Auctions and liquidity conditions in the Italian government bond market.

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Preliminary version

Abstract

In this paper, we contribute to the literature analyzing the liquidity loop between primary and secondary markets of government bonds. Relying on primary market and MTS data, we empirically assess and identify a significant effect of auctions on the price discovery process of the secondary market. By the introduction of a new auction performance indicator – which we measure as an overpricing index – we show that better auctions lead to more liquid quoting books. The overall effect is long-lasting and larger during periods of wider uncertainty. Furthermore, our findings suggest a heterogeneous quoting behaviour among dealers and over time.

Keywords: Market microstructure; Market Makers; Public Debt Auctions Performance; Market Sentiment; Volatility.

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1 Introduction

The efficiency of the secondary markets of government debt securities is crucial in a world of growing public debts (OECD). The capacity of public debt managers to trade-off risk exposure and debt service minimization by their issuing strategies on primary markets requires an appropriate microstructure of secondary markets. In particular, the latter should be conducive to liquidity. If the secondary markets of government bonds do not afford *quick trade of large quantities of assets at a low cost*, primary dealers and other market participants will request larger premia, hence higher yields, on issued bonds to face such a liquidity risk. On the other side, the issuing strategy of public debt managers, particularly the outcomes of auctions, play an important role in determining the liquidity conditions of secondary markets. Understanding such a liquidity loop between primary and secondary markets is an interesting, policy-relevant issue.

Auctions can impact on the performance of secondary markets through two intertwined channels. First, the performance of an auction, that is driven by the equilibrium between supply and demand of concerned government bonds, determines a mechanical effect that is linked to the relative scarcity of assets in the balance sheets of market participants and, thus, on the secondary markets. Second, the auction's performance provides an informative signal to primary dealers and other market participants about the "market sentiment", which influences the future value of traded securities.

The finance literature has investigated the impact of primary market performance on prices and yields on secondary markets. As regards government securities, the literature has documented a cyclic movement of prices and yields around the auction day (e.g., Lou et al.; Beetsma et al.). Moreover, the stylized facts of the functioning of government bond markets suggest some kind of relationship between auctions and market liquidity, an issue that has not been explored systematically in the literature yet. For example,

different liquidity measures of the Italian government bond market in the period 2016-2019 show that, on average, liquidity improves in the 11-day time window around the auction. Similar descriptive statistics suggests that the way auctions impact on market liquidity is an interesting research issue, and this motivates our paper.

With this paper, we empirically assess the relationship between government bonds' auctions[1] and the liquidity of the MTS cash market[2] of specific Italian government bonds around the auction event, covering three on-the-run maturities (i.e., 3-year, 7-year and 10-year BTPs), from January 2016 to December 2019. To measure the performance of the auctions we rely on two indicators. First, we use the *bid-to-cover ratio*, that is commonly considered a measure of auctions' success (Beetsma et al.).[3] Then, we introduce a new indicator, the *overpricing index*, that is intended to proxy the "good news" effect of the auction.[4]

We make empirical contributions to the existing literature. From the empirical point of view, our main contribution is to the literature regarding the relationship between primary and secondary markets is the identification of an information channel between the auction (and its outcome) and secondary market liquidity.[5] We find that the main event itself - irrespective of the outcome - affects positively liquidity conditions of the secondary

[1]There are two main periods for auctions, one takes place at the middle of the month and concerns, regarding medium-long term allocation, 3-, 7-, higher than 10-year BTPs and the second one at the end of the month which involves 5- and 10-year BTPs.

[2]MTS is an interdealer platform with a high level of pre- and post-trade transparency established in 1988 by the Italian Treasury. The MTS trading system is quote-driven, electronic limit-order interdealer market, in which market makers' quotes can be hit or lifted by other market participants via market orders. MTS Italy is a branch of the entire MTS trading system and it is the secondary market where Specialists (a subset of primary dealers) are monitored by the Italian Treasury. It is regulated by the Italian Treasury, the Bank of Italy and the Stock Exchange Regulator (Consob).

[3]The bid-to-cover ratio is the ratio between the total amount bid by primary dealers on the auction day and the total amount supplied by the Treasury.

[4]The overpricing index is the difference between the allocation price and the mid-price of the bond on the secondary market five minutes before the auction scaled down but the original maturity of the security. Therefore, the larger the index the better is the signal about the value of the issued bonds, with respect to pre-auction perception.

[5]Market liquidity is studied through several liquidity metrics to provide a more comprehensive approach Mormando and Greco.

market on the same day and this impact is not short-lived, yet, in some cases, it lasts also in the 5 days after the issuance. Furthermore, a "good" auction, in terms of high auction performance indicator, has an impact on overall dealers behaviour leading to a more liquid quoting book. Nevertheless, only the overpricing index is found to be significant in driving the liquidity discovery process of the book. Finally, the improvement of liquidity conditions of the secondary market due to a good auction is even stronger in crisis periods, when volatility is higher than usual.

As regards the external validity of our empirical findings, the Italian government bond market is an interesting case concerning public debt management and the functioning of primary and secondary markets. Since early 1990s, a growing and very large public debt forced the Italian government to pursue a path-breaking model of secondary market, eventually leading to the establishment of MTS Italy, the first electronic market of government securities in Europe.

The paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the dataset, presents the empirical treatments and the final results. Section 4 concludes. The appendix in Section 5 gives higher-level information about the institutional framework and the government securities used in the analysis.

2 Related Literature

As first, this paper contributes to the literature concerning the relationship between primary and secondary markets of government securities. The existing literature has shown that prices and yields follow a specific pattern around auction day, the so called *auction cycle* (Lou et al.; Beetsma et al.; Cafiso). Prices (yields) start decreasing (increasing) on the days before the auction and increase (decrease) thereafter. Also, the cycle is larger in periods of turmoil and unconventional monetary policy dampens further yield changes

(van Spronsen and Beetsma) .

The auction cycle has been attributed to the limited risk-bearing capacity of dealers and to other factors, such as: profit-seeking purposes (Fleming and Rosenberg), the gradual arrival of buyers in the market (Duffie)[6], the price impact of other traders who sell ahead the issuance of bonds (Bessembinder et al.)[7], the characteristics of the auctioned bond and of those already traded in the secondary market (Eisl et al.), and the release of information by the Treasury (Bikhchandani and Huang; Sigaux). To our knowledge, our contribution is the first to analyze the movement of liquidity around and on the auction day.

Yield changes can be altered by a specific indicator of the result of auctions. Beetsma et al. find evidence that the bid-to-cover ratio is a good predictor of the yield movements in the secondary market around auctions. The bid-to-cover ratio is the only indicator of auction performance that has been used in the literature so far. For instance, Lou et al. use it as a proxy of the state of the Treasury markets and of the overall economy. In our work, we focus on the informative effect of auctions on market liquidity on the auction day, that is why we also introduce a new indicator, the overpricing index, that measures the (positive) surprise effect of the auction in terms of prices. Section 3.1.1 describes how this indicator is calculated.

The second strand of literature to which we contribute concerns market microstructure. From an empirical standpoint, information plays an important role in the liquidity discovery process. Nguyen et al. show that liquidity conditions, specifically market depth and trading volumes, change after announcements of macroeconomic data. More generally, (good) news have a (positive) impact on market liquidity (Riordan et al.; Han et al.).[8]

[6]Duffie explains that if capital constraints of market participants are less severe over time because more dealers arrive in the market, yields will be on a decreasing path in the days before the emission of the bond.

[7]Bessembinder et al. do not deal with the Treasury market directly, but their work relates to trading strategies of market participants around large and predictable trades that affect the price pattern of securities traded.

[8]For example, Riordan et al. show that the intraday liquidity in the Toronto Stock Exchange is positively

In line with this literature, we find that also the performance of government bond auctions has an informative effect on market liquidity. Furthermore, as pointed out by Choi, in periods of higher volatility liquidity - in the sense of trading volume - increases around announcements under periods characterized by higher uncertainty. Our results corroborate this statement as we find proof that information from auctions' outcome is more important in higher volatility periods.

Related to our contribution there is also a vast literature analyzing the different determinants of liquidity on government bond markets. Mormando and Greco identify the causal relationship between changes in the evaluation criteria of specialists' activity by the Italian Treasury and market liquidity conditions. Ferrari et al. point out that secondary market liquidity development of government bonds is also affected by the financial constraints of primary dealers.[9] Pelizzon et al. find a strong correlation between liquidity shocks in the futures and cash markets for the Italian government bonds.[10] Moreover, liquidity is determined by the characteristics of issued bonds (Corwin et al.; Rappoport et al.; Eisl et al.). At the same time, (il)liquidity conditions affect dealers bidding behaviour. In particular, Rappoport et al. show that secondary market illiquidity pushes investors to ask for a higher liquidity premium when they participate at auctions. Complementary to this finding, Buis et al. analyze the effect of issuance fees in syndicated issues on liquidity conditions of European government bonds.

3 Empirical Analysis

For our empirical analysis, we use primary and secondary market data for specific Italian government bonds in order to assess whether there is a new, further channel through

affected by good and neutral news, and negatively affected by bad public news.

[9] Adrian et al. confirm a similar relationship for US corporate bonds.

[10] Similarly, expected after-market liquidity determines how much corporate bonds are underpriced at IPO Corwin et al.; Ellul and Pagano.

which the primary market is linked to the secondary one. Namely, the final goal of the analysis is to demonstrate empirically whether, and to what extent, public debt auctions of specific debt instruments have an impact on secondary market liquidity of the same security. Secondly, we aim to establish if not only the auction but also its final outcome has a significant effect in driving market liquidity. In order to do this, we rely on the Italian government bond markets. In Section 3.1 we introduce the dataset and in Section 3.2 we discuss the empirical strategy and present our results.

3.1 Data

Data are collected from the Italian Treasury, which allow us to measure two auction performance indicators (Section 3.1.1), and from MTS Italy, which enable us to estimate the evolution of secondary market liquidity around auctions (Section 3.1.2).[11]

3.1.1 Auctions' performance and other primary market data

Based on auctions data published by the Treasury, we consider all non-first auctions from January 1^{st} 2016 to December 31^{st} 2019 of 3 types of BTPs, i.e. 3-,7-,10-year original maturity, for a total of 103 events of interest and a sample of 27 BTPs [12]. Auctions' results are publicly available on the website of the Treasury, and contain many information, some of which is included in our final dataset. First of all, the auction day, used to create the auction dummy. Second, the auction reopening dummy, a dummy equal to one in case there is a supplementary offering from the Treasury and in case this offer is bid by Primary Dealers for at least 25%. Moreover, the *bid-to-cover ratio* (BC), the ratio between the total amount bid by primary dealers and the total amount supplied by the Italian Treasury,

[11] All high-frequency data were provided by the Italian Ministry of Economics and Finance, in the framework of an institutional collaboration with CRIEP and MTS Italy.

[12] See subsection 5.2 for the list of ISIN codes of the securities included in the analysis. The dates shown in the tables refer to the on-the-run period from beginning 2016 until end 2019

	Mean	Min	25th	Median	75th	Max
BC	1.5	1.22	1.37	1.46	1.61	1.96
OP	0.005	-0.02	0	0.003	0.01	0.055

Table 1 – Descriptive statistics of auction's performance indicators.

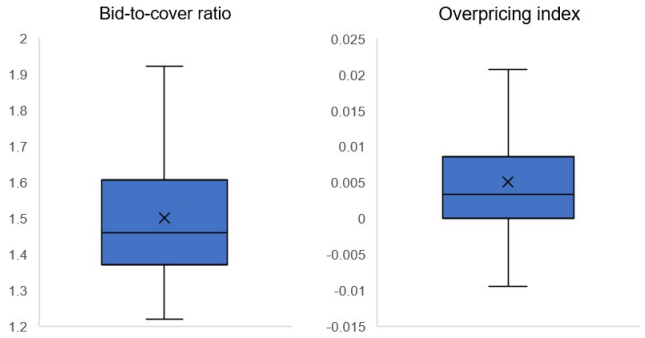

Figure 1 – Bid-to-cover ratio and overpricing index distribution throughout the sample. The box plots show the distribution of the two indicators of auction's performance used in the analysis. The boxes represent the 25th-75th interquartile range, the horizontal lines represent the median values and the crosses inside the box represents mean values. Whiskers show extreme values excluding the outliers.

already available in auction results data. Finally the allotment price net of fees, important for the calculation of the *overpricing indicator* (OP). This last indicator, specifically, is calculated as the difference between the allocation price net of fees and the secondary market mid-price for the same security, obtained from the limit order book, five-minutes before the auction time. In addition, this indicator is scaled by the duration of the title, which is proxied by the original maturity of the security in order to capture the different impact the overpricing might have on the liquidity discovery process whether it is a 3- ,7-,or 10-year bond. The overpricing indicator is a novelty we introduce in the literature as auctions' performance have always been based on bid-to-cover ratios (Beetsma et al.; Beetsma et al.; Fuhrer and Giese).

Table 1 presents some descriptive statistics of the two indicators, while figure 1 shows

graphically the two measures. Overall, since we consider 103 auctions, we have 103 values for both BC and OP.

3.1.2 Liquidity measures

MTS Italy is an electronic quote-driven market. The dataset used contains all the quoted bid and ask prices in the book, with the relative volumes and the number of dealers quoting at each price on both sides of the market. We study the liquidity development of three segments of government bonds (i.e., BTPs): 3-year BTP, 7-year BTP, and 10-year BTP. All prices and volumes are observed at a 5-minute frequency, from 9am to 5pm for each trading day.[13] For each 5-minutes snapshot, we calculated liquidity measures and then we took daily averages.[14] Moreover, as we considered only on-the-run BTPs, we analyzed different BTPs of the same segment, identified by different ISIN codes. A BTP is considered as on-the-run from its first day of issuance until the day before the auction of a BTP with a new ISIN code.[15] The sample period goes from January 1^{st} 2016 to December 31^{st} 2019, however only snapshots of 11 days each are analysed to consider the auction cycle.

The most widely used liquidity measure is the best bid-ask spread (BA_{it}), i.e. the difference between the best bid-price and the best ask-price of the book as a percentage of the mid-price, but using a unique liquidity metric may be misleading (Schneider et al.). Therefore, in order to have a more comprehensive approach and following also, but not only, Sarr and Lybek and Mormando and Greco, we compute the following additional liquidity measures from the limit order book:

[13] MTS Italy is open from 8am to 5:30pm, however outside the interval we chose the trading activity is low.

[14] In order to clean the data and get rid of outliers, we considered prices (and related quantities and number of dealers quoting at those prices) that were at most 0.5 ticks further from the best price of the market, on both sides of the book.

[15] See section 5.2 of the Appendix.

$VWBA_{it}$ the *volume-weighted bid-ask spread*: the difference between the average of prices on both sides of the book, weighted by the respective quoted quantity and in percentage of the mid-price;

PI_{it} the *price impact of 20mm*: the difference between the mid-price and the realizable execution price of a deal of 20 millions of euros;

QS_{it} the *quote slope*: the bid-ask spread divided by the sum of the logarithmic bid and ask quoted quantity at the best prices of the book (as introduced by Hasbrouck and Seppi);

BD_{it} the *best quoted depth*: the quoted amount at the best bid- and ask-prices;

ND_{it} the *number of dealers*: the average amount of dealers quoting at the best prices;

AQQ_{it} the *average quoted quantity*: the average quoted amount at the best prices of the book;

Considering multiple measures allows us not to lose important information, as some liquidity variables are price-related, some quantity-related and some multidimensional, i.e. they consider both prices and volumes. These liquidity measures are considered for all 103 time windows of 11 days each, for a total of 1133 observations as a result of daily calculations of 5-minute frequency data. Table 2 shows the descriptive statistics of the liquidity measures in our sample.

	Mean	25th	Median	75th
BA	0.09	0.052	0.074	0.103
VWBA	0.15	0.096	0.131	0.173
PI	0.05	0.028	0.041	0.055
QS	0.04	0.021	0.029	0.042
BD	22.09	14.87	19.08	26.29
ND	3.54	2.61	3.2	4.23
AQQ	5.73	5.35	5.9	6.59

Table 2 – Descriptive statistics of liquidity measures

Figures 2 and 3 display the average development of the analyzed liquidity measures throughout the 11-day time window.[16] With auction day being on t=0, we clearly see a systematic pattern around auctions. Namely, price-based and multidimensional metrics are lower on the day of the main event at time t=0 compared to before the auction. These better conditions, given by lower values of the measures, keep getting better also afterwards as, on average, the lines of the relevant quantities continue decreasing. On the other hand, the reduction of quantity-based measures suggests a lower willingness of market makers and other market participants to trade large quantities around the auction. Nevertheless, this effect seems to be limited to the auction day only.

[16]The width of the window was chosen to avoid overlaps between two consecutive auctions and also to be in line with other studies using a 5-day time window around the auction day (Beetsma et al.)

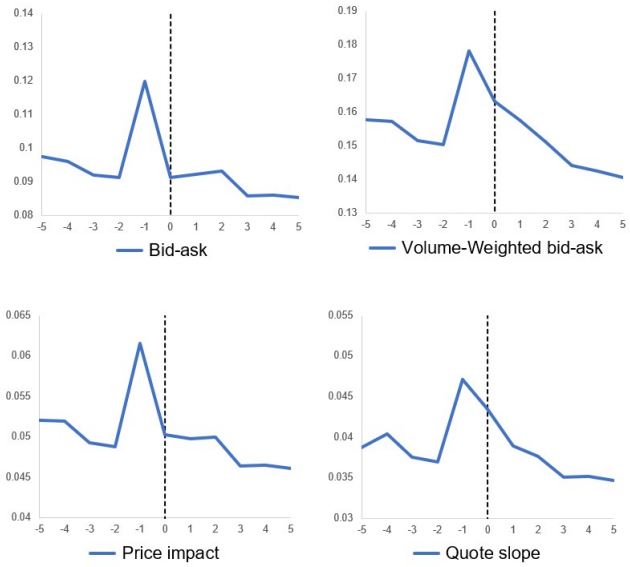

Figure 2 – Price-based and multidimensional liquidity measures evolution around auctions. The figure shows the dynamics of the bid-ask spread in percentage of the mid-price (BA), the volume-weighted bid-ask spread in percentage of the mid-price (VWBA) the price impact of a 20 mn deal (PI) and the quote-slope (QS).

Figure 3 – Quantity-based liquidity measures throughout the sample. The figure shows the dynamics of the depth at the best available quotes (BD), the average number of dealers quoting at the best prices (ND) and the average quoted quantity by a single dealer at the best prices (AQQ).

	Before	After
Bid-ask spread	0.099	0.089
Volume-weighted bid-ask spread	0.159	0.147
Price impact	0.053	0.048
Quote slope	0.040	0.036
Best depth	22.709	21.918
Number of dealers	3.64	3.53
Average quoted quantity	5.987	5.964

Table 3 – Average values of liquidity metrics before and after the auction in a 9-day time window. The values before the auction are averages of the 5 days before the auction. The values after the auction are averages of the 5 days next to the auction.

Table 3 confirms these first descriptive results by showing what happens in the five days before and five days after the auction, on average. In general, liquidity is worse before the auction than after the event: price-related and multidimensional liquidity measures are smaller.[17] A remarkable exception concerns quantity-based only liquidity metrics, i.e. best depth, number of dealers, average quoted quantity, which decrease in the 5-day time window after the auction. This reduction might be related to the fact that market makers hedge the risk associated to tighter bid-ask spreads, by quoting smaller quantities (Best Depth) overall (Mormando and Greco), or because more risk-averse dealers will no longer quote at more competitive prices (decrease in the number of dealers, even if small). This also explains the slight increase in the average quoted quantity.

[17]The bid-ask spread is 1 tick tighter in the four days after the auction. The volume weighted bid-ask spread decreases less (by 1.2 ticks) but, after the auction, also the entire book is more liquid. Also the price impact decreases by 0.5 tick and the quote slope is flatter.

3.2 Econometric model

To test our main predictions about the relationship between auction performance and market liquidity on auction day, we regress alternative liquidity measures on the auction event, the post-auction event, the two indicators of auction performance, controlling for market volatility and financial markets condition. The empirical strategy consists in performing several panel regressions with fixed-effects.

3.2.1 Baseline regression

The baseline model is the following:

$$LIQ_{i,t} = \alpha_0 + \beta_1 AUC_t^i + \beta_2 postAUC_t^i + \sum_{m=1}^{2} \gamma_m X_m + \varepsilon_t \quad (1)$$

where $LIQ_{i,t}$ is the liquidity metric for auction i on day t, α_0 is the constant term, β and γ specify the effect of the auction indicators and the control variables used. AUC is the auction indicator, a dummy variable that equals to 1 when the auction takes place on day t. $postAUC$ is another dummy variable that equals to 1 in the days after the auction. The time variable t of the panel consists of an 11-day time window around the auction of the bond. Therefore, the auction dummy AUC will be equal 1 when t = 6, while the dummy $postAUC$ when $t > 6$. Moreover, we control for two variables describing market conditions X_m, where m stands for the specific control variable, whose effect is captured by γ_m. Specifically, we control for funding liquidity risk measured by the difference between the 3-month Euro Area Inter-Bank Offered Rate (EURIBOR) and the 3-month Euro OverNight Index Average (EONIA) and for market volatility, which in our case it is constructed as the interdaily range of the midprice of the bond in that specific auction cycle on day t.

From Table 4, we see that auctions have a significant effect on liquidity metrics on

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.018***	-0.011*	-0.008**	-0.002	-2.63***	-0.52***	1.24
postAUC	-0.015*	-0.019**	-0.007*	-0.006**	-0.17	-0.02	7.61

Table 4 – Baseline regression. The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression (equation (1)). The effect of the auction event and of market conditions is estimated on seven liquidity measures: the best bid-ask spread (BA); the volume weighted bid-ask spread (VWBA); the price impact of a deal of 20 millions on the total quoting book (PI); the quote slope (QS); the best depth (BD); the average number of dealers quoting at the best prices (ND); the average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.

the auction day. Indeed, the only fact that there is an auction, irrespective of its outcome, affects liquidity conditions. However this effect is uneven. On the one hand, auctions have a significant negative effect on the bid-ask spread (BA) which decreases by 0.018 basis points on auction day. This negative impact, which translates into better liquidity conditions, significantly affects also two of the multidimensional liquidity measures (i.e. VWBA and PI), with both being smaller when the auction takes place. Specifically, the negative impact of the auction on VWBA means that the whole book, even if slightly, is more liquid on the day of the auction. With respect to the price impact (PI), a 0.008 basis points decrease means that for an investor it is less costly to submit an order of 20 €million. This effect persists over time as it is captured by the significant and negative impact of the post-auction dummy which captures the impact of the issuance in the 5 days after. Furthermore, the whole book is affected to a stronger extent given both the higher significance and the coefficient in absolute values with respect to VWBA and QS, which cannot significantly be explained by the auction event alone. These results suggest the existence of heterogeneous quoting behaviour among market makers both on auction day and over time. The heterogeneity is captured by the difference in the coefficient for BA

and VWBA. On auction day, indeed, the most competitive dealers quote at a tighter bid-ask on auction day compared to less competitive market makers, which tighten the spread of their quoting prices less (i.e. larger coefficient - in absolute terms - of the auction dummy on BA compared to VWBA). However, those dealers that are less competitive on the day of the issuance, tighten their spreads more on the day after the auction - as suggested by the higher absolute coefficient of *postAUC* when regressed on VWBA than when used as a covariate for BA.

On the other hand, liquidity metrics related to the best prices are also significantly influenced by the auction event, but without a persistent effect and in an opposite manner. Precisely, the depth quoted at the best prices (BD) and the number of dealers quoting at those prices (ND) decrease, respectively by 2.63 million and 0.52. This decrease might be explained by the fact that since a tighter bid-ask spread is synonym of more competitive quoting prices, market makers are reluctant to increase their quoted amount at those quotes. Hence, the number of dealers quoting at the best prices shrinks as only the more competitive ones submit orders. As a consequence, the total quoted amount at the best prices will decrease too. However, there is no significant impact on the average quoted quantity (AQQ). This overall negative effect of auctions on quantity-related liquidity metrics does not mean to be unfavorable in terms of liquidity conditions, but these are only expressions of liquidity metrics related to more competitive prices (Mormando and Greco).

In general, we find empirical evidence that auctions do have an impact on liquidity conditions. Specifically, after the auction, liquidity conditions improve and in some cases this positive impact persists in the days after the issuance.

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.018***	-0.011*	-0.008**	-0.002	-2.63***	-0.52***	1.22
postAUC	-0.015*	-0.019**	-0.009*	-0.006**	-0.21	-0.0001	8.57
reopening	-0.001	0.003	-0.005	0.002	0.303	-0.13	-8.88

Table 5 – Baseline regression with supplementary placement dummy. The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression (equation (1)). The effects of the (post) auction event, the reopening and of market conditions are estimated on seven liquidity measures: the best bid-ask spread (BA); the volume weighted bid-ask spread (VWBA); the price impact of a deal of 20 millions on the total quoting book (PI); the quote slope (QS); the best depth (BD); the average number of dealers quoting at the best prices (ND); the average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.

3.2.2 Auction reopening

Additionally to the main auction, for specific Italian government bonds, there is the option of supplementary placement reserved for Government bond Specialists - or primary dealers - which took part in the main event. Auction reopening takes place on the following day the main auction event and usually consists of an offer of the Treasury equal to 15% of the amount offered. This tap is sold at the same price defined in the auction, so in this case there is not a price discovery process but only an opportunity offered by the Treasury to the specialists to subscribe an additional amount of the bond. Since the main auction event has a significant impact on the liquidity discovery process around and after the auction, this section investigates whether re-openings are also a determinant in the liquidity conditions of specific Italian BTPs. Therefore, the empirical model considers a further dummy which is equal to 1 when there is a reopening and the amount allotted by the Treasury is at least 25% of the one offered.

As table 5 shows, the fact that the Treasury allots a supplementary amount the day after the auction, and that the final amount offered to allowed dealers is at least 25% of

the supplied quantity, does not affect market liquidity conditions. Therefore, the market is more interested in the main auction event and not in whether a reopening takes place or not. Our interpretation is that this difference can be determined by the absence of a price discovery process in the reopening auction. In this sense, differently from the standard auction, the reopening does not offer any additional information to market participants on the bond fair value. Also in this case, the heterogeneity among dealers is confirmed as in the baseline regression (see section 3.2.1).

3.2.3 Indicators of performance

As the baseline specification shows that auctions have an important effect on liquidity on the auction day, and that this effect persists in the 5 days after the issuance in some cases, we intend to understand whether it is due to the auction event only or (also) to its performance. We therefore introduce a new variable in our specification to control for auction performance. The new empirical model is the following:

$$LIQ_{i,t} = \alpha_0 + \beta_1 AUC_t^i + \beta_2 I_t^i + \beta_3 postAUC_t^i + \sum_{m=1}^{2} \gamma_m X_m + \varepsilon_t \tag{2}$$

where, in addition to the baseline model, we have also the variable I_t^i which defines the indicator of performance of the auction. Its effect is given by the coefficient β_2. In terms of indicators, we adopt the two measures introduced and described in section 3.1.1 : the bid-to-cover ratio and the overpricing indicator. The motivation behind this further check is to investigate whether - and to what extent - there is an impact in case the outcome of the auction improves and if one of the two measures has a stronger signaling impact on the market.

As we can notice from Table 6, the overpricing index - corrected for the duration of the issued security proxied by its original maturity - improves liquidity conditions

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.013**	-0.004	-0.005**	0.006	-2.69***	-0.53***	-3.45
OP	-1.069	-1.3*	-0.582	-046**	12.45	1.34	917.5
postAUC	-0.015*	-0.019**	-0.007*	-0.006**	-0.17	-0.02	7.61
AUC	-0.03	-0.005	-0.01	0.004	0.27	0.16	-8.48
BC	-0.01	-0.01	-0.001	-0.004	-1.94	-0.45	6.49
postAUC	-0.015*	-0.019**	-0.01*	-0.006**	-0.17	-0.02	7.61

Table 6 – Baseline regression with supplementary placement dummy. The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression (equation (1)) with the addition of the reopening dummy. The effects of the (post) auction event, the outcome and the market conditions are estimated on seven liquidity measures: best bid-ask spread (BA); volume weighted bid-ask spread (VWBA); price impact of a deal of 20 millions on the total quoting book (PI); quote slope (QS); best depth (BD); average number of dealers quoting at the best prices (ND); average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.

significantly only in specific cases. Namely when liquidity measures that consider the whole order book are used, i.e. VWBA and QS. Moreover, when OP is significant, the auction dummy has no longer an effect on liquidity. This might be explained by the fact that all dealers quoting on the order book - and the market over all - are more concerned by the auction's outcome than by the event itself. While more competitive market makers are focused on the main event. The story is different when looking at the bid-to-cover ratio (BC) which has no significance in predicting any of the liquidity measures.

These findings corroborate the initial ones (see section 3.2.1) and add that more informed market makers contribute more to market liquidity. Unfortunately, a robust empirical argument in this direction necessarily requires a richer dataset, that could allow the analysis of individual behaviors of market makers.

3.2.4 High volatility period

The results of the regressions in Table 4 and Table 6 might be influenced by special market events that may hamper secondary market liquidity and change the degree of informativeness of the auction and of its outcome. We thus control for market events, by splitting the sample periods in two sub-samples. However, the cut-off is not time-dependent as done in other works (e.g. Beetsma et al.), but volatility-dependent. Given the market volatility variable, expressed as the daily range of the mid-price as described in section 3, we consider its long term median and use this value, different for each BTP line of emission, as cut-off. If the auction takes place on a day above the long-term average, then the whole time window is considered to be in a high-volatility period. Hence, the empirical model is the same as in (2) but the sample of auctions shrinks from 103 to 58, as 58 are the auctions happened in periods of high-volatility.

Considering Table 7, the results are in line with the regressions shown in Table 6. As a matter of fact, the outcome of the auction - when significant - is in the lead of the

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.014	-0.001	-0.005	0.002	-2.63***	-0.43***	-4.58
postAUC	-0.026*	-0.031*	-0.012*	-0.009*	-0.17	-0.005	13.1
OP	-1.301	-1.596**	-0.708*	-057**	12.23	-0.31	1093.9

Table 7 – Baseline regression with overpricing indicator in high-volatility periods. The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression (equation (2)) limited to a reduced number of event windows where the auction took place in a moment of high market volatility. The effects of the (post) auction event, the outcome and the market conditions are estimated on seven liquidity measures: best bid-ask spread (BA); volume weighted bid-ask spread (VWBA); price impact of a deal of 20 millions on the total quoting book (PI); quote slope (QS); best depth (BD); average number of dealers quoting at the best prices (ND); average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.

	BA	VWBA	PI	QS	BD	ND	AQQ
AUC	-0.013***	-0.007*	-0.006***	0.001	-2.78***	-0.63***	0.32**
postAUC	-0.001	-0.005	-0.001	-0.002	-0.18	-0.05	0.0005
OP	0.261	-0.348	0.071	-0.115	7.84	-0.16	32.19

Table 8 – Baseline regression with overpricing indicator in low-volatility periods. The table shows the coefficients of auction's performance indicators of the panel estimation with individual fixed effects of the baseline regression (equation (2)) limited to a reduced number of event windows where the auction took place in a moment of low market volatility. The effects of the (post) auction event, the outcome and the market conditions are estimated on seven liquidity measures: best bid-ask spread (BA); volume weighted bid-ask spread (VWBA); price impact of a deal of 20 millions on the total quoting book (PI); quote slope (QS); best depth (BD); average number of dealers quoting at the best prices (ND); average quoted quantity by dealers at the best prices (AQQ). The P-value of the F-test rejects always the null hypothesis that coefficients are not significant. * marks significance at 10%, ** marks significance at 5%, *** marks significance at 1%.

liquidity discovery process and the impact of the auction event persists on the following days. This happens with respect to the multidimensional metrics. This result, indeed, corroborates the previous ones that, overall, dealers behaviour is driven by outcome of the auction and that this effect persists over time. The auction dummy, instead, remains significant only with respect to the measures that describes the competition among dealers at the best quotes. Opposite to this, as shown in Table 8, in calmer periods, market makers change their quotes and make the market more liquid only on the auction day, irrespective of the outcome. The effect is indeed no longer persistent over time and the outcome has no impact on the liquidity discovery anymore. As a result, market makers bid at more competitive prices, however their behaviour is different depending on market uncertainty. In calm periods, auctions affect market liquidity positively (i.e. negative impact on price-based measures) as stand-alone events. Nevertheless, in more turbulent periods, the event itself is no longer enough to facilitate the price discovery process. Therefore, market makers need more information in order to be more competitive and make the market more liquid. This information comes from the auction's outcome. The better the auction, the higher the incentive of market makers to quote at more competitive prices and increase market liquidity.

4 Conclusion

In this paper, we analyzed the impact of auctions on liquidity of secondary market of government bonds. Relying on data from the Italian primary and secondary markets of specific government bonds, we empirically assessed the effect of auctions on the liquidity of these debt securities in an 11-day time window, by combining two datasets. Our empirical strategy consisted of using auctions and specific auction's performance indicators (i.e., the bid-to-cover ratio and the overpricing index) to infer their effect on several

liquidity measures on auction day together with other market variables. We found significant evidence that auctions have a positive effect on the liquidity discovery process, that this effect is positive on specific metrics, i.e. price-based liquidity indicators are better on auction day, and long-lasting as found out from the statistically significance of the post-auction dummy. Secondly, also the outcome of the auction influences liquidity conditions in the secondary market. However, this holds only for the overpricing index. Indeed, a good auction, in terms of high overpricing, affects positively specific liquidity indicators that consider the whole quoting book. Therefore, we can conclude that the bid-to-cover ratio is not a good indicator to predict liquidity in the secondary market of Italian government bonds, while the overpricing index is. Furthermore, we obtain different results whether we carry out the analysis in crisis or calm periods. In the first case, we have a loss of significance of the auction event but a more effective overpricing index in improving market liquidity. In the latter, market makers quote at more competitive prices and provide liquidity to the markets every time there is an auction event, whatever the outcome. This final result confirms that the public information, provided by the price discovery process of an auction, is even more important in periods of crisis and high uncertainty. Finally, our results suggest the existence of heterogeneity among dealers and over time with more competitive dealers tightening more their bid-ask spread on auction day, while less competitive dealer close more their spreads on the days after the auction. However, more granular, dealer-level data are needed to confirm this final result.

Overall, our findings allow us to conclude that there is a new channel through which the primary market is linked to the secondary one. Further investigation can be implemented in this framework in order to infer better how liquidity of secondary market of government bonds may change when interacting with the primary market, particularly focusing on the contribution of individual market makers to market liquidity.

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5 Appendix

5.1 Institutional Framework

5.1.1 Functioning of the Primary Market and instruments issued by the Treasury

In the primary market, the sovereign issuer, that in Italy is the Ministry of Economics and Finance (henceforth Treasury, or Italian Treasury), places different type of securities[18] depending on the liquidity needed to finance its spending.

Depending on the kind of instrument, we can distinguish two different auction protocols: competitive yield auction and marginal price auction. The former involves BOTs' issuance and it is in yield terms. With this protocol, each bid placed by the dealers is awarded at the yield rate proposed.[19] The latter regards all the other instruments issued by the Treasury and it is in terms of price. The winning bids are all settled at the same price, the lowest winning one, also called stop-out price.[20] Usually, auctions concern on-the-run bonds , the latest issued bond until a new one is issued and takes the place of the old one that obtains the off-the-run status. Off-the-run bonds can be issued as well, depending on the liquidity needs of the Treasury and on the market shortage of these specific bonds. Sometimes, tranches of off-the-run bonds can be placed on the market together with on-the-run ones. In this case, we talk about joint auction and the range of the offered amount must be considered for the two securities together. This choice of the Treasury

[18] Among Italian government bonds we can distinguish 17 segments of emission: 6-, 12-month BOTs, 24-month CTZ, 3-,5-, 7-, 10-, 15-, 20-, 30-, 50-year BTPs, 5-, 10-, 15-. 30-year BTP€I, CCTeu and the retail bond Btp Italia. Every year the Treasury publish a calendar where dealers can find the date of interest of the auction process (announcement, issuance and settlement dates).

[19] The maximum numbers of bids that can be placed by a singular bidder are five, with yield differing one from the other by one thousandth of one percent. The minimum quantity to be bid is 1.5 million euros. The first bids to be allocated are those with the lowest yields. In order to avoid misbehaviour from primary dealers in placing the bids in terms of yields, a range from a minimum acceptable yield to a maximum one is calculated.

[20] For marginal price auction, primary dealers can place at most always 5 bids, but the minimum bidding amount is 500,000€ and less than the amount being issued. Prices must vary by at least one tick, which is one hundredth. Concerning our three segments of BTPs, the 10-year maturity is issued at the end of the month and the 3- and 7-year BTPs at the middle.

is adopted when the securities to be issued are perceived to be highly requested by the market, but also to be more flexible in the issue distribution.[21]

Irrespective of the auction format, the process starts some days before the auction. During these days, the debt management office of the Treasury announces the auction in a press statement. The announcement for all auctions is issued three business days prior to the placement date. The statement confirms the auction date, the maturity of the bond(s) to be auctioned and provides a target range for the volume (the minimum and the maximum amounts offered to the market, i.e., a "fork"). The to-be issued bond starts trading before the proper issue, i.e. the "grey market", precisely the day after the announcement has been published.

On auction day, primary dealers submit their bids during the pre-announced time window.

Each primary dealer has at most five bids to place (the quantities and the correspondent prices at which they are willing to buy the bond) and they are sent electronically and anonymously to the Bank of Italy within 11 a.m. of the auction day. After the Bank of Italy receives all the bids from the market makers, a decrypting procedure starts and send the list of bids to the Treasury.

The results are published as soon as possible after the cut-off of the auction, typically within 11.30 a.m. In the announcement of the results, the Treasury publishes all relevant information of the process. Concerning securities issued through a uniform price auction, we can find the ISIN code, the tranche of issuance, the coupon, the issue date, the maturity date, the date of the auction, the settlement date, the interval of the amount to be offered, the amount requested and the amount allotted, which usually corresponds to the top amount of the range disclosed (full allotment), the allotment price and the placement fee[22] which has to be scaled down from the allotment price in order to know the real bid

[21] MEF.

[22] The amount of the placement fee depends on the type of security issued. Considering the four BTPs

price, and the bid-to-cover ratio. Settlements take place on the second working day after the auction.

There are two main periods for auctions, one takes place at the middle of the month and concerns, regarding medium-long term allocation, 3-, 7-, higher than 10-year BTPs and the second one at the end of the month which involves 5- and 10-year BTPs.[23]

For a more efficient placement of bonds to properly satisfy the aggregate investor demand and cut the borrowing cost, the Public Debt Management meets the Specialists (a subset of primary dealers) before the announcement date. These meetings are very important for the Public Debt Management as in this way it is more informed about secondary market developments.

Moreover, there are other informative documents, published by the Treasury, that overcome the information asymmetry problem between issuer and dealer. These are, mainly, the Annual Calendar (published at the beginning of each year, it contains information about the dates of announcement size, issuance/re-opening and settlement of each security), the Guidelines on Public Debt Management (yearly documents that provide qualitative and quantitative information on the issuance and management of the government securities in the following year) and the Quarterly Issuance Program (where information about new bonds to be issued and re-openings of on-the-run bonds for the next quarter of the year are released). These documents, together with other information such as Public Debt Reports, are available on the website of the Italian Treasury.

object of the analysis, we can find placement fees for 0.15%, 0.25%, 0.30%, 0.35% for the 3-, 5-, 7-, 10-year maturities, respectively.

[23]The reference is to on-the-run bonds. Off-the-run BTPs can be issued also in slots that do not concern their initial maturity.

5.1.2 Specialists' evaluation criteria

In order to be classified as a Specialist, and benefit from some privileges[24] , a primary dealer must meet several requirements and accomplishments as outlined in the Decree no. 993039 of November the 11th 2011.[25]

With the aim of being sure about Specialists' compliance with their obligations, the Italian Treasury continuously monitors their behaviour both in the primary and secondary markets.

The main evaluation criteria give the possibility to Specialists to gain points to better compete and be placed at the top of the final ranking. The final purpose of the Treasury is to foster demand at auctions, increase secondary market liquidity and receive advice from the Specialist on debt management policy issue. The points granted depend on the behaviour of Specialists in the primary and secondary markets. Different factors are at the heart of the evaluation: the quantity allocated by each bidder at auctions, the measure to which the specialists contribute to overpricing and overdemanding, the regularity of participation to all the auctions, the quality of bid and ask price proposals on the secondary market and the associated quantities, the type of bonds and volumes traded with other investors, the number of bonds quoted and the number of those traded, the activity in the repo market, the market share in the special operations (i.e., exchange transactions and buyback operations), the overall contribution to the management of public debt (i.e., advisory and research activity). The most important index (that gives 33 out of 100 in 2019) concerns the primary market and it is a quantitative indicator that involves the

[24] For example, only Government Bond Specialists that took part in the main auction can participate in the re-openings of the same bond. The maximum amount offered in the re-opening depends on the type of security, i.e. re-openings are equal to 15% of the ordinary issue (10% for BOTs), 30% for medium- and long-term bonds if newly issued.

[25] Among all the criteria, they must participate efficiently at the auctions in terms of quality, quantity and continuity of bidding, with a minimum allocation higher, or equal, than 3% of the overall amount auctioned, considering the characteristics of the subscribed securities. Furthermore, they have secondary market commitments *in terms of contribution to the volumes traded, to liquidity and to the depth of the market.*

share allocated obtained in the reference period.

Moreover, to make Specialists more compliant with the regulations, the Treasury makes, at the end of each year, a ranking and the top five is made public.[26]

5.1.3 MTS Italy

A more efficient placement of bonds for sovereign issuers, in terms of lower borrowing costs and lower risk premia demanded by investors, is guaranteed by a good functioning of the secondary market, the market where primary dealers act as market makers, i.e. they trade to provide liquidity to other investors that cannot access the primary market.

MTS is an interdealer platform with a high level of pre- and post-trade transparency established in 1988 by the Italian Treasury. The MTS trading system is quote-driven, electronic limit-order interdealer market, in which market makers' quotes can be hit or lifted by other market participants via market orders.

MTS Italy is a branch of the entire MTS trading system and it is the secondary market where Specialists are monitored by the Italian Treasury. It is regulated by the Italian Treasury, the Bank of Italy and Consob. Here, there are two types of participants: market makers and market takers. The former are primary dealers that act on the basis of the Market Making Commitments, which establish the rule that market makers have to provide liquidity continuously by quoting two proposals (one for the bid side and one for the ask side) during the trading hours. They can place quote anonymously, at least until one of the two counterparties settles bilaterally. They issue standing quotes but are not obliged to display the maximum quantity they want to bid, but only a non-negative fraction of the quantity they are willing to trade. Quotes must be at least of 2 million on both ask- and bid side. The latter, market takers, act as price takers, by hitting or lifting market makers'

[26] A placement at the top five of the ranking can signal the Specialist in the financial market as it gives a higher reputation Mormando and Greco.

quotes by market orders.

Finally, MTS Italy is divided into two segments: Cash and Repo. In the former, only Italian government debt securities are traded. In the latter we can find also government bonds of different Governments and non-government bonds, e.g. Asset-backed securities.[27]

If the secondary market is not functioning in an orderly manner and is not liquid as it should be, the primary market suffers in terms of placements and buy-back operations carried out by the Treasury. If this situation exists, the Italian Treasury, together with the technical assistance of both the Bank of Italy and the main Specialists[28], can change the debt management and issuance choices to improve the overall level of efficiency and ensure a sufficient liquidity and breadth of trading in the secondary market.

[27] These two markets are different also in terms of market hours. For the Cash Market, we can find the following hours: Pre-Market: 7:30am – 8:00am; Trading Hours: 8:00am – 5:30pm; Market Closed: from 5:30pm until the next morning. For the Repo Market, instead: Pre-Market: 7:30am – 7:45am; Market Open: 7:45am – 6:30pm; General Collateral allocation window: 6:30pm – 6:45pm; Market Closed: 6:45pm.

[28] As stated in the Specialists Decree MEF: *The enrolment of the Candidate Specialist in the List of Specialists is dependent upon the satisfaction, during the observation period, of a series of requirements as Assistance in choosing how to improve the overall efficiency of debt management, also by proposing useful contributions to issuance and debt management choices.*

5.2 On-the-run BTP descripition

ISIN Code	Description	From (dd/mm/yyyy)	To (dd/mm/yyyy)
IT0005139099	BTP 0,3% 15Ott18	01/01/2016	08/04/2016
IT0005177271	BTP 0,1% 15Apr19	09/04/2016	10/10/2016
IT0005217929	BTP 0,05% 15Ott19	11/10/2016	07/04/2017
IT0005250946	BTP 0,35% 15Giu20	08/04/2017	09/10/2017
IT0005285041	BTP 0,2% 15Ott20	10/10/2017	09/04/2018
IT0005330961	BTP 0,05% 15Apr21	10/04/2018	08/10/2018
IT0005348443	BTP 2,3% 15Ott21	09/10/2018	08/03/2019
IT0005366007	BTP 1% 15Lug22	09/03/2019	09/09/2019
IT0005384497	BTP 0,05% 15Gen23	10/09/2019	31/12/2019

Table 9 – 3-year BTP

ISIN Code	Description	From (dd/mm/yyyy)	To (dd/mm/yyyy)
IT0005135840	BTP 1,45% 15Set22	01/01/2016	08/03/2016
IT0005172322	BTP 0,95% 15Mar23	09/03/2016	08/09/2016
IT0005215246	BTP 0,65% 15Ott23	09/09/2016	08/03/2017
IT0005246340	BTP 1,85% 15Mag24	09/03/2017	08/09/2017
IT0005282527	BTP 1,45% 15Nov24	09/09/2017	08/03/2018
IT0005327306	BTP 1,45% 15Mag25	09/03/2018	10/09/2018
IT0005345183	BTP 2,5% 15Nov25	11/09/2018	08/04/2019
IT0005370306	BTP 2,1% 15Lug26	09/04/2019	12/11/2019
IT0005390874	BTP 0,85% 15Jan27	13/11/2019	31/12/2019

Table 10 – 7-year BTP

ISIN Code	Description	From (dd/mm/yyyy)	To (dd/mm/yyyy)
IT0005127086	BTP 2% 01Dic25	01/01/2016	23/02/2016
IT0005170839	BTP 1,6% 01Giu26	24/02/2016	25/07/2016
IT0005210650	BTP 1,25% 01Dic26	26/07/2016	25/01/2017
IT0005240830	BTP 2,20% 01Giu27	26/01/2017	27/06/2017
IT0005274805	BTP 2,05% 01Ago27	28/06/2017	25/01/2018
IT0005323032	BTP 2% 01Feb28	26/01/2018	25/07/2018
IT0005340929	BTP 2,8% 01Dic28	26/07/2018	22/02/2019
IT0005365165	BTP 3% 01Ago29	23/02/2019	26/08/2019
IT0005383309	BTP 1,35% 01Apr30	27/08/2019	31/12/2019

Table 11 – 10-year BTP