and B. Sack (2010). Large-scale asset purchases by the federal reserve - did they work? Federal Reserve of New York Staff Report 441.

Gengenbach, C, J. -P. Urbain, and J. Westerlund, (2008). Panel Error Correction Testing with Global Stochastic Trends, No 051, Research Memorandum, Maastricht University. Maastricht Research School of Economics of Technology and Organization (METEOR).

Glosten, L. and P. Milgrom (1985). Bid, ask and transaction prices in a specialist market with heterogeneously informed traders. Journal of Financial Economics, 14, pp. 71-100.

Grande, G., S. Masciantonio and A. Tiseno (2014). The interest-rate sensitivity of the demand for sovereign debt. Evidence from OECD countries (1995-2011), Bank of Italy Working papers no. 988/ October 2014.

Grinblatt, M. (2001). An analytic solution for interest rate swap spreads. International Review of Finance, 2(3), 113–149.

Kapetanios, G., M. Pesaran, and T. Yamagata (2011). Panels with Nonstationary Multifactor Error Structures. IEPR Working paper no. 06.62 and CESifo Working paper no. 1788 and IZA Discussion paper no. 2243.

Kyle, A. (1985). Continuous auctions and insider trading. Econometrica, 53, pp. 1315-1335.

Krishnamurthy A. and A. Vissing-Jorgensen (2012). The Aggregate Demand for Treasury Debt. Journal of Political Economy, 120:2 , pp. 233-267.

Krishnamurthy A. and A. Vissing-Jorgensen (2015). The Impact of Treasury Supply on Financial Sector Lending and Stability. Swiss Finance Institute Research Paper No. 15-46.

Kurosaki T., Y. Kumano, K. Okabe and T. Nagano (2015). Liquidity in JGB Markets: An Evaluation from Transaction Data. Bank of Japan Working Paper Series, no. 15-E-2.

Im, K., Pesaran, M. and Shin, Y. (2003). Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115, 53 –74.

Levin, A., Lin, C.-F. and Chu, C.-S. (2002). Unit root tests in panel data: asymptotic and finite sample properties. Journal of Econometrics, 108,1 –24.

Levy H. and M. Levy (2014). The home bias is here to stay. Journal of Banking & Finance, 47, pp. 29–40.

Lewis K.K. (1999). Trying to Explain Home Bias in Equities and Consumption. Journal of Economic Literature, 37: 2, pp. 571-608.

Madhavan A., 2000. Market microstructure: A survey. Journal of Financial Markets, 3, 205-258.

Manna M. (2004). Developing statistical indicators of the integration of the euro area banking system. ECB working paper, no. 300.

Manna M, F.M. Signoretti and P. Tommasino (2016). Large-country bias and the limits on sovereign concentration risk. Bank of Italy, Notes on Financial Stability and Supervision, no. 5.

Merler S. and J. Pisani-Ferry (2012). Who's afraid of sovereign bonds. Bruegel Policy Contribution, no. 2.

Neely, C. J. (2010). The Large-Scale Asset Purchases Had Large International Effects. Federal Reserve Bank of St. Louis Working Paper No. 2010-018D.

Pagano, M. (1989). Trading volume and asset liquidity. The Quarterly Journal of Economics, 1989, vol.104, issue 2.

Park C.-Y. and R.V. Mercado (2014). Equity Home Bias, Financial Integration, and Regulatory Reforms: Implications for Emerging Asia. ADB Working paper Series on Regional Economic Integration, no. 133.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and Statistics 61 (0), 653–70.

Pesaran, M. (2004). General diagnostic tests for cross section dependence in panels. Cambridge Working Papers in Economics 435, and CESifo Working Paper Series 1229.

Pesaran, M. (2006). Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure. Econometrica, Econometric Society, vol. 74(4), pages 967-1012, 07.

Pesaran, M. (2007). A simple panel unit root test in the presence of cross-section dependence, Journal of Applied Econometrics, 22, 265–312.

Pesaran, M., Shin, Y. C. and Smith, R. (1999). Pooled mean group estimation of dynamic heterogeneous panels, Journal of the American Statistical Association, 94, 621–34.

Pesaran, M. and E. Tosetti (2011). Large panels with common factors and spatial correlation. Journal of Econometrics 161 (2), 182ñ202.

Trebbi F. and K. Xiao (2015). Regulation and Market Liquidity. NBER Working Paper No. w21739.

US Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, US Securities and Exchange Commission, US Commodity Futures Trading Commission (2015). The U.S. Treasury market on October15, 2014. Available at https://www.treasury.gov/press-center/press-releases/ Documents/ Joint_Staff_Report_Treasury_10-15-2015.pdf.

Vanpée R. and L. De Moor (2012). Bond and Equity Home Bias and Foreign Bias: an International Study. Katholieke Universiteit Leuven, AFI_1269.

Vayanos, D. and J.-L. Vila (2009). A preferred-habitat model of the term structure of interest rates. National Bureau of Economic Research, Inc NBER Working Papers 15487.

Warnock, F.E., and V.C. Warnock (2009). International capital flows and U.S. interest rates. Journal of International Money and Finance, Vol. 28, pp. 903–19.

Weymuller C.-H. (2013). Banks as Safety Multipliers: a Theory of Safe Assets Creation. Working Paper, Harvard University, 2013.

Annex

A.1. The data

The backbone of our inputs is formed by quarterly stock data, 2004Q1 through 2016Q2 for a total of 50 quarters, on holdings by six categories of investors, from IMF (Arslanalp and Tsuda, 2012). Data are from 21 countries, of which 11 belong to the euro area, 5 are European countries outside the area and other 5 are non-European countries; the full list is in footnote 5. In order to derive measures of home and foreign bias we use also data from ECB and BIS. All in all, our main dataset counts 5.796 data points, which is the product of 21 (countries) times 6 (sectors) times 46 (quarters).

Again in the econometrics, data on holdings are ratios between the stock of holdings and the current GDP of the country issuing the bonds. Due to data limitations, in the econometric analysis we are forced to restrict the analyses to a subset of 16 countries.[37]

Bloomberg is the source of series on interest rates and long-term inflation expectation. Expectation on real GDP growth and short term inflation rate are from Consensus Forecast.

The long-term interest rate refers to a series representing yield-to-maturity of the 10-year government bond benchmark while the short-term interest rates are the 3- and 12-month interest rates; expectations on 10-year inflation rate are mainly derived from market inflation swap data. However market data without gaps for expectations on long-term inflation are obtained only for a subset of 12 countries out of the 16 we are interested in. Following Grande et al. (2014), we specify a regression model able to explain the expectations on 10-year inflation rate for these 12 countries. Then, through the regression coefficients, we obtain a theoretical inflation expectation variable for all the countries of the sample. We estimate a fixed-effect panel regression model. The model specifications we estimate are shown in Table A.5. We choice the model with the 1-year forecasted inflation and 1-year expected values of GDP growth (both obtained from Consensus Forecast) as regressors as our preferred specification (equation (4) in Table A.5).

As a measure of a country's creditworthiness, for European countries, fiscal variables as the general government primary deficit and the public debt are taken from the Eurostat quarterly database. For United States, data are from Congressional Budget Office (CBO). Other macroeconomic variables (GDP growth, GDP potential growth, inflation rate) are from Thomson Reuters Datastream, Bloomberg and IMF World Economic Outlook. Given that the literature considers also the international risk aversion (Attinasi et al., 2010 among others), we consider the inclusion of a variable capturing this phenomenon, measured by the VIX, the Chicago Board Options Exchange Market Volatility Index, a measure of the implied volatility of the S&P 500 stock index.[38]

---

[37] Data are from 16 countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom and USA; of which 8 belong to the euro area, 5 are European countries outside the area and other 3 are non-European countries. Comparing to the other analyses in the paper, the econometric analysis has not run for Australia, Greece, Ireland, Korea and Portugal. In particular, Australia and Korea are excluded for lack of data about Consensus Forecast expectations either on short term inflation rate and on gross domestic product. As already mentioned in section 6.2, market data for expectations on 10-year inflation are not available for Greece, Ireland and Portugal; for these countries, data issues arise also in the interest rate series.

[38] The VIX, the Chicago Board Options Exchange Market Volatility Index, is considered a good indicator of the level of risk aversion in global capital markets.

We add further data from the Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012); this adds an important degree of freedom as it allows us to single out the holdings of insurance companies and pension and mutual funds from the sector 'domestic non-banks'.[39] These additional data are available for only nine countries of our initial 16 econometric sample.[40] This narrows the coverage of the sample and it is used only as a robustness check in the econometric analyses.

A.2 The home bias: a numerical example

Consider a two-country world, where banks from A hold 49 units of domestic government bonds (A-issued) and 21 units of foreign (B-issued) bonds while banks from B hold 18 bonds of domestic government bonds and 42 units of foreign (A-issued) ones. Finally, to keep matters simple, let us assume that the size of the balance sheets is the same in the two banking systems, say 200. One might be tempted to state that A banks feature a higher home bias than B banks based on either of the following three statements: (i) A banks hold more units of domestic government bonds than B banks (49 vs 18); (ii) the weight of domestic bonds in the total portfolio is higher for A than for B banks (70% = 49/70 vs. 30% = 18 / 60); (iii) the weight of domestic bonds out of total assets is higher for A than for B banks (24.5%=49/200 vs. 9%=18/200). In fact all three statements fail to seize the fact that in this world all banks prefer bonds issued from government of country A to those issued by government B, in the proportion of 91 (=49+42) vs. 39 (=21+18). Perhaps, A bonds are traded in a highly liquid wholesale market while B bonds are designed to appeal to buy-and-hold households. From this point of view, there is no 'bias' if A banks – just as any bank in this world – picks relatively more A bonds (we picked the numbers of this example so as to obtain exactly the same result for the Home Bias Index we put forward). Last but not least, the weight of the neutral portfolio change are specific to each banking system.

A.3 The home and foreign bias indices: the algebra

In the following we denote with V(i,j) the holdings by banks resident in country "i" of bonds issued the government of country j.[41] Besides "i", our reference country, the legend of geographical locations include: W, world; RWi, rest of the world, that is the world except "i" (to stress the fact that this concept is variable with "i" we adopt the slightly longer notation "RWi" in lieu of the invariant "RW"); A, euro area; RAi, rest of the area outside "i".

A superscript denotes the source of the series: e.g. $V(i,i)^{IMF}$ is the volume of domestic holdings by banks in "i" based on the IMF dataset (see Annex A.1). The absence of a superscript means that the series is derived from our algebra. Finally, a superscript "*" signals that the volume is derived under the assumption of equal distribution of cross-border positions.

---

[39] If data about insurance companies and pension funds were not available, private financial institutions holdings refer to the sum of the holdings of other financial intermediaries and financial auxiliaries, and insurance companies and pension funds unless these institutions belong to the public sector.

[40] Belgium, France, Germany, Italy, Japan, Netherlands, Spain, UK and USA. Japan's data are obtained at Bank of Japan's website to the link:
http://www.stat-search.boj.or.jp/ssi/cgi-bin/famecgi2?cgi=$nme_a000_en&lstSelection=FF

[41] For the sake of simplicity we omit to specify the time index but the reader should bear in mind that the holdings are referred each to a specific end-quarter.

The baseline algebra of the two indices is:

(A.1) $V(i, W) = V(i, i)^{IMF} + V(i, RWi)^{BIS}$

(A.2) $V(W, i) = V(i, i)^{IMF} + V(RWi, i)^{IMF}$

(A.3) $V(RWi, W) = V(W, W) + V(i, W)$

(A.4) $V(W, W) = \max [\sum i\, V(i, W); \sum i\, V(W, i)]$

where "$\sum$i" means the summation over all i's (that is over the 21 countries of the sample)

(A.5) $V(RWi, RWi) = V(RWi, W) - V(RWi, i)^{IMF}$

(A.6) $V(W, RWi) = V(i, W) + V(RWi, W)$

(A.7) $HBI\_i = \{V(i, i)^{IMF} - [V(i, W) \times V(W, i)] / V(W, W)\} / V(i, W)$

(A.8) $FBI\_i = \{V(RWi, i) - [V(RWi, W) \times V(W, RWi)] / V(W, W)\} / V(RWi, W)$

For euro area countries we adopt the following algebra

(A.9) $V(i, W) = V(i, i)^{IMF} + \max [V(i, RWi)^{BIS}, V(i, RAi)]$

(A.10) $V(i, RAi) = V(i, RAi)^{ECB} \times V(i, i)^{IMF} / V(i, i)^{ECB}$

(A.11) $V(W, i) = V(i, i)^{IMF} + \max [V(RWi, i)^{IMF}, V(RAi, i)]$

(A.12) $V(RWi, W) = V(W, W) - V(i,W)$

(A.13) $V(RWi, RWi) = V(RWi, W) - V(RWi, i)$

(A.14) $V(i, A) = V(i, i)^{IMF} + V(i, RAi)$

(A.15) $V(A, i) = V(i, i)^{IMF} + V(RAi, i)$

(A.16) $V(i,j)^* = V(i, W) \times V(W, j) / V(W, W)$

(A.17) $\delta i = \sum j \in A, j \neq i\, V(i,j)^* / \sum j \in W, j \neq i\, V(i,j)^*$

(A.18) $V(i, RAi)^* = \min [\delta i \times V(i, RWi)^{BIS}, V(i, RAi)]$

(A.19) $V(i, W)^* = V(i, W) - [V(i, RAi) - V(i,RAi)^*]$

(A.20) $HBI\_i = \{V(i, i)^{IMF} - [V(i, W)^* \times V(W, i)] / V(W, W)\} / V(i, W)^*\ i \in A$

(A.21) $FBI\_i = \{V(RWi, i) - [V(RWi, W) \times V(W, RWi)] / V(W, W)\} / V(RWi,W)$

A.4 First and second generations of panel unit root tests

As a preliminary step of the econometric analysis, we used both first and second generations of panel unit root tests.

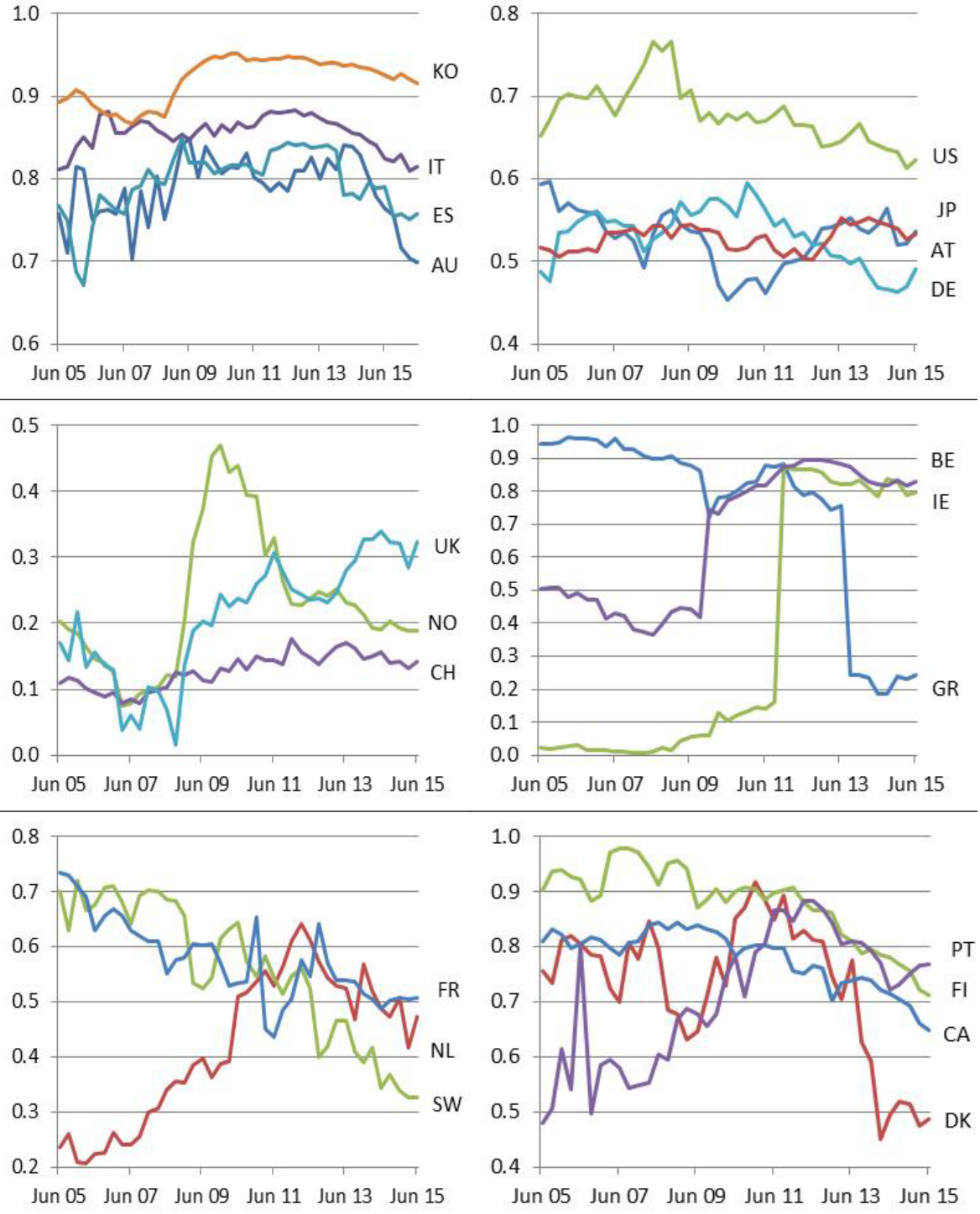
Two generations of panel unit root tests have been developed. One approach is based on the contributions, among others, by Levin et al. (2002) and Im, Pesaran and Shin (2003). While in both these works the null is that the series contains a unit root, Levin et al. (2002) assume that all panels have the same autoregressive parameter, Im, Pesaran and Shin (2003) allow each panel to have its own autoregressive parameter. A second generation of panel unit root tests allows for different forms of cross-sectional dependence, modelled using cross-sectional means of the levels and differences of the variables. Among the second generation of panel unit root tests, we used the Pesaran

(2007) test. In a first-step "cross-sectionally augmented Dickey-Fuller-Test" (CADF), the common factor is approximated by the lagged period-specific cross-section mean.

As stressed by Banerjee et al. (2005) and Afonso and Rault (2015), panel unit root tests of the first generation can lead to spurious results (because of size distortions) if there exists significant error cross-section dependence and this is ignored. A number of works prove that such dependence can be found in the data, particularly in a competitive market or a common currency area (Canova et al., 2007, Pesaran, 2007, Canova and Ciccarelli, 2009, Claessens et al., 2013). Consequently, the use of second-generation panel unit root tests is desirable when it has been established that the panel is subject to a significant degree of error cross-section dependence. One way of testing for the presence of cross-section dependence in the data is to carry out the test of Pesaran (2004) and to compute the Cross-section Dependence (CD) statistic. The test of Pesaran is based on a simple average of all pair-wise correlation coefficients of the OLS residuals obtained from standard augmented Dickey–Fuller regressions for each individual in the panel.

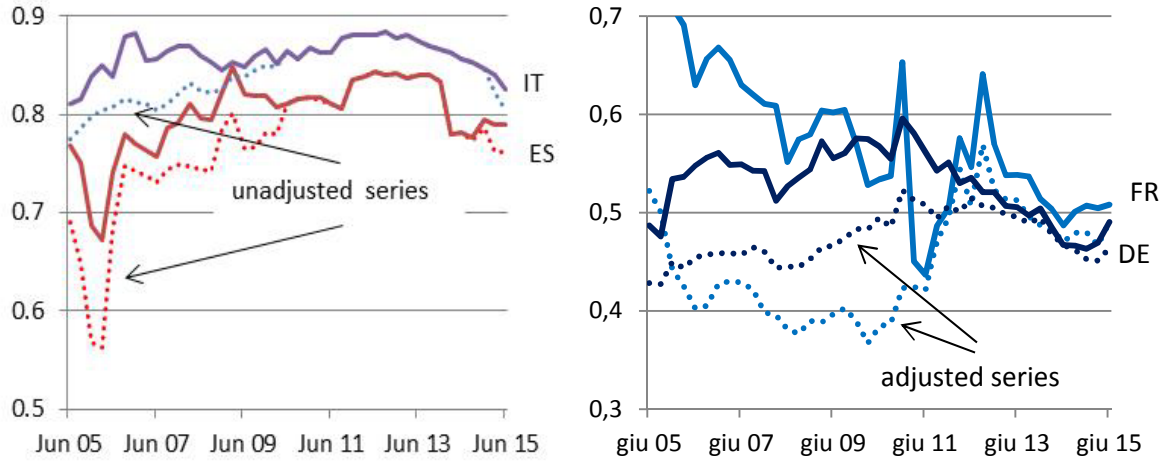
Additional tables and charts

Chart A1: Home bias index: country results



(1) Charts show country results for equation (1).

Chart A2: Home bias index: adjustment for euro area countries (1)



(1) Solid lines: quarterly time series of home bias index adjusted for partial currency risk; dotted lines: corresponding unadjusted series. See Annex A.2 for details.

Table A.1 Weights of holdings, by sector (1)

	2004	2006	2008	2010	2012	2014	2016
	median						
Foreign official sector	5.1%	8.2%	12.3%	16.9%	18.3%	18.5%	18.5%
Foreign banks	12.3%	11.6%	9.8%	9.7%	6.1%	7.3%	7.3%
Foreign non-banks	18.4%	21.9%	18.1%	17.6%	15.2%	10.8%	10.5%
Domestic central bank	1.8%	1.0%	0.9%	1.5%	2.2%	2.2%	9.5%
Domestic banks	16.1%	16.9%	14.9%	16.0%	15.9%	14.7%	14.5%
Domestic non-banks	34.7%	29.7%	27.7%	28.2%	34.9%	32.5%	27.4%
	Trimmed average						
Foreign official sector	6.8%	9.8%	12.8%	16.6%	18.2%	18.5%	20.1%
Foreign banks	11.4%	11.7%	9.7%	9.3%	7.1%	7.6%	8.0%
Foreign non-banks	20.9%	21.0%	22.8%	20.1%	15.8%	16.3%	13.8%
Domestic central bank	3.0%	2.9%	2.2%	3.0%	4.0%	6.0%	11.1%
Domestic banks	15.7%	14.9%	15.2%	17.0%	17.3%	16.4%	15.4%
Domestic non-banks	39.8%	36.4%	34.0%	31.5%	34.9%	32.0%	28.9%

(1) Data based on a sample of 21 countries (see fn. 5), at year-end except for 2016, Q2. (2) Average of country weights, excluding highest and lowest 10% of observations.

Table A.2 **Panel unit root test**

Variable	Levin, Lin, Chu - test	p-value		Im, Pesaran, Shin - test	p-value		Pesaran - test	p-value	
3-m real rate interest rate	-0.224	0.412		1.121	0.869		-1.087	0.138	
10-y inflation rate expectation	2.116	0.983		2.140	0.984		-0.187	0.426	
10-y nominal interest rate	3.595	1.000		6.033	1.000		-0.250	0.401	
10-y nominal interest rate (real)	1.703	0.956		3.772	1.000		-1.135	0.128	
12-m nominal interest rate	0.714	0.762		1.912	9.972		-1.187	0.426	
12-m real interest rate	0.618	0.732		1.077	0.859		-2.023	0.219	
10-y nominal interest rate (mean)	4.314	1.000		6.157	1.000		-0.684	0.247	
Stand. deviation 10-y interest rate	-9.932	0.000	***	-10.080	0.000	***	-11.428	0.000	***
12-m inflation rate expectation	-3.783	0.000	***	-4.030	0.000	***	-1.290	0.198	
GDP expectation	-7.025	0.000	***	-6.929	0.000	***	0.047	0.519	
GDP real growth	-1.349	0.089	*	-4.648	0.000	***	-3.537	0.000	***
DEB / GDP	-0.755	0.225		1.333	0.909		0.147	0.558	
DEF / GDP	-1.658	0.049	**	-2.018	0.022	**	-0.111	0.456	
Foreign official sector's holding GDP	0.811	0.791		4.285	1.000		0.415	0.661	
Foreign banks' holdings GDP	-0.945	0.173		-1.145	0.126		1.953	0.975	
Foreign non banks' holdings GDP	-2.156	0.016	**	-1.601	0.055	*	0.536	0.704	
Domestic central banks' holdings GDP	17.901	1.000		7.407	1.000		4.730	1.000	
Domestic non banks' holdings GDP	-1.199	0.115		-0.255	0.399		0.387	0.651	
Domestic banks' holdings GDP	-1.265	0.105		-0.078	0.469		2.599	0.995	

Notes: *** , **, * means that we reject the null hypothesis of unit root at the 1%, 5%, 10% level

Table A.3: Panel unit root test, First Difference

Variable	Levin, Lin, Chu - test	p-value		Im, Pesaran, Shin - test	p-value		Pesaran - test	p-value	
Δ 3-m interest rate	-16.766	0.000	***	-16.005	0.000	***	-5.281	0.000	***
Δ 10-y inflation rate expectation	-14.404	0.000	***	-23.241	0.000	***	-5.180	0.000	***
Δ 10-y nom interest rate	-18.663	0.000	***	-21.967	0.000	***	-5.970	0.000	***
Δ 10-y real interest rate	-19.522	0.000	***	-21.209	0.000	***	-6.670	0.000	***
Δ 12-m nom interest rate	-21.171	0.000	***	-18.503	0.000	***	-6.518	0.000	***
Δ 12-m real interest rate	-17.063	0.000	***	-22.319	0.000	***	-9.053	0.000	***
Δ 10-y nominal interest rate (mean)	-24.604	0.000	***	-18.118	0.000	***	-5.717	0.000	***
Δ Standard deviation 10-y interest rate	-17.182	0.000	***	-21.455	0.000	***	-10.472	0.000	***
Δ 12-m inflation rate expectation	-16.983	0.000	***	-17.877	0.000	***	-7.435	0.000	***
Δ GDP expectation	-14.872	0.000	***	-14.560	0.000	***	-5.983	0.000	***
Δ GDP real growth	-16.112	0.000	***	-7.209	0.000	***	-11.476	0.000	***
Δ DEB / GDP	-8.911	0.000	***	-9.689	0.000	***	-4.137	0.000	***
Δ DEF / GDP	-4.239	0.000	***	-6.659	0.000	***	-9.667	0.000	***
Δ Foreign Official Sector's Holdings GDP	-13.343	0.000	***	-14.226	0.000	***	-4.519	0.000	***
Δ Foreign Banks' Holdings GDP	-23.230	0.000	***	-20.785	0.000	***	-6.349	0.000	***
Δ Foreign Non Banks' Holdings GDP	-19.626	0.000	***	-16.382	0.000	***	-4.888	0.000	***
Δ Domestic Central Banks' holdings GDP	44.890	1.000		1.009	0.844		4.895	1.000	
Δ Domestic Non Banks' Holdings GDP	-17.079	0.000	***	-16.691	0.000	***	-5.685	0.000	***
Δ Domestic Banks' Holdings GDP	-12.931	0.000	***	-16.729	0.000	***	-4.935	0.000	***

Notes: *** , **, * means that we reject the null hypothesis of unit root at the 1%, 5%, 10% level

Table A.4: Cross section Dependence Test

Variable	CD-test	p-value	corr	abs(corr)
3-m nominal interest rate	67.48	0.000	0.871	0.871
10-y inflation rate expectation	36.94	0.000	0.477	0.521
10-y nominal interest rate	64.46	0.000	0.832	0.832
10-y real interest rate	52.18	0.000	0.674	0.712
12-m nominal interest rate	67.25	0.000	0.868	0.868
12-m real interest rate	51.85	0.000	0.669	0.669
10-y nominal interest rate (mean)	63.83	0.000	0.824	0.824
Standard deviation 10-y interest rate	36.07	0.000	0.466	0.505
12-m inflation rate expectation	36.55	0.000	0.472	0.501
GDP expectation	61.26	0.000	0.791	0.791
GDP real growth	57.98	0.000	0.748	0.748
DEB / GDP	32.05	0.000	0.414	0.718
DEF / GDP	39.81	0.000	0.514	0.543
Foreign Official Sector's Holdings GDP	64.20	0.000	0.829	0.829
Foreign Banks' Holdings GDP	6.11	0.000	0.079	0.446
Foreign Non Banks' Holdings GDP	-1.70	0.089	-0.022	0.389
Domestic Central Banks' Holdings GDP	34.51	0.000	0.445	0.624
Domestic Non Banks' Holdings GDP	19.01	0.000	0.245	0.432
Domestic Banks' Holdings GDP	17.90	0.000	0.231	0.454

Notes: Under the null hypothesis of cross section independence

Table A.5 10-Year Inflation Forecasts Estimation - Dependent variable: 10-year Inflation rate expectation

	(1)	(2)	(3)	(4)
Inflation (Consensus Forecast)	0.463***			0.444***
	(0.0209)			(0.0215)
Current Inflation		0.1806***	0.1791***	
		(0.01346)	(0.01281)	
GDP (Consensus Forecast)			0.109***	0.0420***
			(0.0138)	(0.0126)
Constant	1.209***	1.714***	1.539***	1.174***
	(0.0382)	(0.0267)	(0.0337)	(0.0393)
Observations	600	600	600	600
R-squared	0.457	0.235	0.308	0.467
Number of Countries	12	12	12	12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

RECENTLY PUBLISHED "TEMI" (*)

N. 1142 – *Monetary policy in times of debt*, by Mario Pietrunti and Federico M. Signoretti (October 2017).

N. 1143 – *Capital misallocation and financial development: a sector-level analysis*, by Daniela Marconi and Christian Upper (October 2017).

N. 1144 – *Leaving your mamma: why so late in Italy?*, by Enrica Di Stefano (October 2017).

N. 1145 – *A Financial Conditions Index for the CEE economies*, by Simone Auer (October 2017).

N. 1146 – *Internal capital markets in times of crisis: the benefit of group affiliation in Italy*, by Raffaele Santioni, Fabio Schiantarelli and Philip E. Strahan (October 2017).

N. 1147 – *Consistent inference in fixed-effects stochastic frontier models*, by Federico Belotti and Giuseppe Ilardi (October 2017).

N. 1148 – *Investment decisions by European firms and financing constraints*, by Andrea Mercatanti, Taneli Mäkinen and Andrea Silvestrini (October 2017).

N. 1149 – *Looking behind the financial cycle: the neglected role of demographics*, by Alessandro Ferrari (December 2017).

N. 1150 – *Public investment and monetary policy stance in the euro area*, by Lorenzo Burlon, Alberto Locarno, Alessandro Notarpietro and Massimiliano Pisani (December 2017).

N. 1151 – *Fiscal policy uncertainty and the business cycle: time series evidence from Italy*, by Alessio Anzuini, Luca Rossi and Pietro Tommasino (December 2017).

N. 1152 – *International financial flows and the risk-taking channel*, by Pietro Cova and Filippo Natoli (December 2017).

N. 1153 – *Systemic risk and systemic importance measures during the crisis*, by Sergio Masciantonio and Andrea Zaghini (December 2017).

N. 1154 – *Capital controls, macroprudential measures and monetary policy interactions in an emerging economy*, by Valerio Nispi Landi (December 2017).

N. 1155 – *Optimal monetary policy and fiscal policy interaction in a non-Ricardian economy*, by Massimiliano Rigon and Francesco Zanetti (December 2017).

N. 1156 – *Secular stagnation, R&D, public investment and monetary policy: a global-model perspective*, by Pietro Cova, Patrizio Pagano, Alessandro Notarpietro and Massimiliano Pisani (December 2017).

N. 1157 – *The CSPP at work: yield heterogeneity and the portfolio rebalancing channel*, by Andrea Zaghini (December 2017).

N. 1158 – *Targeting policy-compliers with machine learning: an application to a tax rebate programme in Italy*, by Monica Andini, Emanuele Ciani, Guido de Blasio, Alessio D'Ignazio and Viola Salvestrini (December 2017).

N. 1159 – *Banks' maturity transformation: risk, reward, and policy*, by Pierluigi Bologna (December 2017).

N. 1160 – *Pairwise trading in the money market during the European sovereign debt crisis*, by Edoardo Rainone (December 2017).

N. 1161 – *Please in my back yard: the private and public benefitsof a new tram line in Florence*, by Valeriia Budiakivska and Luca Casolaro (January 2018).

N. 1162 – *Real exchange rate misalignments in the euro area*, by by Michael Fidora, Claire Giordano and Martin Schmitz (January 2018).

N. 1163 – *What will Brexit mean for the British and euro-area economies? A model-based assessment of trade regimes*, by Massimiliano Pisani and Filippo Vergara Caffarelli (January 2018).

N. 1164 – *Are lenders using risk-based pricing in the consumer loan market? The effects of the 2008 crisis*, by Silvia Magri (January 2018).

N. 1165 – *Listening to the buzz: social media sentiment and retail depositors' trusts*, by Matteo Accornero and Mirko Moscatelli (February 2018).

(*) Requests for copies should be sent to:
Banca d'Italia – Servizio Studi di struttura economica e finanziaria – Divisione Biblioteca e Archivio storico – Via Nazionale, 91 – 00184 Rome – (fax 0039 06 47922059). They are available on the Internet www.bancaditalia.it.

2016

ALBANESE G., G. DE BLASIO and P. SESTITO, *My parents taught me. evidence on the family transmission of values,* Journal of Population Economics, v. 29, 2, pp. 571-592, **TD No. 955 (March 2014).**

ANDINI M. and G. DE BLASIO, *Local development that money cannot buy: Italy's Contratti di Programma,* Journal of Economic Geography, v. 16, 2, pp. 365-393, **TD No. 915 (June 2013).**

BARONE G. and S. MOCETTI, *Inequality and trust: new evidence from panel data,* Economic Inquiry, v. 54, pp. 794-809, **TD No. 973 (October 2014).**

BELTRATTI A., B. BORTOLOTTI and M. CACCAVAIO, *Stock market efficiency in China: evidence from the split-share reform,* Quarterly Review of Economics and Finance, v. 60, pp. 125-137, **TD No. 969 (October 2014).**

BOLATTO S. and M. SBRACIA, *Deconstructing the gains from trade: selection of industries vs reallocation of workers,* Review of International Economics, v. 24, 2, pp. 344-363, **TD No. 1037 (November 2015).**

BOLTON P., X. FREIXAS, L. GAMBACORTA and P. E. MISTRULLI, *Relationship and transaction lending in a crisis*, Review of Financial Studies, v. 29, 10, pp. 2643-2676, **TD No. 917 (July 2013).**

BONACCORSI DI PATTI E. and E. SETTE, *Did the securitization market freeze affect bank lending during the financial crisis? Evidence from a credit register,* Journal of Financial Intermediation , v. 25, 1, pp. 54-76, **TD No. 848 (February 2012).**

BORIN A. and M. MANCINI, *Foreign direct investment and firm performance: an empirical analysis of Italian firms,* Review of World Economics, v. 152, 4, pp. 705-732, **TD No. 1011 (June 2015).**

BRAGOLI D., M. RIGON and F. ZANETTI, *Optimal inflation weights in the euro area,* International Journal of Central Banking, v. 12, 2, pp. 357-383, **TD No. 1045 (January 2016).**

BRANDOLINI A. and E. VIVIANO, *Behind and beyond the (headcount) employment rate,* Journal of the Royal Statistical Society: Series A, v. 179, 3, pp. 657-681, **TD No. 965 (July 2015).**

BRIPI F., *The role of regulation on entry: evidence from the Italian provinces,* World Bank Economic Review, v. 30, 2, pp. 383-411, **TD No. 932 (September 2013).**

BRONZINI R. and P. PISELLI, *The impact of R&D subsidies on firm innovation,* Research Policy, v. 45, 2, pp. 442-457, **TD No. 960 (April 2014).**

BURLON L. and M. VILALTA-BUFI, *A new look at technical progress and early retirement,* IZA Journal of Labor Policy, v. 5, **TD No. 963 (June 2014).**

BUSETTI F. and M. CAIVANO, *The trend–cycle decomposition of output and the Phillips Curve: bayesian estimates for Italy and the Euro Area,* Empirical Economics, V. 50, 4, pp. 1565-1587, **TD No. 941 (November 2013).**

CAIVANO M. and A. HARVEY, *Time-series models with an EGB2 conditional distribution,* Journal of Time Series Analysis, v. 35, 6, pp. 558-571, **TD No. 947 (January 2014).**

CALZA A. and A. ZAGHINI, *Shoe-leather costs in the euro area and the foreign demand for euro banknotes,* International Journal of Central Banking, v. 12, 1, pp. 231-246, **TD No. 1039 (December 2015).**

CESARONI T. and R. DE SANTIS, *Current account "core-periphery dualism" in the EMU,* The World Economy, v. 39, 10, pp. 1514-1538, **TD No. 996 (December 2014).**

CIANI E., *Retirement, Pension eligibility and home production,* Labour Economics, v. 38, pp. 106-120, **TD No. 1056 (March 2016).**

CIARLONE A. and V. MICELI, *Escaping financial crises? Macro evidence from sovereign wealth funds' investment behaviour,* Emerging Markets Review, v. 27, 2, pp. 169-196, **TD No. 972 (October 2014).**

CORNELI F. and E. TARANTINO, *Sovereign debt and reserves with liquidity and productivity crises,* Journal of International Money and Finance, v. 65, pp. 166-194, **TD No. 1012 (June 2015).**

D'AURIZIO L. and D. DEPALO, *An evaluation of the policies on repayment of government's trade debt in Italy,* Italian Economic Journal, v. 2, 2, pp. 167-196, **TD No. 1061 (April 2016).**

DE BLASIO G., G. MAGIO and C. MENON, *Down and out in Italian towns: measuring the impact of economic downturns on crime,* Economics Letters, 146, pp. 99-102, **TD No. 925 (July 2013).**

DOTTORI D. and M. MANNA, *Strategy and tactics in public debt management,* Journal of Policy Modeling, v. 38, 1, pp. 1-25, **TD No. 1005 (March 2015).**

LIBERATI D., M. MARINUCCI and G. M. TANZI, *Science and technology parks in Italy: main features and analysis of their effects on hosted firms*, Journal of Technology Transfer, v. 41, 4, pp. 694-729, **TD No. 983 (November 2014).**

MARCELLINO M., M. PORQUEDDU and F. VENDITTI, *Short-Term GDP forecasting with a mixed frequency dynamic factor model with stochastic volatility,* Journal of Business & Economic Statistics , v. 34, 1, pp. 118-127, **TD No. 896 (January 2013).**

RODANO G., N. SERRANO-VELARDE and E. TARANTINO, *Bankruptcy law and bank financing,* Journal of Financial Economics, v. 120, 2, pp. 363-382, **TD No. 1013 (June 2015).**

ZINNA G., *Price pressures on UK real rates: an empirical investigation,* Review of Finance,v. 20, 4, pp. 1587-1630, **TD No. 968 (July 2014).**

2017

ADAMOPOULOU A. and G.M. TANZI, *Academic dropout and the great recession,* Journal of Human Capital, V. 11, 1, pp. 35–71, **TD No. 970 (October 2014).**

ALBERTAZZI U., M. BOTTERO and G. SENE, *Information externalities in the credit market and the spell of credit rationing,* Journal of Financial Intermediation, v. 30, pp. 61–70, **TD No. 980 (November 2014).**

ALESSANDRI P. and H. MUMTAZ, *Financial indicators and density forecasts for US output and inflation,* Review of Economic Dynamics, v. 24, pp. 66-78, **TD No. 977 (November 2014).**

BARBIERI G., C. ROSSETTI and P. SESTITO, *Teacher motivation and student learning,* Politica economica/Journal of Economic Policy, v. 33, 1, pp.59-72, **TD No. 761 (June 2010).**

BENTIVOGLI C. and M. LITTERIO, *Foreign ownership and performance: evidence from a panel of Italian firms,* International Journal of the Economics of Business, v. 24, 3, pp. 251-273, **TD No. 1085 (October 2016).**

BRONZINI R. and A. D'IGNAZIO, *Bank internationalisation and firm exports: evidence from matched firm-bank data,* Review of International Economics, v. 25, 3, pp. 476-499 **TD No. 1055 (March 2016).**

BRUCHE M. and A. SEGURA, *Debt maturity and the liquidity of secondary debt markets,* Journal of Financial Economics, v. 124, 3, pp. 599-613, **TD No. 1049 (January 2016).**

BURLON L., *Public expenditure distribution, voting, and growth,* Journal of Public Economic Theory,, v. 19, 4, pp. 789–810, **TD No. 961 (April 2014).**

BURLON L., A. GERALI, A. NOTARPIETRO and M. PISANI, *Macroeconomic effectiveness of non-standard monetary policy and early exit. a model-based evaluation,* International Finance, v. 20, 2, pp.155-173, **TD No. 1074 (July 2016).**

BUSETTI F., *Quantile aggregation of density forecasts,* Oxford Bulletin of Economics and Statistics, v. 79, 4, pp. 495-512, **TD No. 979 (November 2014).**

CESARONI T. and S. IEZZI, *The predictive content of business survey indicators: evidence from SIGE,* Journal of Business Cycle Research, v.13, 1, pp 75–104, **TD No. 1031 (October 2015).**

CONTI P., D. MARELLA and A. NERI, *Statistical matching and uncertainty analysis in combining household income and expenditure data,* Statistical Methods & Applications, v. 26, 3, pp 485–505, **TD No. 1018 (July 2015).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, v. 49, pp. 74-83, **TD No. 787 (January 2011).**

D'AMURI F. and J. MARCUCCI, *The predictive power of google searches in forecasting unemployment,* International Journal of Forecasting, v. 33, 4, pp. 801-816, **TD No. 891 (November 2012).**

DE BLASIO G. and S. POY, *The impact of local minimum wages on employment: evidence from Italy in the 1950s,* Journal of Regional Science, v. 57, 1, pp. 48-74, **TD No. 953 (March 2014).**

DEL GIOVANE P., A. NOBILI and F. M. SIGNORETTI, *Assessing the sources of credit supply tightening: was the sovereign debt crisis different from Lehman?,* International Journal of Central Banking, v. 13, 2, pp. 197-234, **TD No. 942 (November 2013).**

DEL PRETE S., M. PAGNINI, P. ROSSI and V. VACCA, *Lending organization and credit supply during the 2008–2009 crisis,* Economic Notes, v. 46, 2, pp. 207–236, **TD No. 1108 (April 2017).**

DELLE MONACHE D. and I. PETRELLA, *Adaptive models and heavy tails with an application to inflation forecasting,* International Journal of Forecasting, v. 33, 2, pp. 482-501, **TD No. 1052 (March 2016).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, v. 40, 10, pp. 2078-2096, **TD No. 877 (September 2012).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, v. 17, 6, pp. 1251-1282, **TD No. 898 (January 2013).**

LOBERTO M. and C. PERRICONE, *Does trend inflation make a difference?,* Economic Modelling, v. 61, pp. 351–375, **TD No. 1033 (October 2015).**

MANCINI A.L., C. MONFARDINI and S. PASQUA, *Is a good example the best sermon? Children's imitation of parental reading,* Review of Economics of the Household, v. 15, 3, pp 965–993, **D No. 958 (April 2014).**

MEEKS R., B. NELSON and P. ALESSANDRI, *Shadow banks and macroeconomic instability,* Journal of Money, Credit and Banking, v. 49, 7, pp. 1483–1516, **TD No. 939 (November 2013).**

MICUCCI G. and P. ROSSI, *Debt restructuring and the role of banks' organizational structure and lending technologies,* Journal of Financial Services Research, v. 51, 3, pp 339–361, **TD No. 763 (June 2010).**

MOCETTI S., M. PAGNINI and E. SETTE, *Information technology and banking organization,* Journal of Journal of Financial Services Research, v. 51, pp. 313-338, **TD No. 752 (March 2010).**

MOCETTI S. and E. VIVIANO, *Looking behind mortgage delinquencies,* Journal of Banking & Finance, v. 75, pp. 53-63, **TD No. 999 (January 2015).**

NOBILI A. and F. ZOLLINO, *A structural model for the housing and credit market in Italy,* Journal of Housing Economics, v. 36, pp. 73-87, **TD No. 887 (October 2012).**

PALAZZO F., *Search costs and the severity of adverse selection,* Research in Economics, v. 71, 1, pp. 171-197, **TD No. 1073 (July 2016).**

PATACCHINI E. and E. RAINONE, *Social ties and the demand for financial services,* Journal of Financial Services Research, v. 52, 1–2, pp 35–88, **TD No. 1115 (June 2017).**

PATACCHINI E., E. RAINONE and Y. ZENOU, *Heterogeneous peer effects in education,* Journal of Economic Behavior & Organization, v. 134, pp. 190–227, **TD No. 1048 (January 2016).**

SBRANA G., A. SILVESTRINI and F. VENDITTI, *Short-term inflation forecasting: the M.E.T.A. approach,* International Journal of Forecasting, v. 33, 4, pp. 1065-1081, **TD No. 1016 (June 2015).**

SEGURA A. and J. SUAREZ, *How excessive is banks' maturity transformation?,* Review of Financial Studies, v. 30, 10, pp. 3538–3580, **TD No. 1065 (April 2016).**

VACCA V., *An unexpected crisis? Looking at pricing effectiveness of heterogeneous banks,* Economic Notes, v. 46, 2, pp. 171–206, **TD No. 814 (July 2011).**

VERGARA CAFFARELI F., *One-way flow networks with decreasing returns to linking,* Dynamic Games and Applications, v. 7, 2, pp. 323-345, **TD No. 734 (November 2009).**

ZAGHINI A., *A Tale of fragmentation: corporate funding in the euro-area bond market,* International Review of Financial Analysis, v. 49, pp. 59-68, **TD No. 1104 (February 2017).**

2018

BELOTTI F. and G. ILARDI *Consistent inference in fixed-effects stochastic frontier models,* Journal of Econometrics, v. 202, 2, pp. 161-177, **TD No. 1147 (October 2017).**

CARTA F. and M. DE PHLIPPIS, *You've Come a long way, baby. husbands' commuting time and family labour supply,* Regional Science and Urban Economics, v. 69, pp. 25-37, **TD No. 1003 (March 2015).**

CARTA F. and L. RIZZICA, *Early kindergarten, maternal labor supply and children's outcomes: evidence from Italy,* Journal of Public Economics, v. 158, pp. 79-102, **TD No. 1030 (October 2015).**

CECCHETTI S., F. NATOLI and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, v. 14, 1, pp. 35-71, **TD No. 1025 (July 2015).**

NUCCI F. and M. RIGGI, *Labor force participation, wage rigidities, and inflation,* Journal of Macroeconomics, v. 55, 3 pp. 274-292, **TD No. 1054 (March 2016).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, v. 22, 2, pp. 661-697, **TD No. 1100 (February 2017).**

FORTHCOMING

ADAMOPOULOU A. and E. KAYA, *Young Adults living with their parents and the influence of peers,* Oxford Bulletin of Economics and Statistics, **TD No. 1038 (November 2015).**

ALBANESE G., G. DE BLASIO and P. SESTITO, *Trust, risk and time preferences: evidence from survey data,* International Review of Economics, **TD No. 911 (April 2013).**

BARONE G., G. DE BLASIO and S. MOCETTI, *The real effects of credit crunch in the great recession: evidence from Italian provinces,* Regional Science and Urban Economics, **TD No. 1057 (March 2016).**

BELOTTI F. and G. ILARDI, *Consistent inference in fixed-effects stochastic frontier models,* Journal of Econometrics, **TD No. 1147 (October 2017).**

BERTON F., S. MOCETTI, A. PRESBITERO and M. RICHIARDI, *Banks, firms, and jobs,* Review of Financial Studies, **TD No. 1097 (February 2017).**

BOFONDI M., L. CARPINELLI and E. SETTE, *Credit supply during a sovereign debt crisis,* Journal of the European Economic Association, **TD No. 909 (April 2013).**

BRILLI Y. and M. TONELLO, *Does increasing compulsory education reduce or displace adolescent crime? New evidence from administrative and victimization data,* CESifo Economic Studies, **TD No. 1008 (April 2015).**

CASIRAGHI M., E. GAIOTTI, L. RODANO and A. SECCHI, *A "Reverse Robin Hood"? The distributional implications of non-standard monetary policy for Italian households,* Journal of International Money and Finance, **TD No. 1077 (July 2016).**

CIPRIANI M., A. GUARINO, G. GUAZZAROTTI, F. TAGLIATI and S. FISHER, *Informational contagion in the laboratory,* Review of Finance, **TD No. 1063 (April 2016).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, **TD No. 787 (January 2011).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, **TD No. 877 (September 2012).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, **TD No. 898 (January 2013).**

NATOLI F. and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, **TD No. 1025 (July 2015).**

RIGGI M., *Capital destruction, jobless recoveries, and the discipline device role of unemployment,* Macroeconomic Dynamics, **TD No. 871 (July 2012).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, **TD No. 1100 (February 2017).**