Price Effects of Sovereign Debt Auctions in the Euro-zone: The Role of the Crisis

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ABSTRACT

Exploring the period since the inception of the euro, we show that secondary market yields on Italian public debt increase in anticipation of auctions of new issues and decrease after the auction, while no or a smaller such effect is present for German public debt. However, those yield movements on the Italian debt are largely confined to the period of the crisis since mid-2007. We also find that there is some tendency of the yield movements to be larger when the demand for the new issue is smaller relative to its supply. Our results are consistent with a framework in which a small group of primary dealers require compensation for inventory risk and this compensation needs to be higher when market uncertainty is larger. We also find that the secondary market behaviour of series with maturity close to the new series for which there is *no* auction is very similar to the secondary market behaviour of the new series. This particular finding gives credence to an explanation of the yield movements based on the behaviour of primary dealers with limited risk-bearing capacity over other explanations based on supply effects or liquidity effects.

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"Italy's borrowing costs are under pressure to rise further at a bond sale next Friday because investors are nursing renewed doubts about whether highly-indebted euro zone governments can get their finances under control.

Five days is a long time in the euro zone crisis and the market mood may swing sharply, but the auction has been singled out as a central "risk event", watched not only by bond investors but by most people involved in global financial markets."

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1. Introduction

The recent economic and financial crisis has given rise to substantial fiscal stimulus in the industrialised world, both through the operation of the automatic stabilisers and through active fiscal expansion. As a result of these fiscal expansions as well as intervention measures in the financial sector, public debt levels have increased enormously. This has had consequences for the confidence of financial markets in the sustainability of those debts and thus also for the yields charged on the debt. Not surprisingly, rating agencies have regularly downgraded the debt of vulnerable countries. Moments at which new debt issues were auctioned have been moments of particular nervousness in the financial markets, as a lack of investor interest could be a sign of impending difficulties to future market access.

In this paper, we explore for two major euro-zone countries, Germany and Italy, movements in the yields on their public debt shortly before and after the auctions of new issues of the debt. We also explore spill-overs of these movements between the two countries. We do this for the period since the inception of the euro-zone until now. Hence, we cover the recent crisis that started with the problems in the U.S. housing market in 2007. We select Germany and Italy for our analysis, because these countries are large and have substantial amounts of public debt outstanding.[1] Hence, the markets in the debt instruments of Germany and Italy are the most liquid and most active in the euro-zone. Moreover, the yields on their public debt have clearly been affected by the recent euro debt crisis, but they have been

[1] At the end of December 2012, the total Italian public debt was €1,990 (of which €1,640 billion of outstanding bonds), while the German public debt was €1,139 billion.

influenced in substantially different ways, with German yields falling to unprecedentedly low levels and Italian yields rising to dangerously high levels.

Investigating the effect of auctions on yields is important for a number of reasons. First, these effects may provide an indicator of roll-over risk, the risk that a government is not able to refinance its debt. Second, they point to potential profit opportunities for market participants. Third, if an upcoming auction drives up yields, this implies additional costs for the issuing authority. As a result, it is of interest to measure those additional costs. One would then be particularly interested in ways in which those costs can be reduced through a better organization of the auctioning process.

The limited current literature indeed suggests that upcoming auctions of U.S. public debt drive up the yields on this debt (Fleming and Rosenberg, 2007, and Lou *et al.*, 2012). This paper contributes to the existing work in a variety of ways. First, we focus on a new set of countries. Second, we exploit the fact that the current euro debt crisis adds another dimension to the study of the relationship between yields and auctions. It may well be the case that upcoming auctions have larger effects on yields of countries that are affected by the crisis than for countries that are not affected. If this is indeed the case, then the additional costs associated with an upcoming auction of new debt will become particularly high for precisely those countries for which these extra costs are most harmful. Third, while Lou *et al.* (2012) is based on an event analysis, the results of which we confirm for Italy with our own event study, most of our analysis is based on a regression framework that allows us to control for the effects of auctions of other series that take place close in time to original auctions. We regress yield movements on future and past auctions variables of the own maturity and other maturities. The regression analysis allows further flexibility in exploring the effects of the size of the auctions and the bid-to-cover ratio.

Our regression results are strongly in line with those we obtain with our event analysis. Secondary market yields on Italian public debt increase in anticipation of an auction of a new issue and decrease after the auction, while no or a smaller such effect is present for German public debt. These yield movements on the Italian debt are largely concentrated in the period of the crisis since mid-2007, while there is only limited movement in the period before the crisis. Moreover, the yield movements tend to be larger when the bid-to-cover ratio is smaller, while the marginal positive effect of a lower bid-to-cover ratio on yields is larger when the bid-to-cover ratio is relatively small to start with. Importantly, we also find that the secondary market behaviour of series for which there is *no* auction but with a maturity close to that of the newly-created series is very similar to the secondary market behaviour of the new series. This finding may help us in discriminating explanations for the observed yield movements around auctions.

We present a simple theoretical framework in which a small group of primary dealers require compensation for inventory risk and this compensation needs to be higher when market uncertainty is larger. Our empirical results are consistent with this mechanism and, in particular, the behaviour of yields of close-maturity series seem to favour an explanation of yield movements based on the behaviour of primary dealers with limited risk-bearing capacity over other explanations based on supply effects or liquidity effects.

Exploiting that there is an almost one-to-one link between secondary market yields and yields at which new series are auctioned, our results also allow us to make a rough assessment of the issuance costs of public debt. On average during the whole period we obtain a very rough estimate of the issuance cost of a five-year bond over its entire life of about 4.25 million euro's. By exploiting the relative movement in the auction yield and the secondary market yield we can in addition establish that the issuance cost has increased substantially between the pre-crisis and the crisis period. This increase for a five-year bond over its entire life is estimated at between 14 and 15 million euro's.

Finally, we try to assess the opportunities to profitably exploit the yield movements around auctions. However, the transactions costs and the tendency of the market volatility to increase during the run-up of the auctions seem to make it hard to earn "excess profits".

The remainder of this article is structured as follows. Section 2 contains a brief literature review and set out the conceptual framework for our empirical analysis. After a short description of the dataset in Section 3, Section 4 presents the results of the event study. Section 5 contains the regression analysis, while Section 6 provides a rough assessment of debt issuance costs and profitability of trading strategies based on the price effect of auctions. Finally, Section 7 concludes the main body of the paper.

2. Evidence from literature and conceptual framework

2.1. Evidence from the literature on yield effects of auctions

Several papers have documented unusually high yields, relative to some benchmark, on treasury bonds during and around auctions. A first line of studies compares the average yield bid in the auction to the yield on another instrument, which at the time of the auction is almost identical to the auctioned bond. Examples of such studies are Simon (1994), Nyborg and Sundaresan (1996) and Goldreich (2007). They find a small underpricing of treasury auction securities, in the order of magnitude of a 1 basis point higher yield. Recent evidence for underpricing of the auctioned bond is given by Lou *et al.* (2012). They provide some statistics on the difference between the auction yield and the on-the-run bond yield on the day of the auction. The auction yield is always higher than the on-the-run bond yield, with a difference ranging from 0.8 basis points for the 10-year maturity, 1.4 basis points for the 5-year maturity, and 2.5 basis points for the 2-year maturity.[2] A second line of literature explores yield effects in the days around the auctions. Fleming and Rosenberg (2007) study the price returns of U.S. treasury bonds on days surrounding the auctions, and relate these to the position changes of primary dealers, decomposed into a part related to auctions and a residual part. They document positive yield changes before the auction (1 to 1.5 basis points), and negative yield changes after the auction (1 to 2.5 basis points), as a result of the auction-driven position changes. They also show that the larger the position change, the larger the yield effects. Lou *et al.* (2012) empirically document that yields in the secondary market increase before auction days and decline again in the days after the auction. The effect is quite large and roughly the same for 2, 5 and 10-year maturities, namely around 2.5 basis points (measured in a five-day window around the auction). They also document spillovers from the 10-year bond auctions to the 5-year yield (and less so to the 2-year yield) and stronger effects in volatile periods. Forest (2012) adds to this literature by investigating the effect of bid-to-cover ratios on U.S. Treasury interest rates during the 1990s. He finds that a higher-than-expected bid-to-cover ratio, which indicates strong auction demand, tends to push the yield of 5 and 10-year Treasury notes down. Conversely, a lower ratio, indicating a weak auction demand, is associated with increased interest rates.

A closely related literature studies the effect of bond purchases under the recent Quantitative Easing programmes of central banks in the U.S., the U.K. and the euro-zone. Most of these papers explore the price effects of the announcement of the programmes (e.g. Krishnamurthy and Vissing-Jorgensen (2011) for the U.S. and Joyce *et al.* (2011) for the U.K.). However, a few papers look at price effects on and around the days of the actual bond purchases. D'Amico and King (2013) estimate the impact of the bond purchases by the U.S. Fed. Given the way the purchase programme was structured, the amount and issue purchased

[2] These numbers are our own calculations based on the data in Tables II and IV in Lou *et al.* (2012).

on specific days were known in advance, similar to the information structure in auctions. D'Amico and King find significant price effects on the day of the purchase. For a representative 10 year bond, the yield decreases by 0.3 basis points per billion dollars purchased. The price effects on bonds with a similar maturity (in a window of two to six years around the bond purchased) are almost as large, indicating a high degree of substitutability between bonds with similar maturities. The price effect is temporary and is reverted within six days after the purchase. Eser and Schwaab (2013) study bond purchases by the ECB under its Securities Market Programme (SMP). In contrast to the Fed programmes, the ECB did not announce when, how much and which bonds to purchase. They estimate a yield decrease for Italy of 1.5 basis points per billion purchased. Most of this price impact is temporary, but around 20 percent of this initial price effect is permanent, although the authors acknowledge that the latter number is not very precisely estimated.

2.2. Potential source of yield effects of auctions

There is a number of factors potentially affecting yield movements during and around auctions. These yield effects could pertain to the primary market, to the secondary market, or both. First, auctions change the supply of treasury bonds. As such, there could be an effect of auctions on the interest rates on both outstanding and new debt issues. Krishnamurty and Vissing-Jorgensen (2012) find a negative effect of U.S. treasury bond supply on the difference between corporate bond yields and treasury yields. *Ceteris paribus*, a doubling of the debt-to-GDP ratio leads to a 44 basis points increase in treasury yields. Of course, any single auction can change the debt-to-GDP ratio only by a tiny fraction. For example, in our data the average auction size for Italy is between 3 and 5 billion euro, relative to a total stock of debt of 2000 billion euros. Hence, a single auction raises the debt to GDP ratio by at most roughly 0.25% percentage points.[3] This is a very small change in the total supply and all in all, the supply effect of an auction should have a negligible impact on yields. Obviously, to the extent that part of the debt stock is not traded but passively held by investors in their portfolios, the supply effect on prices may be magnified as the supply pressure concentrates on the much smaller part of debt that is actually traded.

[3] Often, older bond issues expire on the auction days (which are at regular cycles), so the net supply effect tends to be even smaller.

Second, with the auction of a new series of a given maturity the latest issue of the same maturity goes “off-the-run”, while the new series becomes the “on-the-run” series.[4] The liquidity of the latest issue is generally higher, for example because it is better collateral for repo transactions. Hence, in anticipation of the auction the yield on the previous latest issue is expected to increase, because it will go off-the-run and lose liquidity after the auction. Third, the new on-the-run series has a longer maturity than the series that goes off-the-run, implying that, with an upward-sloping term structure, this pushes up the yield on the new on-the-run series compared to the previous on-the-run series.

Finally, if the primary dealers who are the treasury’s counterparty at the auction have limited risk-bearing capacity,[5] for example, because they are risk averse or their capital is costly, they need to be compensated for their large position in the asset and the price risk they take on their inventory.[6] Hence, the primary dealers provide liquidity in the auctions and this compensation comes in the form of higher auction yields, from which the dealer generates trading profits. If the dealers’ risk aversion or the price risk is larger, one may expect them to charge a higher yield at the auction. Other series, and in particular those for which the returns are highly correlated with the return on the new series, will also see an increase in the yield. Hence, during the run up to the auction we may expect a rising yield on the latest issue of the same maturity, while after the auction we expect a decrease in the yield of the new (and the old) series as the primary dealers unload their positions in the new issue.

2.3. The auction procedures for Germany and Italy

Appendix A describes the auctioning procedures in detail. Both governments report the days on which public debt auctions take place in an annual issuance calendar, implying that auction dates are precisely known for quite some time in advance. The terms and conditions of each specific auction, including its size, are announced about a week before it actually takes place.

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[4] The switch to the new on-the-run bond does not necessarily occur on the auction day. For instance, Bloomberg, our data source, reports the yield of “*bonds and bills selected on the closest current nominal maturity to the indicated term*”. Whereas for Germany the change in the benchmark bond typically happens on the auction day, for Italy it is not standardized and occurs a few days after the auction.

[5] Notice that in the U.S. treasury bond market, dealers absorb 95% of all auction volume, so the inventory control models seem very relevant.

[6] Simon (1994) explains the underpricing in the auction by the quantity risk involved in bidding at the auction, because the quantity allotted to the bidder may be different from the quantity that the dealer bid for.

Acting for the Federal Government, the German Finance Agency (GFA) auctions federal securities via the Bundesbank. Only members of the "Bund Issues Auction Group" can participate directly. Bids above the lowest accepted price are allotted in full. Non-competitive bids are possible and are allotted at the weighted average price of the accepted competitive bids. The auction results are published on the auction day, while the financial settlement and transfer of ownership of the allotted securities typically takes place two days after the auction. Nevertheless, trading in the security on the stock exchange starts immediately after the auction.

The auctioning procedure for Italian public debt, which is done by the Bank of Italy, is similar to the German one, although some specific differences can be identified. Only specific agents, the so-called "Authorized Dealers", can submit bids. The most important difference is that the Italian Treasury uses both competitive and marginal auctions. The former are used for maturities of up to one-year and, as in the German case, satisfy bids at the yield offered. Marginal auctions are applied for medium- and long-term securities and have all bidders pay the same price, the so-called marginal price.

2.4. A simple model of primary dealer behavior

We present a simple theoretical framework that models the behaviour of primary dealers with limited risk-bearing capacity. The model is relevant for the primary market, as suggested by the description of the auction processes in the previous subsection. It is also relevant for the secondary market, as the group of secondary market dealers in public debt to a large extent coincides with the group of primary dealers.

Starting point is the model by Ho and Stoll (1983) of oligopolistic dealers who make the market in several correlated assets. Assuming a mean-variance utility function, in a one-period setting, the dealers will quote a price P_j (mid-point of bid and ask prices) based on the equilibrium ("fundamental") value F_j of the asset, corrected for the current inventories of the dealer in all correlated assets (i = 1,..,N):

$$P_j = F_j - A\sum_{i=1}^{N} Cov\left(R_j, R_i\right) I_i ,$$

where $Cov\left(R_j, R_i\right)$ is the covariance between the returns on the assets *i* and *j*, *A* is the coefficient of absolute risk aversion and I_i is the inventory in asset *i*. Hence, the effect of an increase in the inventory of asset *i* on the price of asset *j* is given by:

$$\frac{\partial P_j}{\partial I_i} = -ACov\left(R_i, R_j\right) = -A\beta_{ji}\sigma_i^2 ,$$

where $\sigma_i^2 = Var\left(R_i\right)$ is the variance of the return on asset *i* and β_{ji} is the exposure of the return on asset *j* to the return on asset *i*, $\beta_{ji} = \frac{Cov\left(R_j, R_i\right)}{\sigma_i^2}$. The own price effect of a change in the inventory of asset *i* simplifies to

$$\frac{\partial P_i}{\partial I_i} = -A\sigma_i^2 ,$$

and, hence, is proportional to the variance of asset *i*.

This model yields several useful predictions for our own analysis of the bond auctions. First, an upcoming auction in asset *i* will lead to a positive position of this asset. This will have a negative effect on the price (and hence a positive effect on the yield) at which the asset can be issued. Second, the larger the size of the auction, the larger the inventory and, hence, the larger this price effect, which is equal to $\left(\partial P_i / \partial I_i\right)\left(\Delta I_i\right) = -A\sigma_i^2 \Delta I_i$. Third, in the run up to the auction, the yield on the latest issue of the same headline maturity, which we denote by asset *j*, will increase, as the correlation of returns on bonds with close maturities tends to be high, at least at the daily frequency. Fourth, the price effect on this asset *j* will be larger if the amount issued of the new asset *i* of the same headline maturity is larger. This effect will be equal to $\left(\partial P_j / \partial I_i\right)\left(\Delta I_i\right) = -A\beta_{ji}\sigma_i^2 \Delta I_i = \beta_{ji}\left(\partial P_i / \partial I_i\right)\Delta I_i$. That is, the cross price effect of an auction in bond *i* on the price of bond *j* is equal to the own price effect on bond *i* multiplied by the return exposure of bond *j* to the return on bond *i*. Therefore, we expect strong effects of the auctions in a particular maturity on the secondary market price of bonds with a maturity similar to the bond auctioned. Fifth, in a crisis period, the variance of the return on asset *i* is higher and, hence, the effect of an auction of given size of asset *i* on the prices of assets *i* and *j* will be larger.

3. Data description

Our dataset consists of secondary market daily yields and information on auctions of 2, 5 and 10-year Treasury bonds for Germany and Italy over the period from 1st January 1999 until 12th February 2013. The secondary market yields are obtained from Bloomberg, which has agreements with a set of brokers who report their daily bid prices to Bloomberg, which then publishes an average of these prices for their customers. The information on the auctions is collected both from Bloomberg and directly from the countries' debt agencies, and it consists of the specific maturity of the new issue, the auction date, the total amount bid, the total amount allotted and the "average accepted yield" at which the debt is sold.[7]

Figures 1a (for Germany) and 1b (for Italy) plot the end-of-day secondary market yields on 2, 5 and 10-year government bonds.[8] The effects of the crisis are clearly visible. Over the period since mid-2007 we observe a downward trend in the yields on German debt, while relative to the preceding period the yields on the Italian debt have gone up during the last two years. Yields also have become significantly more volatile during the period since mid-2007 (see Table 1). Hence, most our analysis will distinguish between bond market behavior in the "pre-crisis period" before mid-2007 and in the "crisis period" since mid-2007.

Table 2 reports some key statistics for the auctions data. Over the entire sample period, the number of auctions of specific maturities ranges from 90 for 5-year German debt to 189 for 2-year Italian debt. For the sub-periods, these numbers range from 43 for 5-year German debt during the first sub-period to 122 for 2-year Italian debt during the first sub-period. The

[7] For Germany, Bloomberg reports the sum of competitive and non-competitive bids, whereas for Italy only competitive bids are published. However, non-competitive supplementary bids are limited to a fixed quota (fluctuating between 10% and 30%, depending on the type of bond auctioned) of the amount offered. See Appendix A for more details.

[8] Consistent with the previous literature, in our paper we only focus on 2, 5 and 10-year bonds. These bonds are typical benchmark maturities for government bond traders. Auctions of these maturities are also quantitatively very important. During the year 2012, the total amount allotted of 2, 5 and 10-year bonds at Italian auctions was €40, €36 and €38 billion, respectively. These bonds accounted for around a quarter of the total amount allotted (€472 billion) by the Italian government. For Germany, the importance of these three maturities is even more significant. During 2012, issues of 2, 5 and 10-year bonds in the primary market accounted for 23%, 20% and 22% of the total volume auctioned. This was reflected by their dominance in the secondary markets. At the end of 2012, 2-year bonds accounted for about 10%, 5-year bonds for about 20%, and 10-year bonds for roughly half of the Federal Government's outstanding debt portfolio (http://www.deutsche-finanzagentur.de).

total number of Italian auctions exceeds the number of German auctions, while Italian auctions are on average smaller, both in terms of the total amount bid and in terms of the amounts allotted. However, to a large extent the difference in size is accounted for by Bloomberg not publishing non-competitive bids for Italy (see Footnote 7). As reported by Bloomberg, average total bids in Italian auctions lie in the range of 4 – 5 billion and in German auctions in the range of 6 – 15 billion, while average allotted amounts lie mostly in the range from 1.8 – 3 billion for Italy and in the range of 4 – 6 billion for Germany. The average accepted yields at the auctions for Germany lie uniformly below those for Italy for given maturity, although during the first sub-period the differences are small. These differences are substantially larger during the second sub-period with the average accepted yield ranging between 1.40 and 2.82 for German debt and between 2.98 and 4.82 for Italian debt. Finally, Table 2 reports average bid-to-cover ratios, which for the full sample period are in the range of 1.7 – 2.2 for Germany and 1.6 – 2.2 for Italy. However, for each of the two countries and for all maturities considered, the average bid-to-cover ratios have gone down. While during the first sub-period they are in the ranges of 2.0 – 2.6 for Germany and 1.7 – 2.4 for Italy, during the second sub-period they are in the ranges 1.5 – 1.8 for Germany and 1.4 – 1.7 for Italy.

Figures 1a and 1b also show the dates at which auctions take place, as well as the average accepted yields on the auctions. We observe that the frequency of the Italian auctions is higher than that for Germany. Moreover, for Italy the frequency of the 2 and 5-year auctions is higher during the first half of the sample, while for Germany for all three maturities the frequency is higher during the recent crisis period. Finally, we can see that the average accepted yields are always very close to the secondary market yields.

4. The event study analysis

This section presents the results of an event study in which we report the average difference between the on-the-run yields during both the 5 days before and 5 days after the auction and the yield on the auction day.[9] Specifically, following Lou *et al.* (2012) we report the average of $y_t - y_0$, where y_t is the end-of-day yield of the on-the-run Treasury bond being considered

[9] We limit ourselves to a 10-day window around each auction, because by far most of the movement in the yields is concentrated on these days. Moreover, by focusing on a relatively narrow window we reduce the risk of contamination due to the presence of auctions of different Treasury bonds. These potential effects will be controlled for in the regression analysis below.

on day *t*, and y_0 is the end-of-day yield of the same headline maturity (2, 5 and 10-years) bond on the auction day.[10] We report 95% confidence bands (based on Newey-West adjusted standard errors) around these yield differences. Figure 2a shows these movements in basis points for the full sample and the two countries. Consistent with the results by Lou *et al.* (2012) who focus on the U.S. Treasury bond market, we find an inverted-V shaped pattern. That is, there is a tendency for yields to increase in the run-up to the auction and to fall once the auction has taken place. For Italy these movements are both larger and tend to reach a higher degree of significance than for Germany. In the run-up to the auction yields increase by up to 3.5 basis points for five- and ten-year debt and by up to almost 3 basis points for two-year debt. For German debt, the maximum yield increase is around 2.5 basis points for the five-year debt. Next, we split the sample in our two sub-periods. Comparing the before-crisis (Figure 2b) and crisis periods (Figure 2c) we observe that for Germany there is hardly any change in the movements of the yields. This contrasts substantially with Italy, where yield movements before the crisis are very small and only occasionally significant, while during the crisis they are substantially larger and in many instances highly significant. The magnitude of the movements ranges from around 6 basis points to around 10 basis points at the limits of the window we consider.[11]

A potential complication is that Bloomberg reports the yields on the instrument that has its maturity closest to the headline maturity. This implies that usually in the days before the auction of a maturity *m* debt instrument Bloomberg reports the yields on the latest issue of a maturity *m* debt instrument, while shortly after the auction Bloomberg switches to reporting the yield on the newly issued debt instrument of maturity *m*.[12] In other words, for most auctions we are comparing yield movements in two different instruments (although usually with maturities very close to each other) around the time of the auction. To assess the relevance of this switch of the benchmark bond, for each of the headline maturities we explore the yield movements of an instrument with a maturity close to the headline maturity. Specifically, we study the yields on the 3-year (6-year, 9-year) instrument around the issuance dates of the 2-year (5-year, 10-year) instrument. The advantage of this approach is that we can explore the yields movements on instruments that are as much as possible kept unchanged

[10] As discussed above, Bloomberg reports the yield of the bond or bill with maturity closest to the headline maturity. As a result the underlying benchmark bond may switch within the remaining part of the window after the auction date.
[11] Appendix B reports the average yield differences in the window around the auction.
[12] The first series goes off the run, while the other one is the new on-the-run series.

around the auction dates. Figure 3 shows the results of this variation. Both qualitatively and quantitatively, the results are very similar to those shown in Figure 2. In particular, by far most of the action is for Italy during the second sub-period. These findings suggest that the tendency to switch the instrument for which yields are reported after the auction is of very little consequence for our results. Hence, these findings cast an interesting perspective on various theoretical explanations for yield movements around auction dates. The findings suggest that liquidity effects, effects of changes in the benchmark security and supply effects are of relatively little importance, while they are consistent with the theory of limited risk-bearing capacity of dealers as discussed in Section 2. According to this theory the price effects of assets with similar risk profiles should be similar. This can, in particular, be observed from the switch from the 10-year to the 9-year maturity.

5. Regression analysis and interpretation of results

The drawback of an event study analysis is the potential presence of confounding factors occurring during the event window. In particular, debt auctions of different maturities sometimes take place at the same moment or are rather close in time. Moreover, with a regression we can control for other variables, such as auctions taking place in the other country in our sample.

5.1. Regressions with auction dummies

For maturity *m* of country *i*, we estimate the following equation:

$$\Delta y_t^{i,m} = c_0^{i,m} + \sum_{l=4}^{-5} \beta_l AUC_{t+l}^{i,m} + \sum_{l=4}^{-5} \gamma_l AUC_{t+l}^{i,n(\neq m)} + \sum_{l=4}^{-5} \delta_l AUC_{t+l}^{j(\neq i),m} + \varepsilon_t^{i,m}. \qquad (1)$$

where *AUC* is a dummy that takes a value of 1 (0) when there is an (no) auction of the specified country-maturity combination on the indicated date, ε is a disturbance term and $n \neq m$ denotes the maturity of another series. We estimate equation (1) for Germany and Italy and for the maturities of 2, 5 and 10 years, either setting the γ coefficients to zero or allowing them to be free. Equation (1) also allows the corresponding maturity dummy for the other country ($j \neq i$) to be included in the regression. We use an *F*-test to test the hypotheses:

$$
\begin{aligned}
&H_0^{\beta}:\ \left(\sum\nolimits_{l=4}^{0}\beta_l\right)-\left(\sum\nolimits_{l=-1}^{-5}\beta_l\right)=0,\\
&H_0^{\gamma}:\ \left(\sum\nolimits_{l=4}^{0}\gamma_l\right)-\left(\sum\nolimits_{l=-1}^{-5}\gamma_l\right)=0,\\
&H_0^{\delta}:\ \left(\sum\nolimits_{l=4}^{0}\delta_l\right)-\left(\sum\nolimits_{l=-1}^{-5}\delta_l\right)=0.
\end{aligned}
\tag{2}
$$

We expect that $\sum_{l=4}^{0}\beta_l > 0$ and $\sum_{l=-1}^{-5}\beta_l < 0$. In other words, we test the presence of a full cycle of temporary up and down movements in yields as a result of a given auction.

Table 3 reports the OLS estimates of the coefficient sums $\left(\sum_{l=4}^{0}\beta_l\right)-\left(\sum_{l=-1}^{-5}\beta_l\right)$ and the associated test statistic. The standard errors are Newey-West adjusted. The regression results are in line with the results of the event study. For the full sample period and with only the own maturity included on the right-hand side of the regression equation, we see that for Germany the cycle of yield movements is significant only at the 5 and 10-year maturity,[13] while for Italy at all maturities the level of significance is higher and the size of the sum of the coefficients is about double the size of that for Germany. Again the action is essentially concentrated for Italy in the crisis period, as for the first sub-period the only instance of significance is left for the German 10-year auction. For the second period, for Germany only the 5-year maturity is significant, while for Italy all maturities are significant, while in addition the size of the coefficient sum is more than double that for the full sample period. For example, for the 2-year maturity the full movement in the yield is 17 basis points over a period of 10 business days.

Inclusion of another headline maturity of the same country *i* on the right-hand side of the regression equation (the γ coefficients) tends to have only limited effect on the size of the own-maturity coefficients when they are significant and does not affect statistical significance at our standard confidence levels. Specifically, the sums of the own-maturity coefficients for Italy during the second sub-period remain highly significant and, in fact, it even increases substantially for the 2-year maturity regression with the 10-year alternative maturity. Except in one case, for Italy during the second sub-period the coefficient sums of the alternative maturities are significant or highly significant and substantial in size.

[13] A regression coefficient is considered "significant" when it is statistically significant at the 10% confidence level.

Finally, Table 3 also reports the estimates when the other country *j*'s auction dummy of the same maturity is included in the regression for country *i*, while dropping the dummy for other maturities of country *i* from the right-hand side. The estimated magnitudes of the coefficients on the own dummy of maturity *m* are very similar to the original estimates, while the significance of the coefficients is unchanged in all instances. In particular, in the case of Italy during the second sub-sample, an upcoming auction has a substantial upward effect on the bond yields. The foreign dummy is generally insignificant. Only the yields on the 10-year Italian bond in the full sample and the first sub-sample are affected significantly by auctions of 10-year German debt. In these cases, an upcoming German auction pushes up yields on the Italian same-maturity debt.

5.2. Regressions with auction size

We can refine baseline regression (1) by replacing the auction dummies with the size of the auctions:

$$\Delta y_t^{i,m} = c_0^{i,m} + \sum_{l=4}^{-5} \beta_l SIZE_{t+l}^{i,m} + \sum_{l=4}^{-5} \gamma_l SIZE_{t+l}^{i,n(\neq m)} + \sum_{l=4}^{-5} \delta_l SIZE_{t+l}^{j(\neq i),m} + \varepsilon_t^{i,m}, \qquad (3)$$

where *SIZE* is the total amount allotted in billions when there is an auction of the specified country-maturity combination on the indicated date. When there is no auction on a given date, then *SIZE* is zero. It is important to recall that the size of the auction is announced well before the auction, so that any potential feedback effects of yield movements onto the size of the auction are absent. We expect that, if there is any effect of the auction size, the effect is positive, because the larger the size of the auction, the more difficult it will be for the primary dealers to sell their inventory of the acquired new issue. This is borne out by the estimates shown in Table 4. Whenever the coefficient sum is significant, it is positive. As far as the significance of the coefficient sums is concerned, it is very much in line with the results for the regression with the auction dummies. In the case of the full sample regression, for Germany only the 5-year and 10-year regressions yield significance, while for Italy the coefficient sums are highly significant at all maturities and, moreover, the coefficient sums are much larger than in the case of Germany. Again, most of the action is found for Italy for the second sub-period, where in the case of the 2-year maturity, an increase by one billion in the amount allotted produces an additional up and down movement in yields by almost 6 basis points. For the regressions with the other maturity included, we see that the coefficient sums on the own maturity have generally become somewhat smaller, except in the case of the 2-year own maturity combined with the 10-year other maturity, where an additional allotment of one billion produces an almost 10 basis points additional yield. Further, for the combination of the 10-year own maturity with the 2-year foreign maturity the coefficient sum on the own maturity has become insignificant.

The estimated yield impact per billion auctioned are higher than the estimates for the U.S. auctions documented by Fleming and Rosenberg (2007), who report a 0.3 to 0.5 basis point yield increase per billion dollar auctioned for the five year U.S. Treasury note. The yield impacts can also be compared with the effects of the recent large-scale bond purchases by the ECB. Eser and Schwaab (2013) find a yield decrease for Italy of 1.5 basis points per billion bond purchases.

5.3. Assessing the potential role of non-linear size effects

A relevant question from a policymakers' point of view is whether the movements in the yields around the auction date depend in a nonlinear way on the size of the auction. For example, if these movements are convex in the auction size, it may be cheaper for the government to organise more frequent, but smaller auctions. In order to the test the presence of non-linear effects of the size of the auction on yield movements we estimate the following regression:

$$\Delta y_t^{i,m} = c_0^{i,m} + \sum_{l=4}^{-5} \beta_l SIZE_{t+l}^{i,m} + \sum_{l=4}^{-5} \gamma_l \left(SIZE_{t+l}^{i,m} \right)^2 + \varepsilon_t^{i,m}. \qquad (4)$$

In the interest of parsimony, in going from equation (3) to equation (4) we have dropped the size associated with other maturities and with auctions in the other country, because the addition of these variables did not materially affect the coefficient on the own auction size. Table 5 reports the sums of the absolute values of the coefficients for the regression that includes the square of the own size of the auction. The German auctions reveal only insignificant effects of the size and its square, except for the case of the 5-year auction during the second sub-period, where the effect of both variables is actually significantly negative. We have no interpretation of this result, except that it may be caused by the rather low number of observations in this case. Again, in the case of Italy the size and its square seem to play a larger role. For the 5- and 10-year auction over the full sample period the coefficient on the size rises substantially, while the coefficient on the size-squared is negative and significant for the 10-year auction, suggesting that the effect of the auction size on the yield movements is in fact concave. These findings for the full sample period are substantially strengthened when the sample is confined to the second sub-period.

Using the estimated quadratic relationship between the cumulative yield movement and the auction size, we can calculate the effect of having an auction of the average size reported in Table 2 versus no auction (an auction of size zero). Plugging the average size of 2.79 for the two-year Italian auction in the second period into the function 16.15 x – 3.29 x^2 implies a positive effect of 19.45 basis points of the auction. Similarly, for the 5-year Italian auction in the second period we estimate a positive effect of 17.81 basis points and for the 10-year auction a positive effect of 15.45 basis points. Further, at the relevant average auction size the estimated functions of the auction size are decreasing for each of the maturities.

5.4. The role of the bid-to-cover ratio

Our next variant on the baseline regression includes the bid-to-cover ratio (defined as the total amount bid over the total amount allotted) in addition to the auction dummy:

$$\Delta y_t^{i,m} = c_0^{i,m} + \sum_{l=4}^{-5} \beta_l AUC_{t+l}^{i,m} + \sum_{l=4}^{-5} \gamma_l BC_{t+l}^{i,m} + \varepsilon_t^{i,m}. \quad (5)$$

where BC denotes the bid-to-cover ratio (0) when there is an (no) auction of the specified country-maturity combination on the indicated date. Our hypothesis is that that the higher the bid-to-cover ratio, or the more successful an auction is, the smaller will be the auction cycle. Similarly to the previous section we use an F-test to test the hypotheses:

$$H_0^{\beta}: \left(\sum_{l=4}^{0} \beta_l\right) - \left(\sum_{l=-1}^{-5} \beta_l\right) = 0,$$
$$H_0^{\gamma}: \left(\sum_{l=4}^{0} \gamma_l\right) - \left(\sum_{l=-1}^{-5} \gamma_l\right) = 0.$$

Here, H_0^{β} is the null that there is no cycle of up and down movements in yields as a result of a given auction, whereas H_0^{γ} is the null that the degree of success of the auction does not have non-linear quadratic effects.

Table 6 reports the regression results for this variant. To enhance the comparability with the baseline regression we repeat the results of the estimation of equation (1) with the γ coefficients set to zero. The new results show that, whenever the coefficient sum on the auction dummies is significant, it is positive, while at the same time the coefficient sum on the bid-to-cover ratios is also significant and negative. This indicates that, while an upcoming auction leads to a rise in the yield, a larger bid-to-cover ratio reduces the effect on the yield, as a larger relative demand means that the lead parties in the auction can more easily unload their stock of the issue. This pattern is clearly visible for the Italian auctions over the full sample and, in some instances, for the German auctions. However, contrary to what might be expected, significance of both the coefficient sum of the auction dummies and the coefficient sum of the bid-to-cover ratio is lost during the second sub-period. The reason is the presence of multi-collinearity, which arises from the high correlation between the auction dummy and the bid-to-cover ratio. For each of the maturities, this correlation is well over 90 per cent for the first sub-sample and close to one for the second sub-sample. Of course, these high correlations are to a large extent driven by the fact that most of the observations are zeroes.

So far we have assumed that the bid-to-cover ratios are perfectly anticipated before the auction takes place or that the dealers taking part in the auctions exchange information on each other's forthcoming bids. However, this seems to be a strong and unrealistic assumption. Therefore, in Table 6 we also report a variant in which only the current and past values of the bid-to-cover ratios are included, that is we replace $\sum_{l=4}^{-5} \gamma_l BC_{t+l}^{i,m}$ by $\sum_{l=0}^{-5} \gamma_l BC_{t+l}^{i,m}$. The overall results are qualitatively similar to what we find when estimating equation (5). This indicates that most of the effect of the auction performance on secondary market yields occurs in the aftermath of the publication of the auction's bid-to-cover ratios.

The above exercise is informative, but, as previously discussed, it faces multi-collinearity problems that make it difficult to estimate the effect of the ratios with precision. To address this drawback, we follow another strategy and estimate for auction days only the following regression:

$$y_t^{i,m} - y_{b,t}^{i,m} = \lambda_0 + \lambda_1 BC_t^{i,m} + \varepsilon_t^{i,m}, \qquad (6)$$

where, as before, $y_t^{i,m}$ is the yield on the secondary market at the end of the auction day and $y_{b,t}^{i,m}$ is the yield on the secondary market at the beginning of the auction day *t*. The parameter λ_1 captures the effect of a higher bid-to-cover ratio on the yield movement on the secondary market. A priori, we would expect it to be negative. We also estimate a more general equation in which allow for the secondary market to react differently according to whether the bid-to-cover ratio is above or below its mean either over the (sub-) sample under consideration or relative to the mean over the previous year. The justification for the latter variant is probably stronger, as the mean over the previous year is in the information set of the traders, while the mean of the (sub-) sample can only be know with limited precision by the traders. More precisely, we also estimate:

$$y_t^{i,m} - y_{b,t}^{i,m} = \lambda_0 + \lambda_1^G BC_{G,t}^{i,m} + \lambda_1^B BC_{B,t}^{i,m} + \varepsilon_t^{i,m} \qquad (7)$$

where $BC_{G,t}^{i,m}$ ($BC_{B,t}^{i,m}$) is the difference between $BC_t^{i,m}$ and the relevant mean, when this difference is positive (negative), while it is zero otherwise. When $BC_{G,t}^{i,m} > 0$, the auction can be interpreted as having gone well, whereas when $BC_{B,t}^{i,m} < 0$, the auction can be interpreted as having gone badly. A priori, we would expect that the coefficients on both $BC_{G,t}^{i,m}$ and $BC_{B,t}^{i,m}$ are negative, because both an increase in $BC_{G,t}^{i,m}$ and an increase in $BC_{B,t}^{i,m}$ imply a higher bid-to-cover ratio.

Table 7 reports the results of the regressions in equations (6) and (7). The estimates of equation (6) reveal a number of instances in which the effect of the bid-to-cover ratio on the change in the yield during the auction day is significantly negative, while the effect is never significantly positive. This is the case for both countries and for the full sample period and each of the two sub-sample periods.

The estimates of equation (7) show frequently a significantly negative effect of an increase in the bid-to-cover ratio on the yield movement. The incidence of the significance and the absolute size of the effect is higher for “bad” than for “good” auctions. Actually, in the latter case, we find for the Italian 10-year bond a significant positive effect in the second sub-period. However, a more detailed inspection of the data reveals that this result is driven by two re-openings of 10-year bonds that are quite small in size, but feature relatively high bid-to-cover ratios. When we drop these two observations, the effect is no longer significant (not reported).

In the case of "bad" auctions, there is a strong and highly significant negative effect of a higher bid-to-cover ratio for each of the Italian bonds during the second sub-period when the split is based on the sub-period average for the bid-to-cover ratio. In other words, during the crisis period, Italian auctions that performed worse-than-average in terms of bid-to-cover ratio *ceteris paribus* resulted in a substantial increase in yields during auction day. Specifically, a one-unit drop in the bid to cover ratio for an auction that goes badly pushes up yields during auction day by 35 basis points. In the light of these results, the nervousness that is frequently expressed during the crisis in the media about upcoming auctions in peripheral euro-zone countries is not too surprising. Table 7 also tests whether the coefficients λ_1^G and λ_1^B are different, and finds that this is the case for Italian 5 and 10-year auctions during the second sub-sample period for the split based on the sub-period average.[14] For the split based on the previous-year mean the results are generally slightly weaker.

6. Implications

6.1 Assessing the potential issuance costs

In the spirit of Lou *et al.* (2012, pages 13-14) the observed yield movements surrounding auctions can be exploited to provide an estimate of the issuance costs borne by the government. Obviously, the problem in calculating these issuance costs is that the secondary market instrument from which we estimate the yield movements generally differs from the instrument that is auctioned in the primary market. In particular, except in the case of a reopening of an existing bond, the auctioned instrument is newly created and becomes the new on-the-run benchmark instrument for its headline maturity shortly after the auction.

In view of the preceding discussion, and to estimate issuance costs on the basis of the movement in secondary market yields, it is necessary to secure that there is a strong

[14] We have also done the corresponding regression based on the change in yield from end of pre-auction day to end of auction day. That is, for auction days *t*, we have done the regressions $y_t^{i,m} - y_{t-1}^{i,m} = \lambda_0 + \lambda_1 BC_t^{i,m} + \varepsilon_t^{i,m}$ and $y_t^{i,m} - y_{t-1}^{i,m} = \lambda_0 + \lambda_1^G BC_{G,t}^{i,m} + \lambda_1^B BC_{B,t}^{i,m} + \varepsilon_t^{i,m}$. The results are qualitatively the same, but tend to be quantitatively slightly weaker.

relationship between primary- and secondary market yields. To this end we estimate for each country i and maturity m combination the regression

$$y_{A,t}^{i,m} = \alpha_0 + \alpha_1 y_{b,t}^{i,m} + \nu_t, \tag{8}$$

where t runs over auction days only, $y_{A,t}^{i,m}$ is the average accepted yield on the country i and maturity m debt instrument on auction day t and $y_{b,t}^{i,m}$ is the corresponding secondary market yield at the *beginning* of auction day t. We include the beginning rather than the closing yield on the auction date, because the former is in the information set of the primary dealers when the auction takes place. To allow for the possibility of a break, the constant and the slope of equation (8) are allowed to differ between the first and second sub-periods. We only report the estimates for the slope (see Table 8). They show that there is an almost perfect one-to-one relationship between the average accepted yield on the auctioned instrument and the secondary market yield at the start of the auction day. That is, in all instances α_1 is (very close to) one. These findings suggest that the movements in the issuance cost as captured by the average accepted yield can be approximated to a high degree of precision by the movements of the yields in the secondary market.

Hence, we calculate the issuance cost by using the movements in the secondary market yield during the run up to the auction. Obviously, for the reasons explained above, this can provide us only with a very rough estimate of the issuance cost. Hence, we run the regression

$$\Delta y_{b,t}^{i,m} = c_0^{i,m} + \sum\nolimits_{l=4}^{0} \beta_l AUC_{t+l}^{i,m} + \varepsilon_t^{i,m}, \tag{9}$$

and take the estimate of the coefficient sum $\sum\nolimits_{l=L}^{0} \beta_l$ to assess the effect of the run-up of the auction on the debt yield. Table 9 reports the estimates of $\sum\nolimits_{l=L}^{0} \beta_l$ for L=0,1, .., 4.

Clearly, for Italy the yield movements as a result of the run-up to an auction are larger than for Germany. We focus on Italy to provide a rough calculation of the issuance costs based on the full-sample data. For example, the average issuance cost that we calculate for an auction of five-year Italian debt is an additional annual interest payment of 2,519 million (the average amount allotted) times 3.12 basis points (hence, using L = 4), which is approximately 785,000 euro's per year. To obtain the cost for the full length of the issue we need to multiply this number by the duration of a typical 5 –year bond. The duration can be calculated as function of the length of the period between settlement date and maturity date, the coupon rate, the frequency of coupon payments and the average accepted yield at the auction date. We take three random five-year bonds issued in 2006, which have an average duration of 4.36 years, and three random five-year bonds issued in 2012. These have an average duration of 4.52 years. For the full sample we use an average duration of (4.36+4.52) = 4.44 years. Hence, we calculate an issuance cost of 785,000 times 4.44 is 3.5 million euro's. Assuming that all the currently outstanding debt issued by the Italian Treasury has been subject to the same issuance cost of approximately 3 basis points, the additional annual cost to the Treasury is almost 500 million euros (1640 billion euros times 3 basis points). Of course, it is important to realise that these are only rough and indicative estimates of the issuance costs.

The larger estimated effects of the auction dummies going from the first to the second sub-period suggest that issuance costs have increased for Italy as a result of the economic and financial crisis. It is of interest to present an estimate of this *increase* in issuance cost between the non-crisis and the crisis period. To this end we can not only make use of the one-to-one link between the secondary market yield at the start of the auction day and the average accepted yield. Table 10 reports the average difference between the average accepted yield and the opening yield $y_{A,t}^{i,m} - y_{b,t}^{i,m}$ on auction days. Clearly, for Italy the average accepted yield tends to be lower than the opening yield on auction date, although this difference tends to be substantially smaller during the second part of the sample than during the first part of the sample. The relative rise in the average accepted yield is consistent with the fact that, according to market participants and backed by the lower bid-to-cover ratios reported in Table 2, during the second sub-period the Italian Treasury found it more difficult to auction the debt.

While this information cannot help us obtaining a better assessment of the *level* of the issuance costs in either sub-period or the full sample period, it thus can help us in assessing the *change* in the issuance costs between the two sub-periods. This is of quite some relevance, because this would provide us with an assessment of the effect of the financial crisis on debt issuance costs. Concretely, we measure the change in the issuance cost of an average-sized issue by adding the increase between the two sub-periods of the average difference $y_{A,t}^{i,m} - y_{b,t}^{i,m}$ to the increase in the estimated coefficient sum $\sum_{l=4}^{0} \beta_l$ and multiplying the resulting number by the average issue size. We take the average issue size in the second sub-period. For the case of 5-year Italian debt, this yields (7.53 – 0.35) plus (-2.97 + 6.32) basis points times

3,080 million, which is approximately 3.25 million euro's per year for an average-sized auction. Here, we have made use of the figures reported in, respectively, Tables 9, 10 and 1. Multiplied by the estimated duration of a five-year Italian bond during the second sub-sample period of 4.52 years yields an estimated cost increase of 3.25*4.52 = 14.7 million.[15]

6.2 Do yield movements around auctions constitute excess profit opportunities?

Market participants could sell the on-the-run bond or a close-maturity off-the-run bond prior to the auction, when the price is still relatively high, and buy it back on the day of the auction, when the price has fallen, and in this way try to make a profit. However, whether this constitutes an opportunity to make excess profits is a question that for at least two reasons cannot so easily be answered.

First, an investor has to overcome the transactions costs involved in this trade. These costs are mainly the bid-ask spread. When selling the security, the trader loses the difference between the "fundamental price" and the bid price, while when buying the security, the trader loses the difference between the ask price and fundamental price. Hence, a rough estimate of the transaction cost of the proposed round trip is the full bid-ask spread on an auction day or a day close to the auction day. Pelizzon *et al.* (2013, their Table 6) report an estimate of the quoted bid-ask spread of Italian 5-year debt of 0.378% of the price of the debt.[16] Dividing by a roughly-estimated duration of 4 years this translated into a 9.5 basis points spread relative to the annual yield on the debt. The corresponding effective bid-ask spread is 3 basis points. A complication may be that bid-ask spreads differ systematically during and around auction days from the bid-ask spreads on other days, but we do not have data on this, so we use the numbers derived from Pelizzon *et al.* (2013).

Second, the strategy is not riskless and it may well be the case that the uncertainty about the returns also increases around auction date. Table 11 reports both the means and standard deviations of yield differences during the run up to an auction 5-day window before and including the auction day and other days. While yield differences are on average positive during the run-up period, they are negative on average during other days. The difference in the means is mostly significant. The comparison of the standard deviations of the yield

[15] Notice that the increase in the duration going from the first to the second sub-period leads to an additional increase in the cost. However, we neglect it, as this increase in the duration is only small and our full calculation is only indicative in any case.

[16] Assuming that the trader is a price taker, hence, cannot "time" the market to get a good bid-ask spread, it makes sense to use the quoted rather than the effective bid-ask spreads as the basis for our calculations.

differences reveals a less systematic pattern, although in a majority of the cases it is higher during the run-up to the auction. However, the differences are generally not too large in magnitude, although they are statistically significant in many cases.

We can assess the possibility of making an "excess profit" by calculating the Sharpe ratio (*SR*) for the abovementioned round trip as:

$$SR = \frac{5\mu - ba}{\sqrt{5}\sigma},$$

where μ is daily return (the yield difference) during the run-up to the auction, σ the standard deviation of the daily return and *ba* the bid-ask spread, all expressed in yield basis points. Using the quoted bid-ask spread and the numbers in Tables 9 and 11, we find for the run-up period *SR* = (7.53-9.5) / (√5*12.10) = -0.07. Using the effective bid-ask spread, we find that *SR* = (7.53-3) / (√5*12.10) = 0.17. Notice that this is the Sharpe ratio for one auction. As there are auctions typically once a month, this strategy can be repeated twelve times per year. Assuming a risk free investment in the non-auction periods, the annual Sharpe ratio for the strategy then is √12*0.17=0.6 if one uses the effective spread as the transaction cost measure, and √12*-0.07=-0.24 if the transaction costs are equal to the quoted spread. These numbers are smaller than the annualized Sharpe ratio of the similar strategy reported in US treasury auctions by Lou et al. (2012). They find a Sharpe ratio above 1 before transaction cost and 0.95 after transaction costs. The explanation for the difference is in the following: before transaction costs, our Sharpe ratios are similar, but the transaction costs on Italian bonds in the recent period are much higher than the transaction costs for US treasury bonds. Lou et al. report transaction cost of 2.44% of the price of a ten year bond. This translates into 0.3 basis points bid-ask spread on the yield, compared to 3 basis points effective spread and 9.5 basis points quoted spread for the Italian bonds. Hence, even with the (relatively low) effective spread estimates of transaction costs, our after-cost Sharpe ratios are smaller than those found in Lou et al. and more in line with Sharpe ratios of other risky investment strategies.[17] When traders have to pay the quoted spread, the after-cost trading profits are negative.

[17] For example, a typical stock index investment with 3% excess return and 15% volatility has an annual Sharpe ratio of 0.20. Lou et al. report Sharpe ratios for momentum strategies in the order of 0.60.

7. Concluding remarks

In this paper, we have shown for the period since the inception of the euro that secondary market yields on Italian public debt increase in anticipation of an auction of a new issue and decrease after the auction, while no or a smaller such effect is present for German public debt. These yield movements on the Italian debt are largely concentrated in the period of the crisis since mid-2007. Moreover, the yield movements tend to be larger when the bid-to-cover ratio is smaller. We also found that the secondary market behaviour of series for which there is *no* auction, but with a maturity close to that of the newly-created series is very similar to the secondary market behaviour of the new series. We presented a simple theoretical framework in which a small group of primary dealers require compensation for inventory risk and this compensation needs to be higher when market uncertainty is larger. Our empirical results are consistent with this mechanism and, in particular, the behaviour of yields of close-maturity series seems to favour an explanation of yield movements based on the behaviour of primary dealers with limited risk-bearing capacity over other explanations based on supply effects or liquidity effects. The results also allow us to make a rough assessment of the issuance costs of public debt. They show that these issuance costs have gone up with the crisis. For example, for a five-year bond the increase in the issuance cost over its entire life is estimated at about between 14 and 15 million euro's. Finally, we have tried to assess the opportunities to profitably exploit the yield movements around auctions. However, the transactions costs and the tendency of the market volatility to increase during the run-up of the auctions seem to make it hard to earn "excess profits".

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Tables

Table 1: Means and standard deviations of daily yield change

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
Mean (in basis points)						
Before crisis	0.06	0.05	0.03	0.06	0.06	0.04
Crisis	-0.29	-0.26	-0.20	-0.19	-0.09	-0.02
Equality test	0.02	0.06	0.13	0.36	0.55	0.76
Standard deviation (in basis points)						
Before crisis	4.09	4.37	3.85	4.10	4.36	3.90
Crisis	5.31	5.77	5.35	12.28	10.44	8.02
Equality test	0.00	0.00	0.00	0.00	0.00	0.00

Notes: "Before crisis" refers to the period January 1, 1999 – June 30, 2007, while "Crisis" refers to the period July 1, 2007 – February 12, 2013. is the standard deviation of the first difference of the respective bond yield. The "Equality test" reports the *p*-value of the *F*-test of equality of means, respectively variances.

Table 2: Summary statistics for auctions

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
Number auctions	112	90	103	189	168	166
Av. amount bid (mil.)	11,618	9,145	9,430	4,296	4,221	4,276
Av. amount allotted (mil.)	5,422	4,789	5,282	2,167	2,519	2,729
Av. bid-to-cover ratio	2.146	1.910	1.776	2.151	1.767	1.612
Av. accepted yield (%)	2.26	2.81	3.57	3.24	3.99	4.67
	January 1, 1999 – June 30, 2007					
Number auctions	53	43	52	122	105	95
Av. amount bid (mil.)	14,810	11,461	12,164	4,100	4,096	4,326
Av. amount allotted (mil.)	5,913	5,353	6,208	1,826	2,183	2,489
Av. bid-to-cover ratio	2.562	2.153	2.018	2.403	1.949	1.767
Av. accepted yield (%)	3.23	3.74	4.31	3.38	4.03	4.55
	July 1, 2007 – February 12, 2013					
Number auctions	59	47	51	67	63	71
Av. amount bid (mil.)	8,751	7,026	6,642	4,655	4,428	4,210
Av. amount allotted (mil.)	4,981	4,273	4,337	2,788	3,080	3,049
Av. bid-to-cover ratio	1.773	1.687	1.530	1.692	1.465	1.405
Av. accepted yield (%)	1.40	1.97	2.82	2.98	3.94	4.82

Table 3: Estimates of equation (1) with auctions dummies

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
Dummy own	1.95	3.34^{*}	3.58^{***}	5.64^{***}	6.80^{***}	6.12^{***}
Dummy own		3.06^{*}	2.98^{**}		6.03^{***}	5.66^{***}
Dummy 2-year		-2.22	-2.12		4.34^{**}	1.88
Dummy own	2.10		3.87^{***}	4.97^{**}		5.80^{***}
Dummy 5-year	1.89		1.64	4.59^{**}		3.63^{***}
Dummy own	1.70	3.46^{*}		3.92^{*}	6.10^{***}	
Dummy 10-year	-0.94	0.61		3.78	6.04^{***}	
Dummy own	2.05	3.07^{*}	3.59^{***}	5.59^{***}	7.00^{***}	6.22^{***}
Dummy foreign	0.94	1.00	0.97	-4.46	-5.55	3.78^{**}
	January 1, 1999 – June 30, 2007					
Dummy own	1.94	-0.31	4.61^{***}	-0.64	1.49	0.93
Dummy own		-0.35	4.48^{***}		1.77	1.60
Dummy 2-year		-0.38	-0.98		0.56	-0.34
Dummy own	2.06		4.48^{***}	-0.39		1.21
Dummy 5-year	0.042		-0.71	1.19		1.33
Dummy own	1.98	-0.077		-0.93	1.75	
Dummy 10-year	0.38	1.56		0.39	0.60	
Dummy own	1.97	-0.67	4.43^{***}	-0.72	1.52	0.90
Dummy foreign	-0.49	1.57	0.19	0.41	-0.81	3.57^{**}
	July 1, 2007 – February 12, 2013					
Dummy own	1.95	6.75^{***}	2.50	16.92^{***}	15.48^{***}	13.01^{***}
Dummy own		6.44^{**}	1.36		13.68^{***}	11.11
Dummy 2-year		-3.40	-3.49		11.98^{***}	15.42^{**}
Dummy own	2.44		3.44	15.81^{***}		11.66^{***}
Dummy 5-year	4.13^{*}		3.95^{*}	10.99^{**}		6.77^{**}
Dummy own	1.16	6.83^{***}		28.65^{***}	12.57^{***}	
Dummy 10-year	-2.66	0.02		1.60	12.78^{***}	
Dummy own	2.33	6.43^{***}	2.63	16.12^{***}	15.17^{***}	13.29^{***}
Dummy foreign	2.90	0.58	1.85	-7.45	-8.96	3.73

Notes: (i) Sums of coefficients $-\sum_{l=-1}^{-5}\beta_l+\sum_{l=4}^{0}\beta_l$ are in basis points. (ii) Significance at the 10, 5 and 1% level is denoted by *, ** and ***, respectively. (iii) Estimation method is ordinary least squares (OLS) with Newey-West adjusted standard errors. (iv) "Dummy foreign" is the Italian (German) dummy corresponding to Dummy own" of Germany (Italy). "Dummy foreign" always has the same maturity as "Dummy own" in the same regression.

Table 4: Estimates of equation (3) with auctions sizes

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
Size own	0.31	0.69*	0.71***	3.17***	2.56***	2.04***
Size own		0.63	0.64***		2.11***	1.16*
Size 2-year		-0.42	-0.39		2.40***	2.20***
Size own	0.34		0.74***	2.98***		1.91***
Size 5-year	0.40		0.30	1.67**		1.49***
Size own	0.29	0.71*		3.49***	2.32***	
Size 10-year	-0.15	0.17		-0.41	2.11***	
Size own	0.32	0.64*	0.70***	3.21***	2.61***	2.08***
Size foreign	0.66	0.47	0.21	-0.60	-0.92	0.65**
	January 1, 1999 – June 30, 2007					
Size own	0.26	-0.11	0.74***	-0.018	0.78	0.32
Size own		-0.12	0.72***		0.83	0.34
Size 2-year		-0.13	-0.19		0.50	0.35
Size own	0.27		0.72***	0.21		0.40
Size 5-year	-0.029		-0.19	0.55		0.70
Size own	0.26	-0.083		0.028	0.85	
Size 10-year	0.001	0.24		-0.38	0.12	
Size own	0.26	-0.17	0.70***	0.007	0.78	0.31
Size foreign	0.07	0.91	0.09	0.045	-0.19	0.56**
	July 1, 2007 – February 12, 2013					
Size own	0.39	1.86***	0.62	5.74***	4.11***	3.54***
Size own		1.77***	0.39		3.29***	1.81
Size 2-year		-0.67	-0.70		3.93***	6.69***
Size own	0.51		0.86*	5.25***		3.22***
Size 5-year	1.15**		1.11**	2.68*		2.06**
Size own	0.26	1.94***		10.49***	3.43***	
Size 10-year	-0.50	0.16		-2.96	3.83***	
Size own	0.43	1.79***	0.61	5.57***	4.05***	3.64***
Size foreign	0.99	0.17	0.28	-1.22	-1.94	0.69

Notes: (i) Sums of coefficients are in basis points per billion euro. (ii) Significance at the 10, 5 and 1% level is denoted by *, ** and ***, respectively. (iii) Estimation method is ordinary least squares (OLS) with Newey-West adjusted standard errors.

Table 5: Estimates of equation (4) with the size squared

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
Size own	0.31	0.69*	0.71***	3.17***	2.56***	2.04***
Size own	0.88	2.29	0.69	1.11	4.73*	5.17***
Size own squared	-0.094	-0.30	0.002	0.74	-0.70	-0.96*
	January 1, 1999 – June 30, 2007					
Size own	0.26	-0.11	0.74***	-0.018	0.78	0.32
Size own	1.44	1.71	1.34	-2.05	-0.46	0.98
Size own squared	-0.18	-0.31	-0.089	0.88	0.45	-0.23
	July 1, 2007 – February 12, 2013					
Size own	0.39	1.86***	0.62	5.74***	4.11***	3.54***
Size own	-0.67	-7.29**	-0.98	16.15*	19.52***	13.97***
Size own squared	0.20	2.01***	0.35	-3.29	-4.46**	-2.92***

Notes: (i) Sums of coefficients are in basis points per billion euro. (ii) Significance at the 10, 5 and 1% level is denoted by *, ** and ***, respectively. (iii) Estimation method is ordinary least squares (OLS) with Newey-West adjusted standard errors.

Table 6: Estimates of equation (5) with the bid-to-cover ratio

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
Dummy own	1.95	3.34*	3.58***	5.64***	6.80***	6.12***
Dummy own	3.31	7.58	11.89***	20.01***	18.01**	18.09**
BC own	-0.63	-2.22	-4.73**	-6.68***	-6.64*	-7.42*
Dummy own	5.76*	11.94**	14.58***	14.08***	17.86***	15.15**
BC own past	-1.78	-4.50*	-6.29***	-3.93**	-6.26**	-5.60
	January 1, 1999 – June 30, 2007					
Dummy own	1.94	-0.31	4.61***	-0.64	1.49	0.93
Dummy own	2.96	-15.53	18.44***	1.31	5.13	-3.97
BC own	-0.40	7.07	-7.02***	-0.81	-1.85	2.77
Dummy own	3.62	-1.58	16.16***	-0.13	3.38	-1.28
BC own past	-0.66	0.59	-5.85***	-0.21	-0.96	1.25
	July 1, 2007 – February 12, 2013					
Dummy own	1.95	6.75***	2.50	16.92***	15.48***	13.01***
Dummy own	6.73	31.55***	2.16	31.82	-31.48	26.09
BC own	-2.70	-14.70**	0.23	-8.76	32.05*	-9.29
Dummy own	9.87	20.83**	18.03*	21.05	-1.75	22.52
BC own past	-4.47	-8.35*	-10.16*	-2.40	9.36	-6.75

Notes: (i) Sums of coefficients are in basis points. (ii) Significance at the 10, 5 and 1% level is denoted by *, ** and ***, respectively. (iii) Estimation method is ordinary least squares (OLS) with Newey-West adjusted standard errors. (v) "BC" is bid-to-cover. In the case of "BC own past", $\sum_{l=4}^{-5}\gamma_l BC_{t+l}^{i,m}$ is replaced by $\sum_{l=0}^{-5}\gamma_l BC_{t+l}^{i,m}$.

Table 7: Estimates of the effect of the bid-to-cover ratio on the secondary market yield movement on auction day

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
λ_1	-0.34	-0.66	-2.08***	-1.25*	-0.55	-1.09
Good / Bad auctions: based on period mean						
λ_1^G	-0.38	1.08	-1.15*	0.53	0.48	0.12
λ_1^B	-0.22	-4.06	-5.34*	-5.71***	-2.63	-4.54
Test	0.94	0.16	0.24	0.01	0.46	0.18
Good / Bad auctions: based on previous-year mean						
λ_1^G	-0.13	-0.56	-2.43***	-0.27	-0.35	-0.05
λ_1^B	-1.35	-4.95**	-3.08*	-3.39**	-2.89	-2.07
Test	0.67	0.26	0.77	0.37	0.49	0.46
	January 1, 1999 – June 30, 2007					
λ_1	-0.69	0.25	-2.07***	-1.11***	0.58	-1.31**
Good / Bad auctions: based on period mean						
λ_1^G	-0.47	0.16	-1.76*	-0.42	2.12	-0.83
λ_1^B	-1.14	0.40	-2.92	-2.49**	-4.84**	-2.63
Test	0.74	0.95	0.76	0.22	0.06	0.39
	Good / Bad auctions: based on previous-year mean					
λ_1^G	-3.44	2.29	-2.40***	-0.41	0.88	-0.95
λ_1^B	0.55	-2.45	-0.91	-2.25**	-2.96	-1.65
Test	0.45	0.21	0.48	0.28	0.50	0.74
	July 1, 2007 – February 12, 2013					
λ_1	0.15	-5.34**	-5.48*	-14.74**	2.18	4.07
Good / Bad auctions: based on period mean						
λ_1^G	1.83	-2.96	-0.67	-1.93	9.14	14.46***
λ_1^B	-3.34	-8.69*	-11.05	-34.64*	-21.14**	-20.81*
Test	0.26	0.41	0.31	0.19	0.07	0.01
Good / Bad auctions: based on previous-year mean						
λ_1^G	2.06*	-4.53	-2.29	8.90	4.09	12.05**
λ_1^B	-4.81	-7.19	-8.48	-37.29**	-9.61	-14.89
Test	0.11	0.67	0.54	0.06	0.31	0.03

Note: The table reports the OLS estimates of equations (6) and (7). Variables are expressed in basis points. Significance (based on Newey-West adjusted standard errors) at the 10, 5 and 1% level is denoted by *, ** and ***, respectively. "Test" reports the p-value of the Wald-statistics testing the equality of λ_1^G and λ_1^B.

Table 8: Estimates of relationship average accepted yield and secondary market yield

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	January 1, 1999 – June 30, 2007					
α_1	0.99***	1.00***	0.99***	1.01***	1.00***	0.99***
	July 1, 2007 – February 12, 2013					
α_1	0.99***	1.00***	1.00***	1.01***	1.01***	1.04***
Adjusted R^2	0.999	0.999	0.999	0.990	0.987	0.99
Number of observations	112	90	103	189	168	166

Note: The table reports the ordinary least squares (OLS) estimates of equation (1). Constant and slope are allowed to differ between the two sub-periods. Variables are expressed in basis points. Significance (based on Newey-West robust standard errors) at the 10, 5 and 1% level is denoted by *, ** and ***, respectively.

Table 9: Estimates of run-up effect from one to five days before the auction

	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
Run-up (1 day)	1.24^{**}	1.52^{**}	0.84^{*}	0.96	0.85	1.48^{***}
Run-up (2 days)	0.88	1.27	0.34	1.49	0.78	1.84^{**}
Run-up (3 days)	0.83	2.11^{**}	0.63	2.04^{*}	1.48	2.97^{***}
Run-up (4 days)	1.00	2.52^{**}	1.37	2.71^{*}	3.11^{**}	3.76^{***}
Run-up (5 days)	1.81	3.10^{**}	1.58	2.61	3.12^{*}	4.09^{***}
	January 1, 1999 – June 30, 2007					
Run-up (1 day)	0.23	0.47	-0.15	0.20	0.77	0.62
Run-up (2 days)	-0.20	0.13	0.07	-0.02	1.11	1.38^{**}
Run-up (3 days)	-0.38	0.37	0.36	-0.12	1.25	2.26^{***}
Run-up (4 days)	0.53	0.80	2.65^{**}	-0.43	1.41	1.41^{*}
Run-up (5 days)	2.15	1.56	2.31^{*}	-0.29	0.35	1.91^{*}
	July 1, 2007 – February 12, 2013					
Run-up (1 day)	2.25^{***}	2.59^{**}	1.90^{***}	2.24	0.95	2.64^{***}
Run-up (2 days)	2.07^{**}	2.56^{*}	0.72	4.05^{*}	0.15	2.51^{*}
Run-up (3 days)	2.24^{**}	4.07^{**}	1.05	5.67^{*}	1.77	4.01^{**}
Run-up (4 days)	1.85	4.58^{**}	0.23	8.01^{**}	5.79^{*}	7.02^{***}
Run-up (5 days)	2.06	5.12^{**}	1.07	7.38^{*}	7.53^{**}	7.17^{***}

Notes: (i) Sums of coefficients are in basis points per billion euro's. (ii) Significance at the 10, 5 and 1% level is denoted by *, ** and ***, respectively. (iii) Estimation method is ordinary least squares (OLS) with Newey-West adjusted standard errors.

Table 10: Difference between average accepted and secondary market opening yield

Germany			Italy		
2-year	5-year	10-year	2-year	5-year	10-year
Full sample period					
-1.28***	0.28	0.42	-6.98***	-5.07***	-3.14***
January 1, 1999 – June 30, 2007					
-1.13*	1.10*	0.24	-9.59***	-6.32***	-5.25***
July 1, 2007 – February 12, 2013					
-1.42**	-0.47	0.60	-2.22	-2.97	-0.31

Note: Significance (based on Newey-West adjusted standard errors) at the 10, 5 and 1% level is denoted by *, ** and ***, respectively. The sub-sample results are obtained through a single regression in which we allow the constant and the slope to differ between the two sub-samples.

Table 11: Mean and volatility of yield difference in run-up auctions versus other days

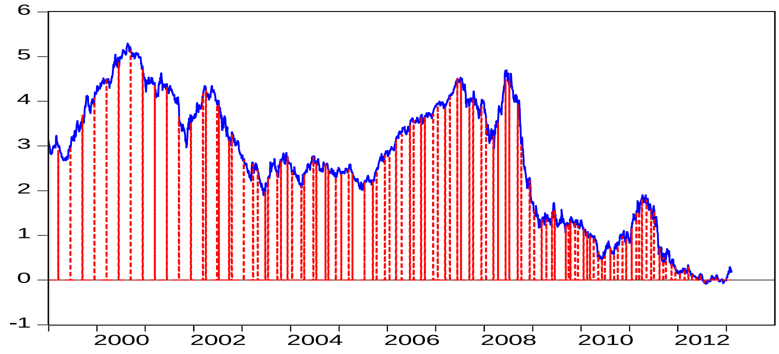
	Germany			Italy		
	2-year	5-year	10-year	2-year	5-year	10-year
	Full sample period					
Mean – normal	-0.10	-0.15	-0.08	-0.08	-0.04	-0.06
Mean – run-up	0.18	0.51	0.31	0.55	0.73	0.72
S.D. – normal	4.56	4.88	4.44	8.91	6.97	5.87
S.D. – run-up	4.90	5.37	4.75	7.81	8.26	5.10
	January 1, 1999 – June 30, 2007					
Mean – normal	0.08	-0.05	-0.02	0.01	-0.13	-0.06
Mean – run-up	0.23	0.45	0.62	0.03	0.44	0.27
S.D. – normal	4.10	4.37	3.87	3.90	4.25	3.86
S.D. – run-up	4.22	4.33	3.90	4.18	4.55	3.72
	July 1, 2007 – February 12, 2013					
Mean – normal	-0.45	-0.34	-0.18	-0.20	0.10	-0.05
Mean – run-up	0.14	0.56	0.01	1.49	1.21	1.32
S.D. – normal	5.32	5.72	5.35	12.66	9.58	8.20
S.D. – run-up	5.44	6.17	5.47	11.80	12.10	6.46

Note: Numbers are in basis points. The “run-up” is the 5-day window before and including the auction day. “S.D.” is the standard deviation of the first difference of the respective bond yield. “Normal” is the period excluding the full auction cycle (i.e., the run-up and run-down phases of the cycle).

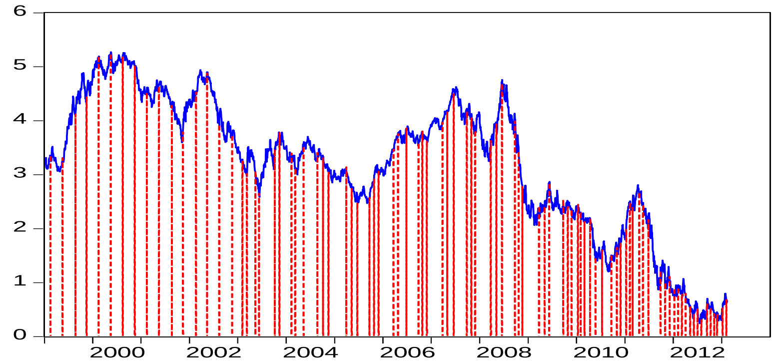
Figures

Figure 1.a: German government bond yields in the primary and secondary markets

Two-year maturity



Five-year maturity



Ten-year maturity

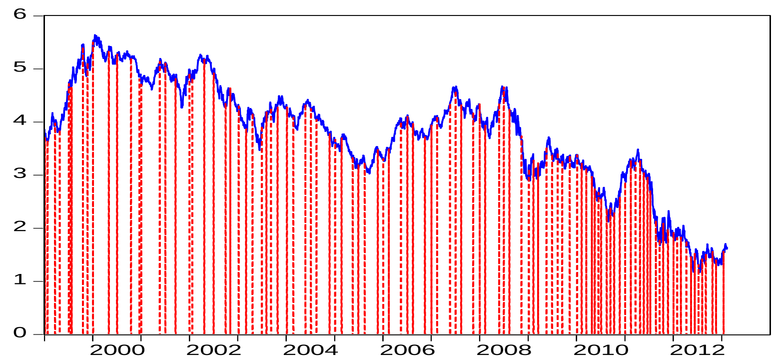
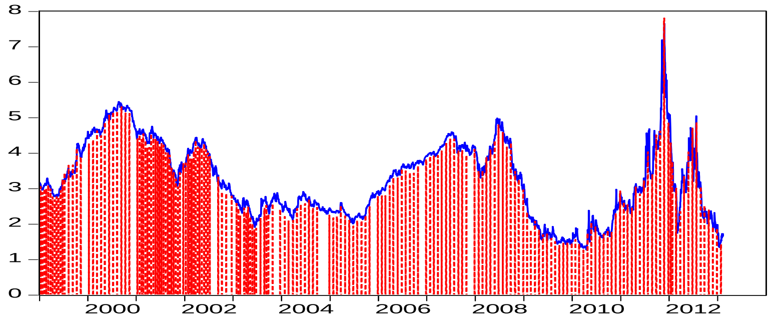
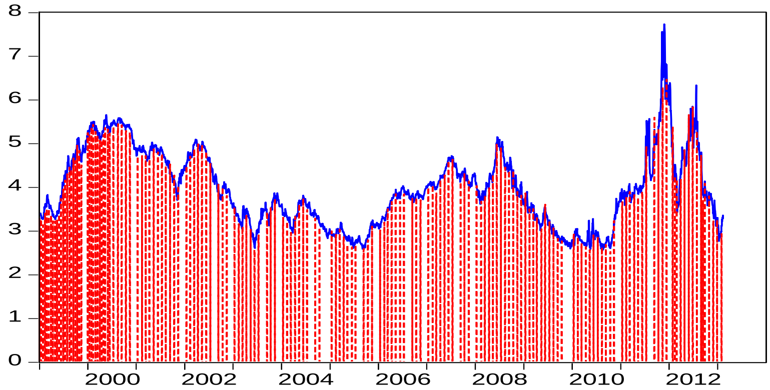


Figure 1.b: Italian government bond yields in the primary and secondary markets

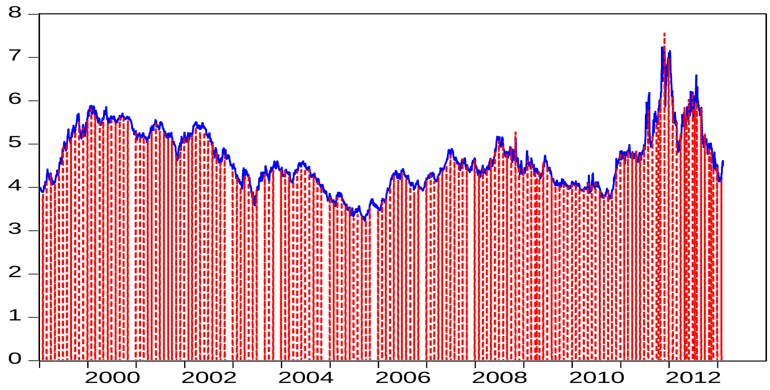
Two-year maturity



Five-year maturity



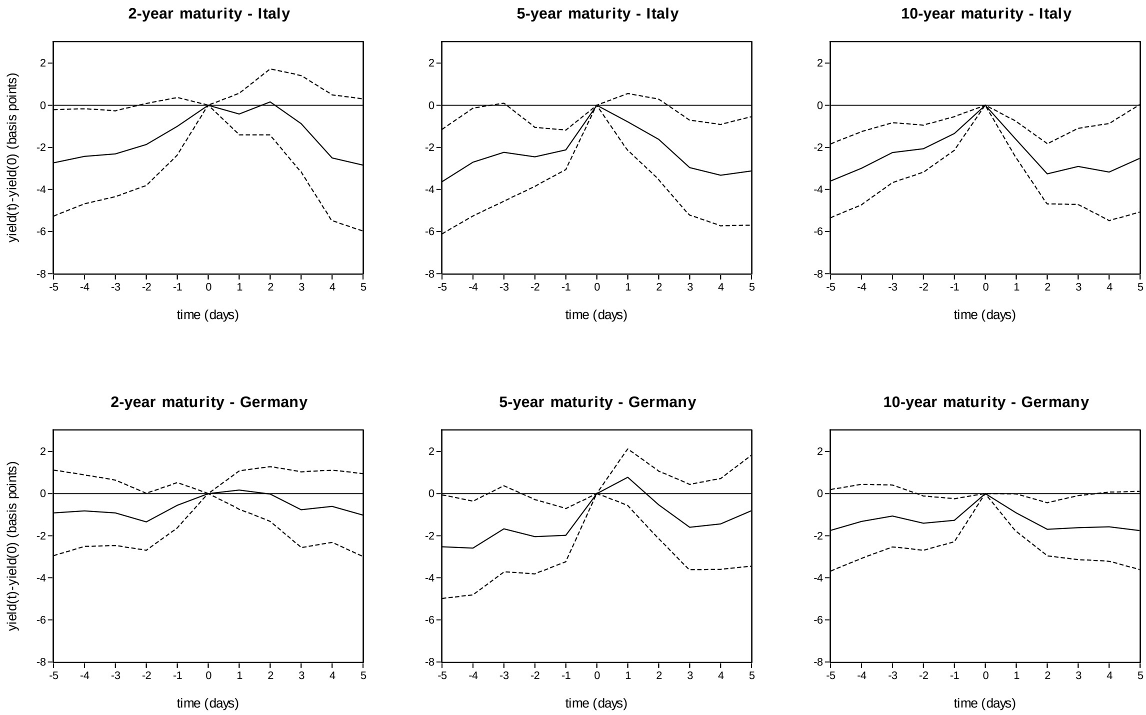
Ten-year maturity



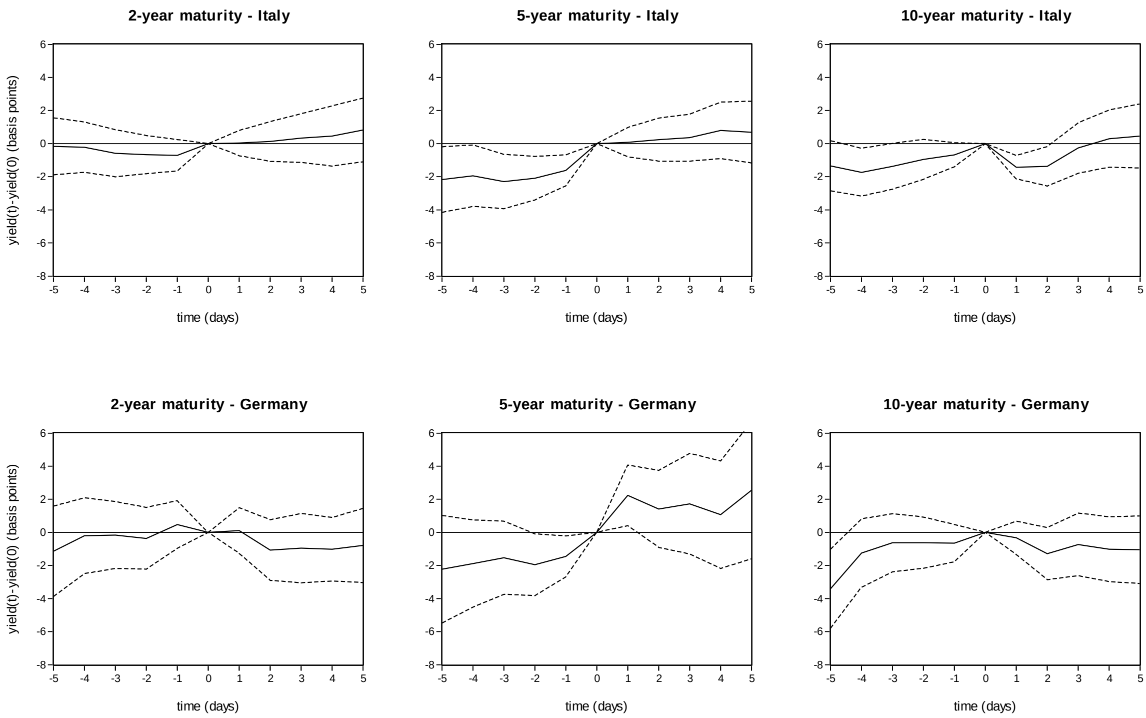
Notes: the blue lines depict the secondary market yields, while the vertical lines show the auction dates and the average accepted yield at the auction.

Figure 2: Yield movements before and after auctions

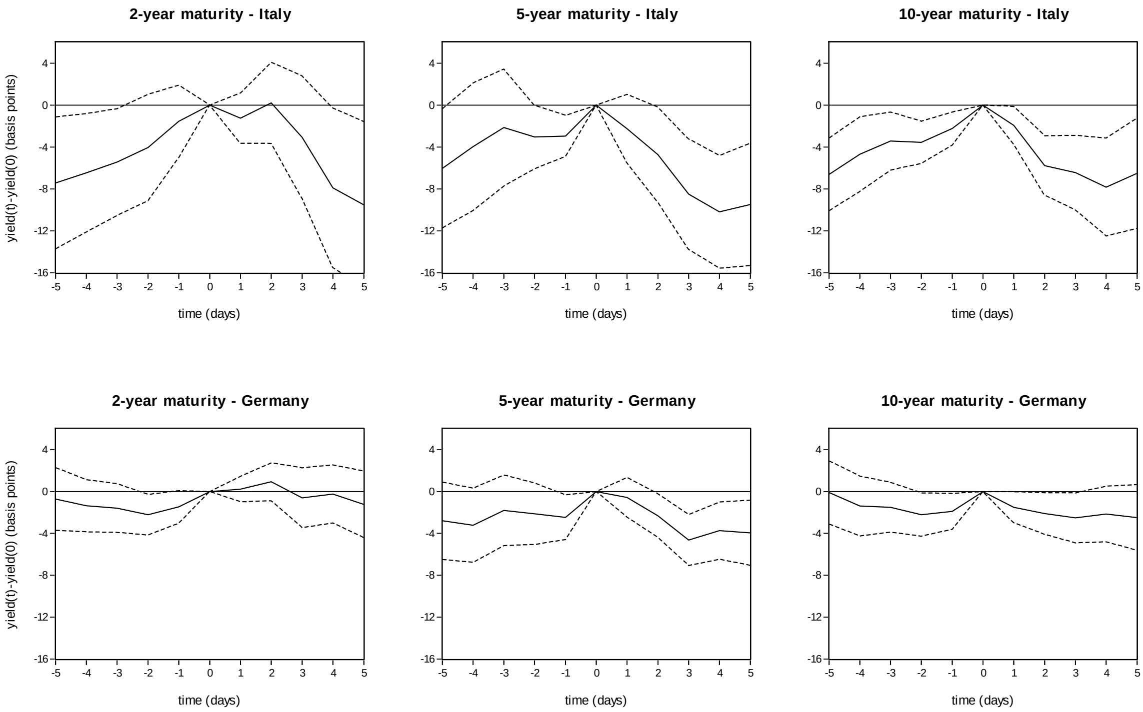
a. Full sample



b. Period January 1, 1999 – June 30, 2007



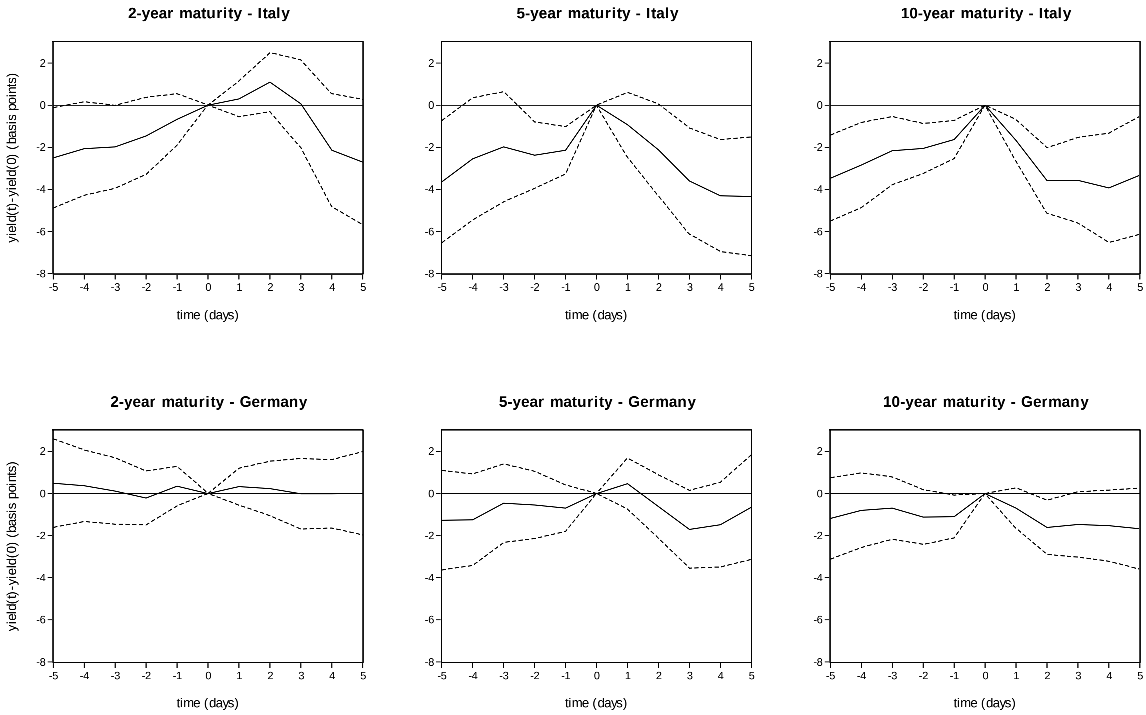
c. July 1, 2007 – February 12, 2013



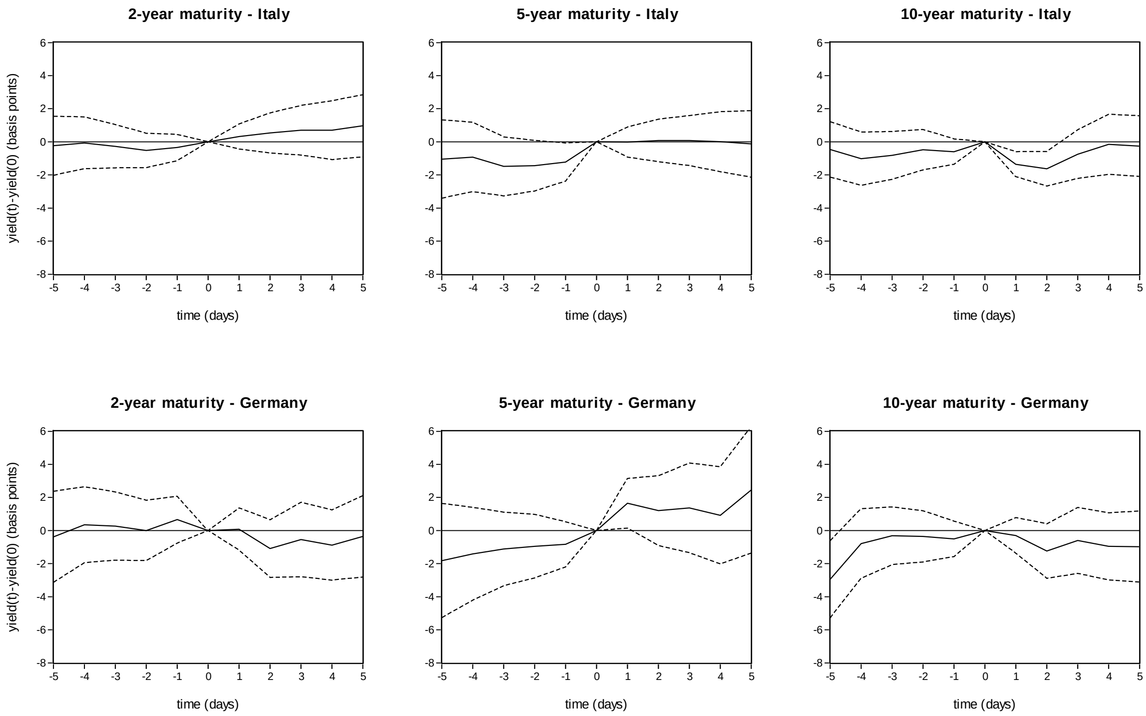
Notes: The figure reports the average of $y_t - y_0$, where y_t is the yield of the Treasury bond being considered on day *t*, and y_0 is the yield on the same bond on the auction day 0. All yields are expressed in basis points. The dotted lines are the 95% confidence intervals with Newly-West adjusted standard errors.

Figure 3: Yield movements around auctions – close maturities

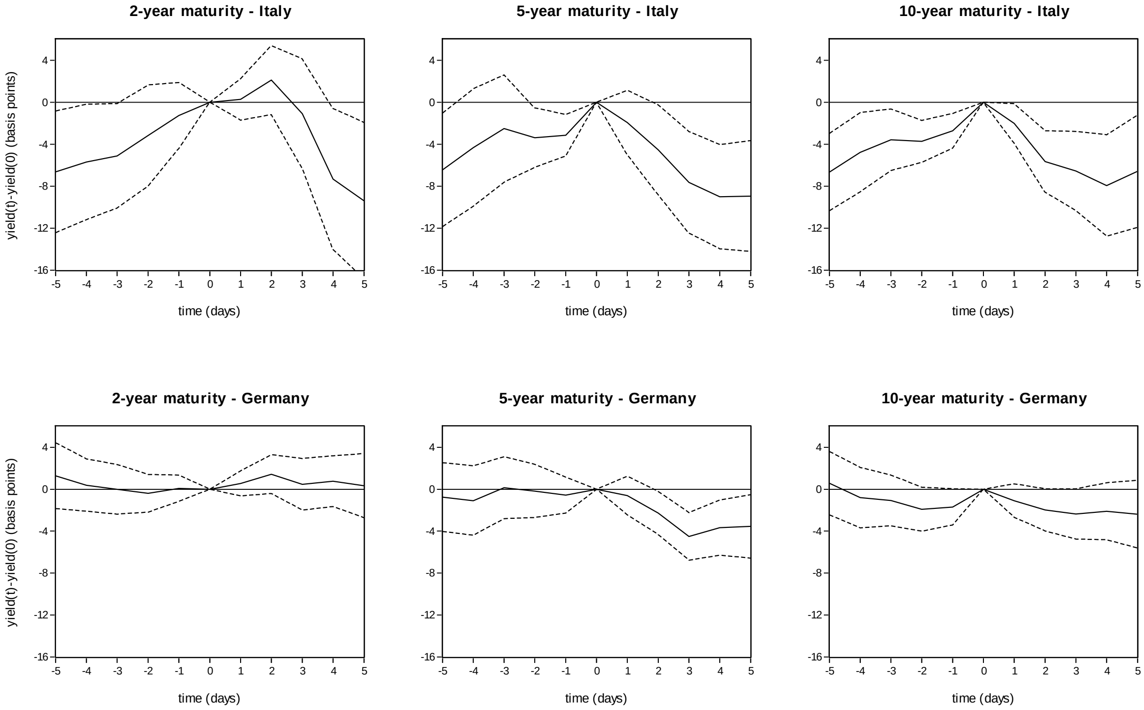
a. Full sample



b. Period January 1, 1999 – June 30, 2007



c. Period July 1, 2007 – February 12, 2013



Notes: the figure reports the average yield movements of the 3-year bond around auctions of 2-year debt, of the 6-year bond around auctions of the 5-year debt and the 9-year bond around auctions of the 10-year debt. Further, see the Notes to Figure 2.

Appendix A: Background information on auction procedures

A.1. Germany

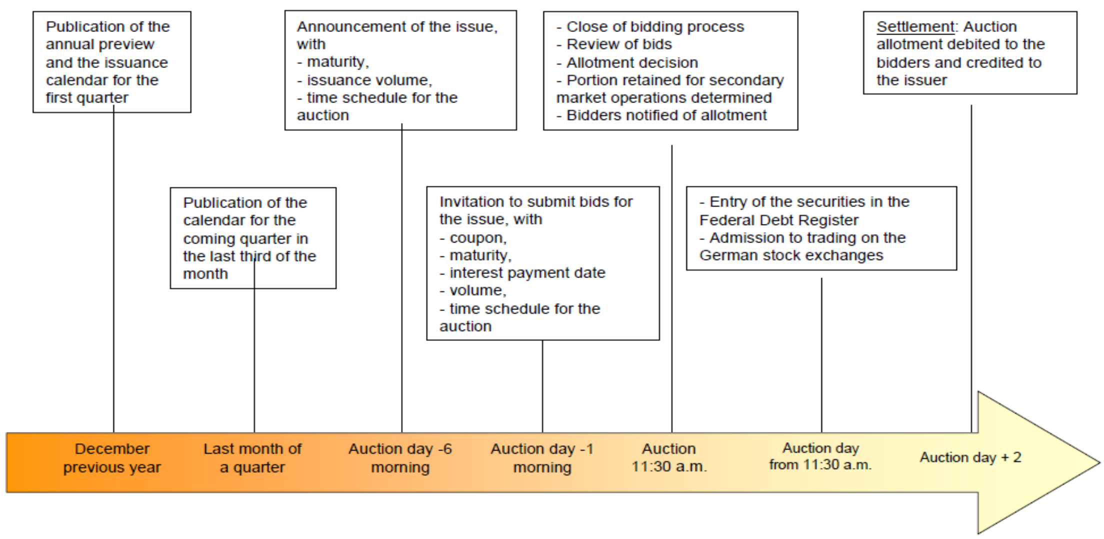
The Deutsche Bundesbank, on behalf of the German Finance Agency (GFA), acts as the fiscal agent of the Federal Government and fulfills the specific tasks related to the issuance and settlement of federal securities. The Bundesbank carries out the auctions of Treasury discount paper (6 and 12-month maturity "Bubills"), Federal Treasury notes (2-year maturity "Schätze"), five-year Federal notes ("Bobls") and Federal bonds (10 and 30-year maturity "Bunds").[18] Only members of the "Auction Group Bund Issues" can participate directly in these auctions. During 2012, the Auction Group comprised 37 credit institutions selected by the GFA. The Group included both German banks (for example, Deutsche Bank and Commerzbank) and foreign banks (for example, Goldman Sachs International Bank, Société Générale, UniCredit Bank, ABN-AMRO).

The procedure to place the individual issues in a year *t* is standardized as follows – see Figure A.1. Towards the end of the preceding year the annual preview and the issuance calendar are published. Further, towards the end of the month preceding a new quarter the new calendar for the coming quarter is published. Then, six days before each auction there is an announcement of the maturity, the issuance volume and time schedule of the auction, while a press release inviting the members of the Auction Group to submit their bids is sent out one working day before the auction. The auctions take place between 8.00 a.m. and 11.30 a.m. and bids are operated through the Bund Bidding System (BBS), an electronic primary market platform. The bidders are bound by their bid until the allotment has taken place at the price specified in their bids. As a result, bids are not settled at a uniform price. Bids above the

[18] The Bundesbank also executes the auctions of inflation-linked Federal notes (five-year Bobl/ei) and inflation-linked Federal bonds (10-year Bund/ei). Other financial instruments of the Federal Government include foreign currency bonds, special securitized loans ("Schuldscheindarlehen") and bonds issued in cooperation with German Federal states (Bundesländer").

lowest accepted price are allotted in full. Non-competitive bids are also possible and are filled at the weighted average price of the competitive bids accepted. The auction results are published on the auction day, while the financial settlement and ownership transfer of the allotted securities take place two days after the auction, although the security is admitted to trading on the German stock exchange immediately after the auction.

Figure A.1: German Auction Procedure



Source: http://www.deutsche-finanzagentur.de/en/institutional/primary-market/auction-procedure/.

6.2. Italy

In Italy, the Ministry of Economy and Finance issues, on the domestic market, four main categories of government bonds: Treasury bills ("BOTs" with a 3, 6, and 12-month maturity or with a flexible maturity between 1 and 12 months), zero-coupon Treasury bonds (24-month maturity "CTZs"), Treasury certificates (5 or 7-year maturity "CCTs"/"CCTs-eu" with a semi-annual floating coupon) and Treasury bonds (3, 5, 10, 15 and 30-year maturity "BTPs").[19] The auctions are executed by the Bank of Italy and their procedure is similar to

[19] The Ministry also issues Treasury bonds linked to the euro-zone inflation (3, 5, 10, 15 and 30-year maturity "BTPs €i") and to the Italian inflation ("BTPs Italia"). Other instruments typically offered on international markets include medium/long-term securities or commercial paper in euros and in other currencies.

that for Germany, although specific differences can be identified. Towards the end of each year, the Ministry of Economy and Finance published the auctions calendar for the following year. This is followed by the publication of a quarterly issuance programme. The terms and conditions of an auction are published roughly one week before the auction. The "Authorized Dealers" who are allowed to participate in the auction are Italian, EU and non-EU banks, financial brokers and EU and non-EU investment companies registered at the Bank of Italy.[20] After subscribing to the auction, where the deadline is the day before the auction, dealers can send their bids electronically through the National Interbank Network strictly before 11.00 a.m. of the auction day.

The most important feature of the auction procedure is that the Treasury uses both competitive and marginal auctions. Competitive auctions are used for maturities of up to one year, and, as in the German case, bids are satisfied at the individual yield offered.[21] Marginal (or uniform-price) auctions are applied for medium- and long-term securities, with all bidders paying the same price, the so-called marginal price. The dealers participating in the auction of medium and long-term bonds are awarded a commission in the range of 0.20% to 0.40% of the amount allotted in order to compensate them for having collected bids from the public. For medium and long-term bonds the settlement takes place two working days after the auction.

[20] A fixed share (between 10% and 35%, depending on the type of bond) of the amount offered in each auction is reserved to "Specialists", who are dealers selected (and evaluated year-by-year) by the Ministry of Economy and Finance. The specialists are allowed to participate in the non-competitive supplementary re-openings which occur on the following working day after each auction. For Italy, Bloomberg does not publish the bids of and amounts offered to the specialists, hence this information is not included in our auction dataset.

[21] Before April 2009 bids were satisfied at the price offered. Notice that each dealer can submit a maximum of three bids. In order for the accepted yields to be in line with the market yields, a minimum acceptable yield, also called safeguard yield, is calculated. Similarly, a maximum acceptable yield, or exclusion yield, is calculated to avoid speculative behavior. An example of the calculation of these yields can be found in http://www.dt.tesoro.it/export/sites/sitodt/modules/documenti_en/debito_pubblico/titoli_di_stato/Government_bond_Auctions.pdf.

Appendix B: Average yield movements in window around auction

(NOT for publication)

Table B.1 – Estimated yield movements in window around auction

	Full sample period					
	Germany			Italy		
t	2-year	5-year	10-year	2-year	5-year	10-year
-5	-0.92	-2.53**	-1.75*	-2.74**	-3.64***	-3.60***
-4	-0.82	-2.59**	-1.32	-2.43**	-2.71**	-3.00***
-3	-0.92	-1.67	-1.07	-2.31**	-2.23*	-2.25***
-2	-1.34*	-2.05**	-1.41**	-1.87*	-2.45***	-2.07***
-1	-0.55	-1.98***	-1.27**	-1.01	-2.12***	-1.34***
1	0.17	0.78	-0.92**	-0.42	-0.79	-1.64***
2	-0.02	-0.53	-1.70***	0.15	-1.62*	-3.26***
3	-0.77	-1.60	-1.62**	-0.88	-2.97**	-2.91***
4	-0.61	-1.44	-1.58*	-2.50	-3.33***	-3.18***
5	-1.03	-0.81	-1.76*	-2.85*	-3.13**	-2.52**

	January 1, 1999 – June 30, 2007					
	Germany			Italy		
t	2-year	5-year	10-year	2-year	5-year	10-year
-5	-1.15	-2.23	-3.41***	-0.18	-2.18**	-1.34*
-4	-0.21	-1.88	-1.26	-0.22	-1.94**	-1.73**
-3	-0.17	-1.53	-0.63	-0.59	-2.29***	-1.37*
-2	-0.37	-1.96**	-0.63	-0.67	-2.09***	-0.96
-1	0.47	-1.45**	-0.66	-0.71	-1.62***	-0.68*
1	0.11	2.24**	-0.33	0.03	0.08	-1.43***
2	-1.08	1.41	-1.29	0.13	0.24	-1.38**
3	-0.95	1.73	-0.73	0.33	0.36	-0.27
4	-1.02	1.07	-1.02	0.46	0.80	0.30
5	-0.79	2.54	-1.05	0.82	0.69	0.46

	July 1, 2007 – February 12, 2013					
	Germany			Italy		
t	2-year	5-year	10-year	2-year	5-year	10-year
-5	-0.72	-2.80	-0.09	-7.43**	-6.04**	-6.62***
-4	-1.37	-3.23*	-1.39	-6.46**	-3.97	-4.68**
-3	-1.59	-1.80	-1.51	-5.44**	-2.14	-3.44**
-2	-2.22**	-2.13	-2.21**	-4.04	-3.05*	-3.56***
-1	-1.47*	-2.46**	-1.90**	-1.55	-2.95***	-2.23***
1	0.22	-0.56	-1.51**	-1.25	-2.25	-1.93**
2	0.93	-2.32**	-2.11**	0.20	-4.73**	-5.77***
3	-0.60	-4.64***	-2.53**	-3.07	-8.51***	-6.45***
4	-0.23	-3.74**	-2.15	-7.90**	-10.20***	-7.83***
5	-1.23	-3.95**	-2.49	-9.53**	-9.49***	-6.50**

Notes: This table reports the average of $y_t - y_0$, where y_t is the yield of the bond on day *t*, and y_0 is the yield on the same bond on the auction day 0. All yields are expressed in basis points. Standard errors are Newey-West adjusted. Significance at the 10, 5 and 1% levels is denoted by *, ** and ***, respectively.