Sovereign bond auctions in the euro area

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Chapter 5
Determinants of the bid-to-cover ratio in euro area public debt auctions

5.1 Introduction

The recent financial and sovereign debt crisis posed challenges to sovereign debt managers in the euro area. When government balances deteriorated, the funding needs of euro area governments rapidly increased. At the same time, markets became increasingly sensitive to the outcome of sovereign debt auctions, which was often regarded as a measure of market confidence and creditworthiness. Therefore, debt managers were under pressure to issue large amounts of government debt, while they also had a strong interest in preventing the occurrence of undersubscribed or 'failed' auctions.

An important indicator used to measure the success of an auction is the "bid-to-cover ratio", which is the total amount bid during an auction divided by the total amount of debt issued. This chapter studies the determinants of bid-to-cover ratios in euro area sovereign debt auctions. As the bid-to-cover ratio is the result of demand and supply, we focus on the determinants of the demand for and supply of newly-issued public debt. We consider in particular the level and volatility of secondary market yields, the demand for safe short-term debt, the budget surplus and the volume of redemptions of outstanding debt. We also study the persistence of bid-to-cover ratios and spill-over effects from foreign bid-to-cover ratios.

Using a sample of Belgian, French, German and Italian auctions for the period 1 January 1999 until 31 December 2017, we find that an

environment of high secondary market yields and low secondary market volatility is associated with more successful auctions. We also find some evidence of flight-to-safety effects during the crisis, in the form of more successful auctions for safe short-term debt, and we find positive spillovers from the success of foreign auctions to domestic auctions.

Our analysis is of interest to sovereign debt managers. Successful auctions result in lower funding costs for the government. An understanding of the factors that contribute to a positive auction outcome can therefore be relevant for debt managers, as it may allow them to issue lower volumes of sovereign debt when such factors point to a challenging funding environment and shift issuance towards periods with a more benign funding environment.

This chapter relates to the literature that studies the demand for sovereign debt. According to the mean-variance model, investors in international bonds wish to maximize their portfolio return for a given risk or to minimize risk for a given portfolio return. As such, demand for sovereign bonds depends on their yields and the volatility of returns relative to alternative assets. Vayanos and Vila (2009) develop a model of demand for bonds with preferred habitat investors. In their model investors' demand is a function of the bond's yield, while arbitrageurs have a mean-variance utility function. In this paper, we will relate the demand for sovereign debt to the level and volatility of secondary market yields, while controlling for the level and volatility of alternative assets.

This chapter relates to a second strand of literature that stresses the demand for safe and liquid sovereign debt. This special demand for sovereign debt is reflected in a safety premium which may for example follow from the money-like properties of short-term debt, such as its extreme safety and its use as collateral in many financial transactions. Krishnamurthy and Vissing-Jorgensen (2012) document time-varying

safety premia for US Treasuries. Kacperczyk *et al.* (2018) model demand and supply for US T-bills and commercial deposits as a function of the safety premium on both. They show that private production of short-term commercial deposits responds to the demand for safety.[54]

The chapter also relates to the literature that studies the relationship between the bid-to-cover ratio and secondary market yields.[55] Spindt and Stolz (1989) develop a theoretical model in which a higher number of bidders in a discriminatory auction is positively related to the bid-to-cover ratio and increases the stop-out price of the auction. In line with this model, Spindt and Stolz (1992) find that U.S. Treasury bill auctions with a higher bid-to-cover ratio result in lower underpricing relative to the secondary market. Goldreich (2007) finds a similar result for US sovereign bond auctions. Cammack (1991) concludes that secondary market prices are higher when the number of competitive bidders in the auction is higher than expected. Beetsma *et al.* (2018a) show that for euro area sovereign bond auctions, a higher bid-to-cover ratio leads to lower secondary market yields following the auctions, and that this effect is stronger when market volatility is higher.

More remotely, this chapter is related to the literature that explores the interplay between primary and secondary markets for sovereign bonds and finds evidence for auction cycles in secondary market yields around primary market issues of sovereign debt. This literature includes Fleming and Rosenberg (2007), Lou *et al.* (2013), Beetsma *et al.* (2016) and Beetsma *et al.* (2018b). Gorodnichenko and

[54] Greenwood *et al.* (2015) and Beetsma *et al.* (2018c) relate the safety premium on short-term debt to the maturity choice of debt managers in the US and the euro area, respectively.
[55] This chapter also connects to the literature on the underpricing of initial public offerings. Models with asymmetric information find that underpricing in auctions is higher if the dispersion of private signals increases (Ritter and Welch, 2002). Several papers (Bradley and Jordan (2002), Loughran and Ritter (2002) and Lowry and Schwert (2002)) find that positive market developments during the road show period are not fully incorporated in adjusted offer prices.

Ray (2018) use intraday data to test the effect of auctions on the term structure of interest rates.

This chapter is also related to the literature on spillovers in sovereign bond markets. Ang and Longstaff (2013) and Battistini, Pagano and Simonelli (2014) for example analyze common risk factors in the euro area, while Baele *et al.* (2013) show "flight-to-safety" effects towards countries with solid fundamentals in the euro area. Beetsma *et al.* (2018b) study the effect of foreign debt auction on auction cycles in the secondary market for domestic debt.

This chapter differs from the existing literature. To the best of our knowledge, this chapter is the first to relate the success of sovereign debt auctions, as measured by the bid-to-cover ratio, to the determinants of the demand for and supply of sovereign bonds. In addition, it is the first paper to relate the success of domestic debt auctions as measured by the bid-to-cover ratio to the success of foreign auctions.

The remainder of this chapter is structured as follows. The next section provides a description of the auctioning process. Section 3 describes the data and reports some key statistics. Section 4 contains the result of our empirical analysis. Finally, Section 5 concludes the paper.

5.2 Description of the auctioning process

Issuance and management of sovereign debt in the euro area is carried out by debt management offices. Prior to each calendar year, the debt management office publishes a debt issuance outlook which states the annual funding target and includes an auction calendar. The annual funding target is based on the forecast of the government cash deficit, the amount of T-bills and government bonds that have to be rolled over and the desired mutation in cash balances. On the basis of the funding target,

the debt management office decides on an auction calendar. The annual auction calendar contains a list of auction dates, thus proving information about the timing and frequency of auctions. The German calendar also provides the issuance volume and the maturity of new issues, which is not the case for France, Belgium and Italy. Updates of the calendar, which provide more detail, are published quarterly for Germany and Italy and monthly for France.

A few days before the auction, the debt management office announces the auction in a press statement with details about the bond to be issued and the target volume. After the auction announcement, end-investors will place their orders with primary dealers, because they cannot participate in the auction themselves. Participation in the auctions is limited to primary dealers, or in the case of Germany members of the "Bund Issues Auction Group". Primary dealers are financial institutions that are selected to submit bids in government bond auctions. To be selected they need to fulfill certain requirements, such as quoting obligations in the secondary market.

During the auction, primary dealers have a pre-announce time window to submit their bids, after which the debt manager decides on the allocation of the new issuance. The auction outcome is published in a press statement, which includes the amount issued and the bid-to-cover ratio.

Debt managers have the discretion to decide on the exact amount supplied after primary dealers have placed their bids. The German debt manager issues only a portion of the announced target volume to members of the "Bund Issues Auction Group". The remainder, on average 15% to 18% of target issuance, is retained (Beetsma *et al*, 2018a). In Belgium, France and Italy, the debt manager announces a target volume, which

allows for flexibility to determine the exact volume supplied during the auction.

In response the recent financial and sovereign debt crisis debt managers adjusted the volume and frequency of auctions, and increased the degree of flexibility they can exercise. Germany increased the frequency of sovereign bond auctions (Blommestein, 2009), France reopened more "off the run" bonds, issued higher amounts at each auction and introduced more flexibility by widening the announced target range for each auction (OECD, 2016), Belgium aimed to use a flexible approach to respond to changing market environments (OECD, 2016), Italy introduced flexibility in the amount issued by introducing the announcement of a target range instead of an exact target volume (Beetsma *et al.* (2018a).[56]

5.3 Data description and key statistics

We intend to study the success of sovereign debt auctions in the euro area. The success will be measured by the bid-to-cover ratio, which is the total amount of bids placed during an auction divided by the total amount of debt issued. As such, the bid-to-cover ratio measures auction demand over auction supply. We collect variables capturing demand and supply to explain the variation in bid-to-cover ratio for Germany, France, Belgium and Italy in the period from 1 January 1999 until 31 December 2017.

Data for the bid-to-cover ratio is collected from Bloomberg and from the websites of national debt management offices. We collect data for auctions of sovereign bonds with a maturity of 2, 5, 10 and 30 years. We exclude foreign currency debt and inflation-linked debt from our

[56] This change took place in October 2018. For 2-year zero coupon bonds (the co-called "CTZs") this change took place in December 2011

analysis. For Belgium we also exclude the 2-year maturity from the analysis because the number of 2- and 3-year auctions in Belgium is very low.

The bid-to-cover ratio is normally measured as the total amount bid over the amount that is actually allotted. However, as explained by Beetsma *et al.* (2017), the amount allotted is partly endogenous to the outcome of the auction, because some treasuries may adjust the volume supplied during the auction. Treasuries may choose to restrict supply if the bidding volume is lower than expected, as was discussed in the previous section. Such reductions in supply inflate the bid-to-cover ratio, which leads to a more positive bid-to-cover ratio in case of low demand. We correct for this endogeneity in the bid-to-cover ratio by calculating the bid-to-cover ratio as the ratio of the total amount bid over the target volume that treasuries announce prior to the auction.[57] Still, the target volume may respond to determinants of bond demand, if Treasuries for example choose to issue more frequently and in smaller portions in case of volatile secondary market yields. This could result in higher bid-to-cover ratios in volatile market environments, and cause an upward bias in the coefficients when the bid-to-cover ratio is regressed on volatility measures. In our empirical analysis, we will decompose the bid-to-cover ratio into its demand and supply components to test whether supply indeed responds to market conditions, and to correct the auction demand for such a possible bias.

Figure 5.1 shows the bid-to-cover ratios and the histograms of their frequency distributions for the countries in our sample. The value of the bid-to-cover ratio seems on average reasonably stable over time.

[57] The French and Belgian debt management offices announce a target range for the combined volume of all the issued maturities on the auction day. For these countries, we calculate the bid-to-cover ratio as the sum of the amounts bid for all maturities issued on the auction day over the upper bound of the target range.

Except in Italy and, to a lesser extent, in France, where the bid-to-cover ratio seems to decrease somewhat over the sample period. Table 5.1 reports summary statistics for the bid-to-cover ratio. The standard deviation of the bid-to-cover ratio ranges from 0.32 to 0.83, while the difference between the maximum and minimum values exceeds 4 in multiple cases. Table 5.2 shows descriptive statistics for demand and supply. We find that the standard deviation of auction demand in all cases exceeds the standard deviation of the amount supplied.

The literature discussed above suggests that demand for sovereign bonds depends on the yield level and the volatility of returns relative to other assets, as well as on the demand for safe government debt. We collect data for secondary market sovereign bond yields and corporate bond yields from Datastream. Sovereign bond yields are available for all countries and maturities (Figure 5.2). We use the Merill Lynch euro area corporate bond index for corporate bond yields (Figure 5.4). For sovereign and corporate bonds we construct a measure of market volatility, which is defined as the 20-day rolling standard deviation of daily yield changes (Figures 5.3 and 5.5). Following Krishnamurthy and Vissing-Jorgensen (2012) and Beetsma *et al.* (2018c), we calculate the safety premium on short-term debt as the difference between BBB- and AAA-rated corporate bond yields with a maturity between 1- and 3-year (Figure 5.6).

To be able to capture variations in the supply of sovereign bonds, we collect data on the annual funding target of the government. As discussed in the previous section, annual funding needs are based on the government cash deficit, the amount of T-bills and government bonds that have to be rolled over and the desired mutation in cash balances. Our focus is on the determinants of the bid-to-cover ratio for sovereign bond auctions, so we exclude T-bill issuance and the mutation of cash balances from our analysis. We use Datastream to collect data from the ECB on

monthly redemptions of sovereign bonds with an initial maturity of above 1 year. We calculate the total volume of redemptions per calendar year (Figure 5.7). We collect vintage data of the European Commission's forecast of the budget surplus in the fall of the preceding year from the FIRSTRUN-database. This forecast is in the information set of the debt management office when it prepares the debt issuance outlook for the consecutive year. The FIRSTRUN-database is available from 2005 onwards, so we collect data from the original documentation by the European Commission for years before 2005 (Figure 8).[58]

5.4 Estimation results

5.4.1 Baseline regressions

We expect that higher sovereign bond yields or lower sovereign bond volatility relative to other assets increases the demand for sovereign bonds. In addition, we expect that a special demand for short-term safe asses, which may in particular arise during crisis periods, generates increased demand for short-term sovereign bonds. Finally, we expect that the bond supply is higher in periods after a high volume of debt has come due and needs to be refinanced, and when the government surplus is lower, as government deficits have to be financed with increased debt issuance. In this section, we will test these hypotheses by regressing the bid-to-cover ratio on these determinants of bond supply and demand. In the consecutive sections, we will decompose the bid-to-cover ratio into its demand and supply components, and investigate the determinants of these individual components. We will in addition analyze cross-border spillover effects.

[58] We do not have vintage data on GDP for the years 1999-2005, so we use ex-post GDP values to express the budget surplus in euros.

To empirically investigate our hypotheses, we estimate the following baseline regression:

$$\begin{aligned} BC_{i,t}^{m} = {} & c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} \\ & + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} \\ & + \mu Surplus_{i,t-5} + \pi Redemption_{i,t-5} \\ & + \theta BC_{i,t-p}^{m} + \varepsilon_{i,t}^{m} \end{aligned} \tag{5.1}$$

Here, BC_t^m is the natural logarithm of the bid-to-cover ratio on auction day *t*, $Yield_{i,t}^m$ is the 1-month (i.e. 20 working days) moving average of secondary market country-*i* maturity-*m* sovereign bond yields, $VOL\_Yield_{i,t}^m$ is the rolling 20-day standard deviation of daily country-*i* maturity-*m* sovereign yield changes, $CYield_t^m$ is the 20-day moving average of maturity-*m* corporate bond yields and $VOL\_CYield_t^m$ is the rolling 20-day standard deviation of daily maturity-*m* corporate yield changes. ST_Safety_t is the short-term safety premium, measured as the 20-day moving average of the difference between the yield on BBB- and AAA-rated corporate bonds with a maturity of 1-3 year. $Surplus_{i,t}$ is the forecast of the budget surplus by the European Commission in the Autumn forecast of the preceding year in 100 billion euros, and $Redemption_{i,t}$ is the volume of long-term bond redemptions in 100 billion euros. $Surplus_{i,t}$ and $Redemption_{i,t}$ are variables at the annual frequency, so their values are constant for all auctions within a calendar year, and jump to a new value in a new calendar year.

We also include the previous bid-to-cover ratio (*p* trading days ago), $BC_{i,t-p}^m$, in the baseline equation. This allows for persistence in the bid-to-cover ratio, which may be due to persistent demand from institutional investors for certain maturities. A correlation between current

and previous bid-to-cover ratios may also arise if the outcome of the previous bid-to-cover ratio as measured by the bid-to-cover ratio serves as an anchor for demand by investors in subsequent auctions. If demand in the previous auction was very high relative to supply, it is possible that primary dealers want to be more aggressive in their bids in the current auction.

Equation (5.1) is estimated for a cross-section of auction days using Ordinary Least Squares, and as a panel with country fixed effects. In both cases, we use Newey-West standard errors. The results of the baseline regression are shown in Table 5.3. As expected, we find that when controlling for corporate bond yields, the bid-to-cover ratio is consistently positively related to sovereign bond yields and negatively related to the volatility of sovereign bond yields. A 1 percentage point increase in the secondary market yield is associated with a 5 to 8 basis points increase in the bid-to-cover ratio. For 10-year debt, the panel coefficient estimate equals 0.06 and the average standard deviation of the bid-to-cover ratio equals 0.45 (Table 5.1), so a 1 percentage point increase in yields is associated with a 0.13 (0.06/0.45) standard deviation increase in the bid-to-cover ratio. The panel coefficients on the volatility measure equals -0.01, so a 10 basis point increase in the volatility measure, which was common during the financial and sovereign debt crisis (Figure 5.3), is associated with a 0.22 (0.1/0.45) standard deviation decrease in the bid-to-cover ratio.

For Italy, the coefficient on the short-term safety premium is negative and significant for 5- and 10-year debt, while the 2-year coefficient for Germany is positive and significant. This suggests that an increase in the short-term safety premium causes a shift away from Italian long-term debt towards short-term debt, and a shift from Italy towards Germany. This pattern could be referred to as a ‘flight-to-safety’.

A higher budget surplus is associated with a higher bid-to-cover ratio. For auctions of bonds with a 5 year maturity in France and Italy, the coefficient on the budget surplus equals respectively 1.27 and 2.68. This implies that a 1 billion euro increase in the budget surplus is associated with a 1.27 and 2.68 basis point increase in the bid-to-cover ratio. This positive coefficient on the budget surplus likely reflects a denominator effect, as supply per auction is expected to be lower in years with a high budget surplus. A higher surplus can also result in higher demand due to lower fiscal risks. However, the inclusion of the level and volatility of secondary market yields is expected to account for variation in fiscal risks. which may result in an increase in demand. The annual volume of redemptions is positively related to the bid-to-cover ratio in Germany, while in France, years with high redemptions seem to have coincided with less issuance of 5-year debt and more 10- and 30-year issuance.

We note that inclusion of the previous bid-to-cover ratio may reduce the explanatory power of the other variables included. To the extent that these are slow-moving variables, the previous bid-to-cover ratio may also capture variation in these variables. Appendix 5.A shows results for equation (5.1) when the previous bid-to-cover ratio is excluded. We indeed find that significance of the other variables improves somewhat if we exclude the previous bid-to-cover ratio from the estimation. The adjusted r-squared of the panel specifications in Table 5.A.1 ranges between 0.48 for 2-year debt and 0.61 for 5-year debt. For the panel specification in Table 5.3 these figures are slightly higher, ranging from 0.55 for 10-year debt to 0.64 for 5-year debt.

5.4.2 Decomposition into demand and supply

Next we distinguish between demand and supply effects by decomposing the bid-to-cover ratio into the amount bid, which is the numerator of the

bid-to-cover ratio, and the target volume, which is the denominator of the bid-to-cover ratio.

For the demand-side, we estimate the following equation:

$$D_{i,t}^{m} = c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} + \sigma S_{i,t}^{m} + \theta D_{i,t-p}^{m} + \rho S_{i,t-p}^{m} + \varepsilon_{i,t}^{m} \quad (5.2)$$

In equation (5.2) $D_{i,t}^{m}$ is the natural logarithm of demand. We also include the natural logarithm of supply, $S_{i,t}^{m}$, because supply, which is measured as the target supply, is announced prior to the auction and therefore public information to primary dealers when they place their bids during the auction. We do not include the budget surplus and the volume of redemptions, because these are supply-side variables and the variation in these variables is expected to be picked up by $S_{i,t}^{m}$. $D_{i,t-p}^{m}$ and $S_{i,t-p}^{m}$ are the natural logarithm of demand and supply in the previous auction of maturity-*m* debt in country-*i*.

Table 5.4 shows the results for demand. The panel estimates show that higher yields are associated with higher demand, while the coefficient for the volatility of sovereign yields has a negative sign. Both coefficients are significant for auctions of 2- and 10-year debt. This is consistent with the mean-variance model of demand for bonds, which suggests that investors maximize returns in their portfolio while minimizing risk. The coefficients on the short-term safety premium again suggest the presence of 'flight-to-safety' effects. The coefficient is positive and significant for auctions of 2-year debt in Germany and France, and negative and significant for Italian 5- and 10-year auctions. The coefficients on supply are positive and highly significant, indicating that investors factor in the

target supply when they place their bids, placing larger bids when target supply is higher. The coefficient on the previous demand is positive and highly significant, which reflects persistence in the demand for sovereign bonds. A higher previous supply is associated with lower demand, which may reflect lower bidding volumes if investor's demand was satisfied in the previous auction.

For the supply-side, we estimate equation (5.3). The right-hand side of equation is highly similar to equation (5.2), except that we remove $S_{i,t}^{m}$ from the independent variables.

$$\begin{aligned} S_{i,t}^{m} = {} & c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} \\ & + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} \\ & + \mu Surplus_{i,t-5} + \pi Redemption_{i,t-5} + \theta D_{i,t-p}^{m} \\ & + \rho S_{i,t-p}^{m} + \varepsilon_{i,t}^{m} \end{aligned} \tag{5.3}$$

Table 5.5 shows the results for equation (5.3) We find strong evidence for a negative relation between the budget surplus and the volume supplied, which reflects lower funding needs in years with a higher budget surplus. The country estimates show some evidence for a positive relation between redemptions and issuance volumes. However, the panel coefficient on the volume of redemptions is never significant. We note that the budget surplus and the volume of redemptions are measured at annual frequency. In years with a high funding need, the agency may choose to issue more frequently, while keeping supply per auction constant. This may be the reason why we do not find strong evidence for a positive effect of redemptions on auction supply. The positive coefficient on the volume supplied during the previous auction points at persistence in supply.

We also find some evidence for an effect of the demand-side variables on supply. We find that in Belgium and Italy, the treasury responds to higher yields by reducing the volume supplied during an auction. These countries may choose to auction more frequently in smaller portions in periods of high yields. In Germany instead, we find evidence that supply is higher in periods of high yields. The response of supply to the demand in the previous auction varies, we find a negative and significant coefficient in France, and a positive and significant coefficient in Belgium and Italy.

5.5 Cross-border spillovers

The results in section 4.1 show a consistent positive relationship between the previous bid-to-cover ratio and the bid-to-cover ratio in the current auction. In this section, we further study the effect of the success of previous auctions on the bid-to-cover ratio by analyzing cross-border spillovers. The results for the short-term safety premium already suggested a particular type of cross-border spillovers, namely the presence of cross-border 'flight-to-safety' in case of an increased demand for safe short-term debt, which was reflected in more successful auctions in Germany and less successful auctions in Italy.

A successful foreign auction may affect the outcome of a domestic auction through different channels. First, if investors regard euro area sovereign debt as an asset class with a correlated risk profile, then a positive signal about demand in a foreign country may enhance area wide confidence and result in a more successful domestic auction. Similarly, the private signals that primary dealers receive from their clients around auctions, in line with the theoretical model of Beetsma *et al.* (2018a), are possibly transmitted only slowly to financial markets. If these signals are

relevant for different euro area countries, then foreign bid-to-cover ratios may have predictive power for the success of domestic auctions. Furthermore, a high foreign bid-to-cover ratio may indicate that a high volume of bids is left unfulfilled. If bonds from different euro area countries are seen as substitutes, then this unfulfilled demand may result in higher demand in the domestic auction. Of course, it could also be the case that a third factor affects confidence in different euro area bond markets. Such a third factor can possibly be captured by an economic sentiment indicator.

Second, the capacity or willingness of primary dealers to bear risks on their balance sheets may result in a correlation in the outcome of foreign and domestic auctions if primary dealers are active in different euro area countries. Beetsma *et al.* (2018b) indeed show the presence of global primary dealers and develop a model of balance sheet constrained primary dealers who want to be compensated for the concentration of sovereign bonds on their balance sheets around auctions. The resulting auction cycle in domestic yields results in cross-border spillovers. Auction cycles are predicted to be larger if primary dealer wealth is lower or primary dealer risk aversion is higher. In similar vein, primary dealers may have less appetite to place bids in domestic and foreign auctions if their risk aversion is higher, or the wealth they can allocate to warehouse sovereign bonds is lower.

Finally, flight-to-safety effects may arise in periods of market stress if investors discriminate between the creditworthiness of different sovereigns within the euro area. The results for the short-term safety premium in Table 5.3 and 4 are indicative of the presence of flight-to-safety effects.

The first two channels suggest a positive correlation between the success of foreign auctions and the bid-to-cover ratio in a domestic

auction, whereas the flight-so-safety effect is consistent with a negative correlation between foreign and domestic bid-to-cover ratios. We will first test the presence of cross-border spillovers empirically to determine the sign of possible spillovers. Therefore, we add a measure of the previous foreign bid-to-cover ratio to specification (5.4). This gives the following regression equation:

$$BC_{i,t}^{m} = c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{i,t-5}^{m} + \delta VOL\_CYield_{i,t-5}^{m} + \varphi ST\_Safety_{i,t-5} + \mu Surplus_{i,t-5} + \pi Redemption_{i,t-5} + \theta BC_{i,t}^{m,-1} + \rho \sum_{j(\neq i)} \frac{1}{3} BC_{i,t-p}^{m} + \varepsilon_{i,t}^{m} \quad (5.4)$$

Here, $\sum_{j(\neq i)} \frac{1}{3} BC_{i,t}^{m,-1}$ is the natural logarithm of the unweighted average of the previous bid-to-cover ratio in the other three countries in the sample. The results in Table 5.6 show consistent positive and significant panel estimates for the previous foreign bid-to-cover ratio. This suggests the dominance of the first two channels mentioned above, namely substitutability of bonds from different euro area countries or international primary dealers. Country estimates are particularly strong in Germany. For 30-year auctions, we find no significant coefficients. This may be due to the fact that the frequency of 30-year auctions is very low, and the previous foreign 30-year auctions can be a few months of longer ago.

We performed various additional regressions (available upon request) to further distinguish between the different spillover channels. First, to ascertain that the results for the foreign bid-to-cover ratio in Table 5.6 are not driven by a common effect of investor confidence in the euro area, we added the Economic Sentiment Indicator of the European Commission as a control variable. The Economic Sentiment Indicator

tends to have a positive effect on the bid-to-cover ratio in France and Italy and a negative effect in Germany, but the panel coefficients for the foreign bid-to-cover ratio remain significant for auctions of 2, 5- and 10-year debt. This suggests that our results are not driven by a third factor that affects confidence in different euro area bond markets.

Second, to determine whether time variation in risk aversion of international primary dealers drives the results in Table 5.6, we add the CBOE volatility index (VIX) as a control variable.[59] The VIX is barely significant, and the panel coefficients for the foreign bid-to-cover ratio remain significant for 2-, 5- and 10-year auctions. Risk aversion of international primary dealers therefore does not seem to be the driving channel of cross-border spillovers from the success of foreign auctions to domestic bid-to-cover ratios.

Third, the inclusion of the short-term safety premium possibly blocks flight-to-safety effects from foreign to domestic bid-to-cover ratios. If capital flight towards safe short term debt takes place when the short-term safety premium is high, then it is possible that a negative spillover from less successful auctions in the periphery to more successful auctions in safe countries is captured by the short-term safety premium. When we exclude the short-term safety premium from the specification in Table 5.6, we however find that the coefficients on the foreign bid-to-cover ratio are largely unchanged.

Finally, we performed a sample split into a pre-crisis and crisis window. Beetsma *et al.* (2018b) find that cross-border spillovers from foreign primary markets to domestic secondary markets are lower in the crisis period, which can be linked to reduced market integration during the crisis. However, we find that a sample split results in reduced significance

[59] See Bekaert *et al.* (2013), who decompose the VIX into a risk aversion component and an uncertainty component, and Groen and Peck (2014)

for both time periods, possibly due to the lower number of observations in each sub-period, and we cannot distinguish between spillovers in the pre-crisis and crisis periods.

5.6 Concluding remarks

We explored determinants of bid-to-cover ratios in euro area public debt auctions. Using a unique and comprehensive database of sovereign bond issues in Germany, France, Belgium and Italy in the period from 1 January 1999 to 31 December 2017, we find that higher secondary market yields and lower secondary market volatility are associated with more successful auctions. We also find some evidence of flight-to-safety effects towards debt issued by Germany, and we find strong evidence of persistence in bid-to-cover ratios and cross-border spillover effects from the bid-to-cover ratio in foreign auctions.

Our results are of interest to sovereign debt managers. Our finding that bid-to-cover ratios are typically higher in an environment of high secondary market yields and low secondary market volatility suggests that debt managers can benefit from shifting issuance towards periods with lower secondary market volatility. However, we note that the decomposition into demand and supply factors suggests that the relationship between secondary market yields and the bid-to-cover ratio is partly driven by lower target volume in periods of high yields. In addition, we fail to find a consistent positive relationship between secondary market yields and auction demand.

Our results also suggest that debt managers can benefit from taking into account the outcome of previous domestic and foreign auctions when they decide on their target volume. We find strong persistence in bid-to-cover ratios, suggesting that it could pay off to apply a conservative

issuance strategy after a domestic auction with a low bid-to-cover ratio. Our finding of cross-border spillovers from foreign auctions suggests that debt managers should also incorporate the outcome of previous foreign auctions into their issuance strategy.

Table 5.1: Descriptive statistics bid-to-cover ratio

	Observations	Mean	Maximum	Minimum	Standard deviation
Germany					
2-Year	172	1.71	5.55	0.80	0.63
5-Year	142	1.45	3.28	0.66	0.45
10-Year	167	1.34	3.49	0.65	0.49
30-Year	59	1.28	2.30	0.61	0.36
France					
2-Year	143	2.85	5.79	1.55	0.83
5-Year	195	2.68	5.79	1.25	0.79
10-Year	194	2.29	4.47	1.34	0.54
30-Year	75	2.29	4.47	1.34	0.62
Belgium					
3-Year	13	2.06	2.65	1.09	0.43
5-Year	70	1.95	4.14	1.09	0.46
10-Year	110	1.89	4.14	0.98	0.42
30-Year	40	1.81	4.14	0.98	0.50
Italy					
2-Year	240	2.06	5.25	1.01	0.70
5-Year	235	1.68	3.10	1.00	0.43
10-Year	222	1.56	4.09	1.07	0.32
30-Year	86	1.63	3.75	0.84	0.46

Table 5.2: Descriptive statistics demand and supply

	Demand		Supply	
	Mean	Standard deviation	Mean	Standard deviation
Germany				
2-Year	9.95	4.85	5.78	1.52
5-Year	7.55	3.64	5.15	1.51
10-Year	7.56	4.24	5.53	1.81
30-Year	3.63	2.70	2.75	1.70
France				
2-Year	15.17	3.67	5.75	2.04
5-Year	15.06	3.63	6.01	1.92
10-Year	13.57	4.18	6.18	2.11
30-Year	13.09	3.91	6.03	2.17
Belgium				
3-Year	5.53	1.85	2.68	0.74
5-Year	5.47	1.66	2.83	0.69
10-Year	5.16	1.56	2.77	0.71
30-Year	4.94	1.49	2.79	0.67
Italy				
2-Year	4.30	1.18	2.25	0.79
5-Year	4.06	1.35	2.53	0.96
10-Year	4.23	1.19	2.77	0.83
30-Year	2.47	1.13	1.58	0.69

Note: Demand and supply are measured in billions of euro's.

Table 5.3: Determinants of the bid-to-cover ratio

$$BC_{i,t}^{m} = c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} + \mu Surplus_{i,t-5} + \pi Redemption_{i,t-5} + \theta BC_{i,t-p}^{m} + \varepsilon_{i,t}^{m}$$

	Germany	France	Belgium	Italy	Panel
2-year					
Yield	0.21***	0.03		0.06**	0.08***
Yield volatility	-0.02	0.01		-0.01**	-0.01***
Corporate yield	-0.17***	0.00		-0.02	-0.03
Corporate volatility	0.28	-1.28***		0.51	-0.05
Short-term safety	0.14***	0.04		-0.02	0.02
Surplus	0.56	1.38**		2.95***	0.68**
Redemption	-0.64	-2.09*		1.09	-0.01
Previous BtoC	0.34***	0.33***		0.33***	0.42***
5-year					
Yield	0.15**	-0.04	-0.01	0.04**	0.05***
Yield volatility	-0.03	0.01	0.00	-0.01	-0.01*
Corporate yield	-0.05	0.06	0.07	0.02	0.01
Corporate volatility	0.20	-1.32***	-1.49**	0.36	-0.43*
Short-term safety	0.03	0.00	0.02	-0.06***	0.00
Surplus	0.44	1.27***	-2.03	2.68***	0.91***
Redemption	1.87**	-3.14**	-11.01	0.96	0.09
Previous BtoC	0.27***	0.20**	0.13	0.13	0.27***
10-year					
Yield	0.10**	0.21***	0.03	0.03**	0.06***
Yield volatility	-0.03**	0.00	0.00	0.00	-0.01**
Corporate yield	-0.07	-0.10**	0.02	0.01	-0.02
Corporate volatility	0.58	-0.15	-0.69	-0.35	-0.10
Short-term safety	0.04	0.03	0.02	-0.03**	0.00
Surplus	0.46	1.39***	-2.99	1.77***	0.37
Redemption	-0.66	4.07***	-6.11	0.44	-0.18
Previous BtoC	0.42***	0.26***	0.15*	0.25***	0.35***
30-year					
Yield	0.04	0.25**	0.18*	0.12**	0.07**
Yield volatility	-0.06*	0.01	-0.02	-0.01	-0.01
Corporate yield	-0.02	-0.08	-0.12	-0.02	-0.01
Corporate volatility	0.01	-0.64	-0.49	-0.57	-0.57
Short-term safety	0.07	0.00	0.01	0.00	0.02
Surplus	1.32	1.09	-5.48	0.69	1.34**
Redemption	-0.44	4.72**	-1.37	-0.20	0.25
Previous BtoC	0.22	0.25***	0.00	0.32***	0.25***

Notes: Estimation is for the period January 1, 1999 – December 31, 2017. Estimation methods is Ordinary Least Squares (OLS) with Newey-West adjusted standard errors. The column under the header "Panel" reports panel OLS regressions estimated with country fixed effects. Further, *, ** and *** denote significance at the 10%-, 5%-, and 1%-levels, respectively.

Table 5.4: Determinants of demand

$D_{i,t}^{m} = c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} + \sigma S_{i,t}^{m} + \theta D_{i,t-p}^{m} + \rho S_{i,t-p}^{m} + \varepsilon_{i,t}^{m}$

	Germany	France	Belgium	Italy	Panel
			2-year		
Yield	0.20***	0.04		0.04	0.07***
Yield volatility	-0.02*	0.01		-0.01***	-0.01***
Corporate yield	-0.14**	0.00		-0.03	-0.03
Corporate volatility	0.54	-1.24***		0.67**	0.06
Short-term safety	0.11***	0.05*		0.01	0.02*
Supply	0.53***	0.57***		0.60***	0.65***
Previous demand	0.41***	0.35***		0.26***	0.43***
Previous supply	-0.04	-0.16*		-0.25***	-0.25***
			5-year		
Yield	0.09	-0.02	-0.03	0.01	0.03**
Yield volatility	-0.03*	0.01	-0.01	0.00	-0.01
Corporate yield	-0.01	0.05	0.09*	0.03*	0.02
Corporate volatility	0.13	-1.44***	-1.92**	0.00	-0.57***
Short-term safety	0.04	0.02	0.03	-0.05***	0.00
Supply	0.32***	0.44***	0.85***	0.79***	0.76***
Previous demand	0.45***	0.19**	0.20*	0.09	0.28***
Previous supply	-0.03	-0.01	-0.19	-0.13*	-0.20***
			10-year		
Yield	0.12**	0.06	0.02	0.01	0.05***
Yield volatility	-0.02*	0.00	-0.02	-0.01	-0.01***
Corporate yield	-0.07*	-0.02	0.03	0.01	-0.01
Corporate volatility	0.88	-0.37	-0.94*	-0.35	-0.13
Short-term safety	0.02	0.00	0.03*	-0.02*	0.00
Supply	0.50***	0.71***	0.85***	0.77***	0.77***
Previous demand	0.46***	0.36***	0.13	0.36***	0.40***
Previous supply	-0.09	-0.09	-0.14	-0.28***	-0.22***
			30-year		
Yield	0.06	0.09	0.07	0.05	0.06**
Yield volatility	-0.06*	0.02	-0.03	-0.01	-0.02
Corporate yield	0.01	-0.01	-0.03	0.02	0.01
Corporate volatility	0.10	-1.31	-0.29	-0.47	-0.54
Short-term safety	0.04	0.00	0.05	-0.01	0.01
Supply	0.85***	0.73***	0.71***	0.80***	0.81***
Previous demand	0.21	0.30***	0.02	0.34***	0.26***
Previous supply	-0.21	-0.02	-0.03	-0.33***	-0.21***

Notes: See *Notes* to Table 5.3.

Table 5.5: Determinants of supply

$S_{i,t}^{m} = c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} + \mu Surplus_{i,t-5} + \pi Redemption_{i,t-5} + \theta D_{i,t-p}^{m} + \rho S_{i,t-p}^{m} + \varepsilon_{i,t}^{m}$

	Germany	France	Belgium	Italy	Panel
			2-year		
Yield	0.05	-0.03		-0.06	-0.04
Yield volatility	0.00	0.00		0.00	0.01*
Corporate yield	0.03	0.01		-0.03	0.01
Corporate volatility	0.54	-0.35		0.35	0.32
Short-term safety	-0.01	0.04		0.06	0.01
Surplus	-1.27***	-1.83***		-3.57**	-2.90***
Redemption	-0.14	6.25***		-2.42**	-0.40
Previous demand	0.00	-0.15		-0.12	-0.01
Previous supply	0.11	0.27**		0.32***	0.44***
			5-year		
Yield	0.11*	0.01	-0.11*	-0.12**	-0.07***
Yield volatility	0.01	-0.01	0.00	0.02	0.01
Corporate yield	-0.05	0.01	0.12*	0.04	0.04*
Corporate volatility	-0.07	-0.25	-2.12***	-1.48*	-0.62*
Short-term safety	0.08**	0.04	0.02	0.01	0.01
Surplus	-0.67	-2.67***	8.40	-7.63***	-4.18***
Redemption	-1.36**	5.43***	29.26**	-1.59	-0.70
Previous demand	0.10	-0.07	0.23*	-0.16	0.04
Previous supply	0.00	0.27***	0.21	0.16	0.25***
			10-year		
Yield	0.16***	0.01	-0.06	-0.09*	-0.04**
Yield volatility	0.02	-0.01	-0.06**	0.00	-0.01
Corporate yield	-0.04	0.00	0.09	0.03	0.03*
Corporate volatility	0.16	-0.55	-0.87	-0.15	-0.14
Short-term safety	0.01	0.04	0.03	0.04	0.00
Surplus	-0.20	-3.21***	3.17	-4.95***	-3.48***
Redemption	0.22	6.74***	26.39**	-0.22	0.44
Previous demand	-0.08	-0.10	0.01	0.22	0.11**
Previous supply	0.38***	0.14	0.33**	-0.06	0.32***
			30-year		
Yield	0.04	-0.07	-0.37***	-0.26***	-0.06
Yield volatility	-0.03	-0.01	-0.04	-0.04*	-0.02
Corporate yield	0.07	0.00	0.36***	0.19**	0.07**
Corporate volatility	0.38	-0.78	0.32	1.02	0.24
Short-term safety	-0.03	0.05**	0.02	-0.08	-0.03
Surplus	-2.37**	-3.69***	3.30	-7.53*	-4.33***
Redemption	0.45	6.06***	23.54**	4.08	0.89
Previous demand	0.02	-0.20***	0.17	0.40**	0.19**
Previous supply	0.58***	0.01	-0.06	0.05	0.41***

Notes: See *Notes* to Table 5.3.

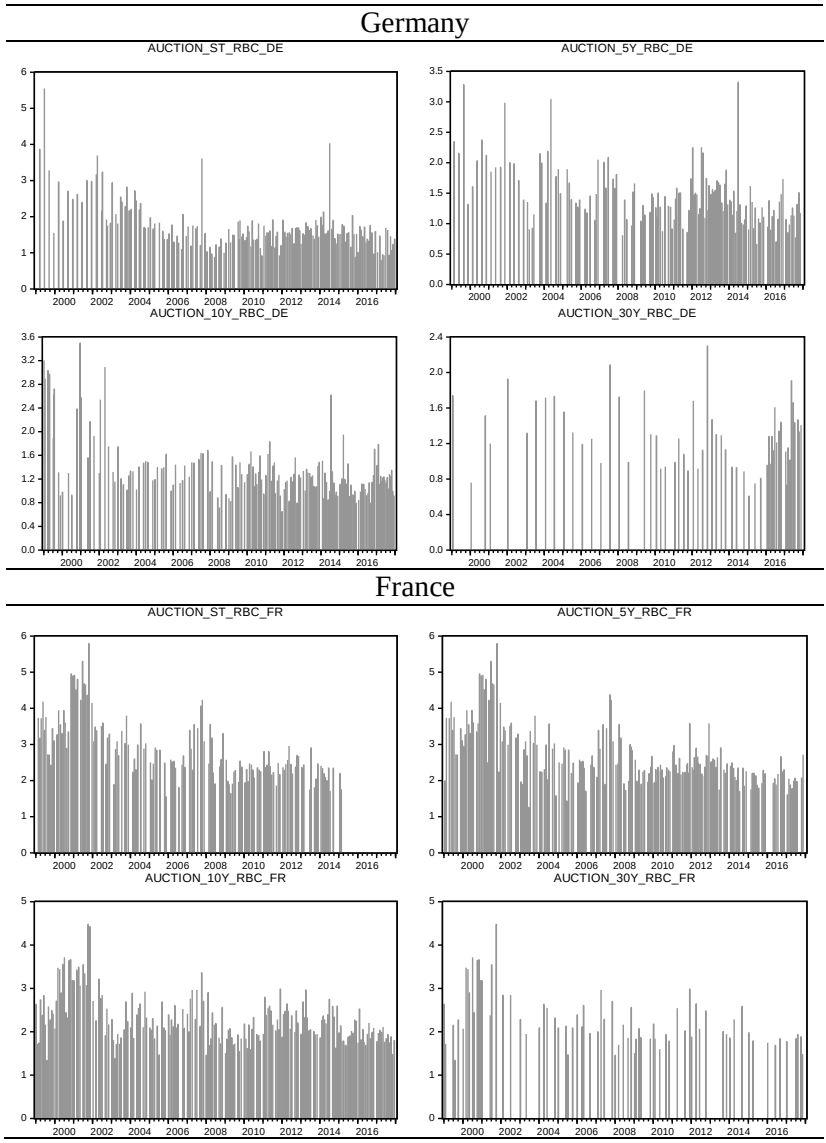
Table 5.6: Bid-to-cover with foreign bid-to-cover

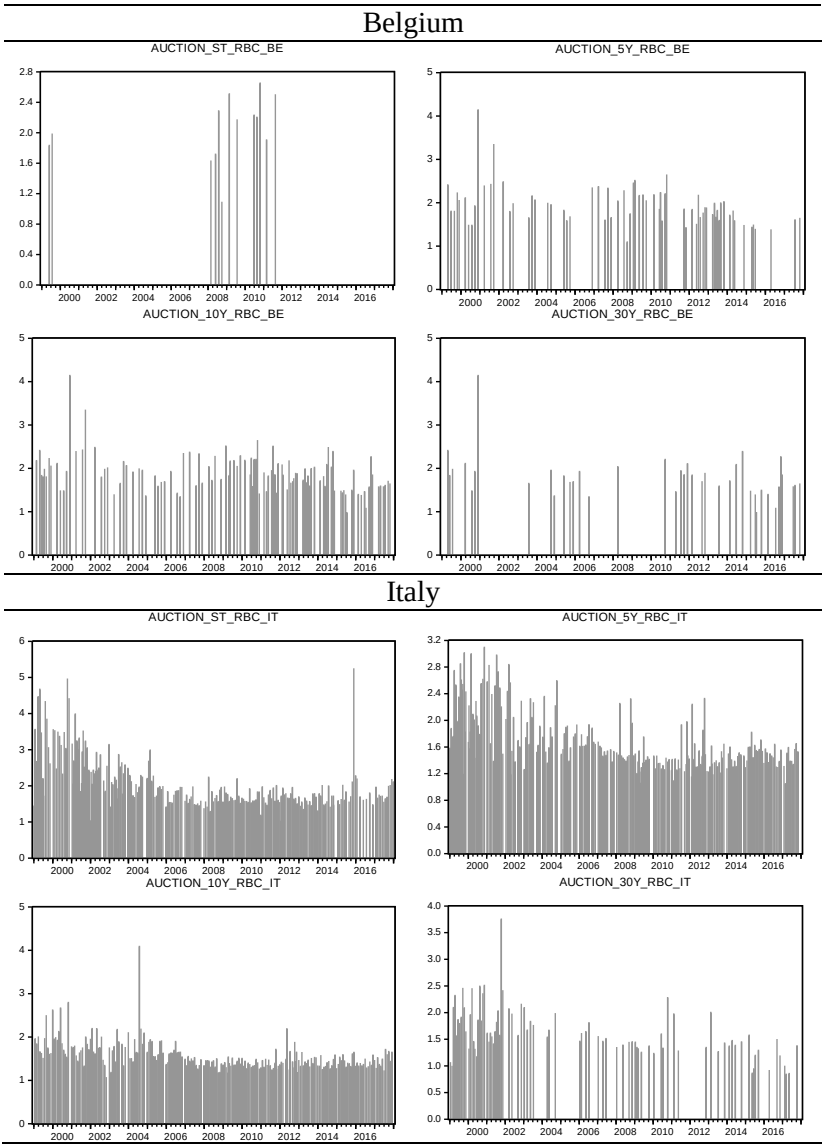
$$BC_{i,t}^{m} = c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} + \mu Surplus_{i,t-5} + \pi Redemption_{i,t-5} + \theta BC_{i,t-p}^{m} + \rho \sum_{j(\neq i)} \frac{1}{3} BC_{j,t-p}^{m} + \varepsilon_{i,t}^{m}$$

	Germany	France	Belgium	Italy	Panel
		2-year			
Yield	0.14**	0.04		0.03	0.04**
Yield volatility	-0.02	0.01*		-0.01	-0.01**
Corporate yield	-0.11*	0.01		0.00	-0.01
Corporate volatility	0.32	-1.25***		0.26	-0.14
Short-term safety	0.08*	0.04		-0.01	0.01
Surplus	0.09	1.23**		1.95*	0.37
Redemption	-0.58	-1.24		0.66	-0.17
Previous BtoC	0.25***	0.33***		0.33***	0.37***
Previous Foreign BtoC	0.63***	0.10		0.20	0.31***
		5-year			
Yield	0.08	-0.04	-0.10	0.04*	0.03
Yield volatility	-0.03	0.01	0.01	-0.01	-0.01
Corporate yield	-0.03	0.05	0.13*	0.02	0.01
Corporate volatility	0.36	-1.20**	-1.58**	0.34	-0.36
Short-term safety	0.02	-0.01	0.00	-0.05***	-0.01
Surplus	0.22	1.09**	-6.67	2.67***	0.74**
Redemption	1.38	-1.78	-14.28*	0.91	-0.04
Previous BtoC	0.21**	0.16*	0.18	0.12	0.24***
Previous Foreign BtoC	0.53***	0.34***	0.39**	0.02	0.23***
		10-year			
Yield	0.06	0.21***	0.02	0.03**	0.05***
Yield volatility	-0.03*	0.00	0.00	0.00	-0.01**
Corporate yield	-0.07	-0.10**	0.03	0.01	-0.02
Corporate volatility	0.90	-0.13	-0.68	-0.35	-0.06
Short-term safety	0.03	0.03	0.02	-0.03**	0.00
Surplus	0.00	1.28***	-3.56	1.78***	0.27
Redemption	-0.90	4.87***	-6.25	0.43	-0.20
Previous BtoC	0.37***	0.24***	0.12	0.25***	0.33***
Previous Foreign BtoC	0.55***	0.22**	0.16	-0.01	0.13**
		30-year			
Yield	-0.01	0.24**	0.12	0.10*	0.06*
Yield volatility	-0.06	0.01	0.01	-0.01	-0.01
Corporate yield	0.02	-0.10	-0.12	-0.02	-0.01
Corporate volatility	0.15	-0.52	-0.19	-0.49	-0.55
Short-term safety	0.06	0.01	0.04	0.00	0.02
Surplus	1.26	1.19	-6.63	-0.27	1.28**
Redemption	-0.70	3.76	-2.16	-0.86	-0.08
Previous BtoC	0.24	0.27***	-0.10	0.27**	0.24***
Previous Foreign BtoC	0.12	-0.05	0.91	0.20	0.11

Notes: See *Notes* to Table 5.3.

Figure 5.1: Bid-to-cover ratios





Notes: this figure shows the realizations of the bid-to-cover From left-to-right and from above to below the charts are based on the 2-year (3-year for Belgium), 5-year, 10-year and 30-year auctions, respectively.

Figure 5.2: Secondary market yields

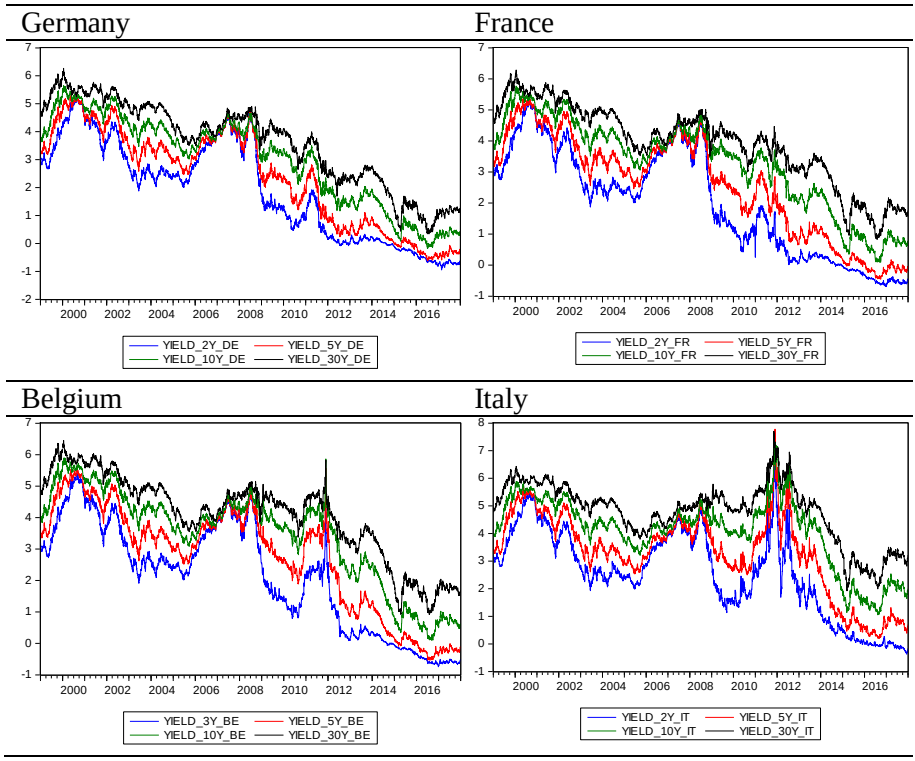


Figure 5.3: Yield volatility

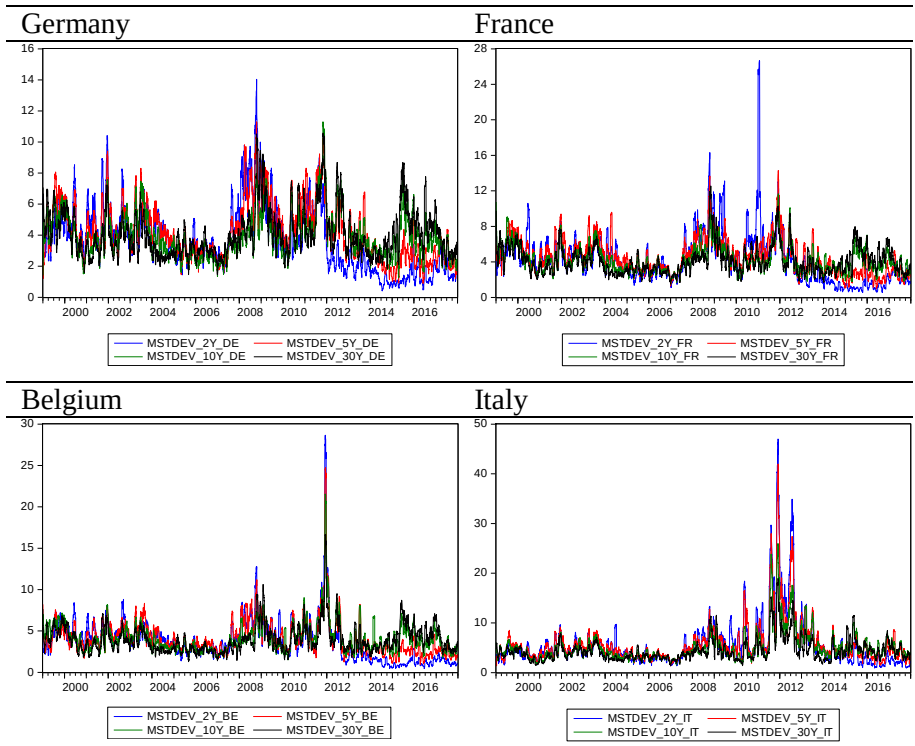


Figure 5.4: Corporate bond yields

Figure 5.5: Corporate bond yield volatility

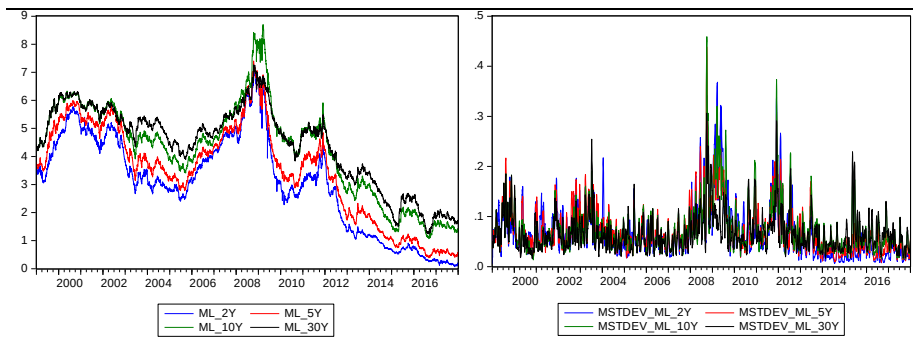


Figure 5.6: Short-term safety premium

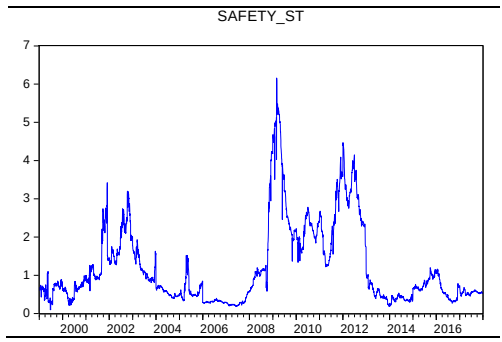


Figure 5.7: Long-term redemptions (100 bn eur)

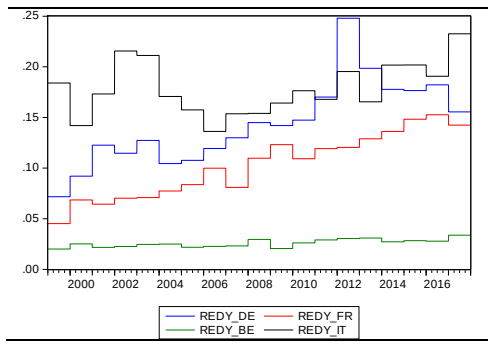
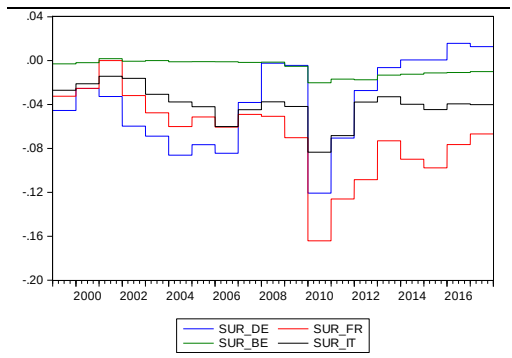


Figure 5.8: Government surplus (100 bn eur)



Annex 5.A: Excluding the previous bid-to-cover ratio

Table 5.A.1: Excluding the previous bid-to-cover ratio from Table 5.3

$$BC_{i,t}^{m} = c_{i,0}^{m} + \alpha Yield_{i,t-5}^{m} + \beta VOL\_Yield_{i,t-5}^{m} + \gamma CYield_{t-5}^{m} + \delta VOL\_CYield_{t-5}^{m} + \varphi ST\_Safety_{t-5} + \mu Surplus_{i,t-5} + \pi Redemption_{i,t-5} + \varepsilon_{i,t}^{m}$$

	Germany	France	Belgium	Italy	Panel
2-year					
Yield	0.35***	0.05		0.08***	0.13***
Yield volatility	-0.02	0.01*		-0.01***	-0.02***
Corporate yield	-0.30***	0.00		-0.02	-0.05***
Corporate volatility	0.36	-1.59***		0.58	-0.02
Short-term safety	0.23***	0.06*		-0.02	0.04**
Surplus	0.93	2.08***		4.82***	1.16***
Redemption	-1.34	-3.25***		1.16	-0.54
5-year					
Yield	0.21***	-0.01	0.01	0.04**	0.07***
Yield volatility	-0.03	0.01	-0.01	-0.01	-0.01***
Corporate yield	-0.08	0.05	0.05	0.02	0.01
Corporate volatility	0.24	-1.41***	-1.40**	0.36	-0.43*
Short-term safety	0.05	0.01	0.03	-0.06***	0.00
Surplus	0.73	1.61***	-2.65	3.11***	1.20***
Redemption	2.17**	-2.96*	-14.84*	1.05	0.09
10-year					
Yield	0.16***	0.24***	0.04	0.04***	0.09***
Yield volatility	-0.03	-0.01	-0.01	-0.01*	-0.02***
Corporate yield	-0.12**	-0.11**	0.01	0.01	-0.03**
Corporate volatility	0.16	-0.32	-0.68	-0.38	-0.20
Short-term safety	0.07*	0.04	0.02	-0.04**	0.00
Surplus	0.95	1.77***	-3.95	2.48***	0.54**
Redemption	-1.67*	4.56***	-9.31*	0.44	-0.47
30-year					
Yield	0.15	0.28***	0.20**	0.15***	0.10***
Yield volatility	-0.05	0.01	-0.02	-0.01	-0.02
Corporate yield	-0.12	-0.09	-0.14	0.00	-0.02
Corporate volatility	-0.59	-0.73	-0.47	-0.27	-0.43
Short-term safety	0.09	0.01	0.01	-0.01	0.02
Surplus	1.74	1.45	-5.19	0.56	1.67***
Redemption	-0.42	4.76**	-2.89	0.12	0.00

Notes: See *Notes* to Table 5.3.