SECOND REPORT ON THE LIQUIDITY OF THE SECONDARY MARKET OF ITALIAN GOVERNMENT BONDS, YEAR 2023

MEF Dipartimento del Tesoro

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SECOND REPORT ON THE LIQUIDITY OF THE SECONDARY MARKET OF ITALIAN GOVERNMENT BONDS, YEAR 2023

The Report was elaborated by CRIEP research team on the liquidity of the secondary market of the Italian government bonds (Ms. Valentina Catapano, Prof. Luciano Greco and Mr. Filippo Mormando), with the technical support of Mr. Fabrizio Tesseri and Mr. Alessandro Iacono from the MEF, and Ms. Carla Tretto and Mr. Antonio Caruso from MTS Spa. Ms. Valentina Catapano's PhD scholarship is funded by the European Union – Next Generation EU. The analyses were carried out based upon the database made available by the MEF, within the framework of the institutional cooperation agreement between the MEF, MTS and CRIEP. The final version of the Report is the result of the review and collaboration in the context of the Technical and Scientific Committee of the above-mentioned agreement, composed of Mr. Davide Iacovoni (MEF), Mr. Ciro Pietroluongo (MTS) and Prof. Luciano Greco (CRIEP).

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1. Summary

The Report analyses the trend in liquidity conditions in the inter-dealer market for Italian government bonds (MTS Italy) in 2023. We explore the different dimensions through which the micro-structural liquidity of the market may be assessed: on the one hand, the quoting activity and availability of market makers to offer competitive prices in the inter-dealer market to execute buy and sell orders (possibly significant ones) of government bonds; on the other hand, the trading activity on the market platform. We also investigate the interaction between the two dimensions, testing the resilience of market makers against trading flows. We conduct the analysis separately for each government bond segment; specifically, we analyse the same metrics for each line on which the Italian Treasury operates through bond issues (so-called on-the-run lines): 6-month and 12-month BOTs, Short Term (2-year), 3-year, 5-year, 7-year, 10-year, 15-year, 20-year, 30-year and 50-year nominal BTPs, Green BTPs, 5-year, 10-year, 15-year and 30-year Euro-zone inflation-indexed BTPs, 3-year, 5-year and 7-year CCTs-eu. The Report focuses primarily on the micro-structural liquidity, that is measured according to established metrics based on existing scientific literature and market best practices; then discrepancies among the liquidity conditions of the various government bond segments are described. Moreover, given the important technological evolution that has increasingly characterised the operations of intermediaries in the financial markets over the last few years, we look at the algorithmic trading of market makers, with a focus on the development and use of auto-hedging functions in the quoting and trading activities of such operators and on the execution of significant flows involving multiple securities in the same flow (so-called basket/block trades). A special section of this second Report looks at the repo market that plays an essential role to warrant the proper functioning and efficiency of government bond markets.

Our main findings are that in 2023 liquidity conditions were good throughout all segments analysed and all the metrics adopted, marking an improvement from the worsening trend in liquidity conditions that is observed since the second half of 2021. In broad terms, the improvement of the quoting activity offered by market makers is quite homogeneous among them, with no significant differences in the behaviour between the more competitive dealers and the more conservative ones. During the 2022-2023 period, the market anticipation of a period characterized by central banks' restrictive monetary policies (particularly in the U.S. and Eurozone) preceded the actual interest rate hike cycle, demonstrating high correlation between the dynamics of liquidity conditions and the measure of market expectations on central banks' interest rate policy and its volatility. The trading volumes on MTS Italy increased starting from April 2020, peaking at the end of 2023, thus fully recovering from the decline in 2022. The rise in traded volumes experienced in 2023 is also representative of a relevant increase of the traded risk in the market. Compared to 2022, the increase in traded volumes was almost evenly distributed across different flow sizes for most of government bond segments. Combining quoting and trading dimensions, in 2023 liquidity conditions did not show any relevant deterioration compared to the previous years after directional fast market phases and medium-sized trading flows, confirming the substantial stability of the quoting activity of primary dealers on MTS Italy. Finally, the environment characterised by good liquidity conditions in terms of quoting has

encouraged the execution of large trades, which frequently involve multiple securities although the maximum number involved in a single flow is lower compared to the previous recent years (revealing a limitation in the execution of basket trades). In 2023 the volumes generated by auto-hedging trading strategies grew, reaching a record high, which is strongly related with the overall good liquidity conditions. In the special section, we provide sound evidence that liquidity conditions on the secondary market and specialness on the Repo market are intertwined and a higher level of specialness in the Repo market negatively affects secondary market liquidity conditions.

2. Market maker quoting

In the context of the micro-structural liquidity, we firstly investigate the quoting activity of market makers on the MTS Italy government bond market, which is the wholesale secondary market selected by the Ministry of Economy and Finance for the evaluation of Specialists in government bonds[1]. The analysis of quoting activity is structured as follows: in Section 2.1 we provide a long-term perspective analysis over the period 2006-2023 focusing on the benchmark securities; then, in Section 2.2, we focus on the 2022-2023 period in order to delve into the effects of the European Central Bank (ECB) interest rate hikes on market liquidity conditions; finally, in Section 2.3, we analyse the evolution of liquidity in 2023 for each segment of government bonds on which the Treasury operates through bond issues.

We conduct the analysis based upon the database containing all quotations on MTS Italy of traders on the government bonds under analysis, in which quoted prices and quantities are recorded every five minutes. From a sample of around 30 indicators of liquidity, we select the following six measures, which allow us to provide a clear picture of the liquidity phenomenon and its evolution[2]:

- one indicator of quoting book tightness: the best bid-ask spread;
- two indicators of quoting book depth: the overall volumes quoted on the platform and the quoted volumes associated with the three best prices as a percentage of the overall quoted volumes;
- three multidimensional indicators: the volume-weighted bid-ask (VWBA) spread, the ratio between the volume-weighted bid-ask spread and the daily volatility of the bond (VWBA spread/volatility) and the slope.

The Appendix provides a description of the six indicators of liquidity and analyses their performance for each of the segments on which the Treasury operates through on-the-run issues. The analysis below addresses the main stylized facts relying on a suitable selection of liquidity measures.

[1] The evaluation of Specialists in government bonds allows the Ministry not only to verify compliance with the minimum requirements of Specialists in order to keep such status, but also to set the conditions to promote competition among operators when providing liquidity on the market. For more details, see Ministerial Decree No. 853355 of 1 March 2011, available at: https://www.dt.mef.gov.it/export/sites/sitodt/modules/documenti_en/debito_pubblico/normativa_spalla_destra/Selection_of_wholesale_Government_bond_markets_eligible_for_the_evaluation_of_Specialists_in_Government_Bonds_-_Decree_1st_of_March_2011_and_Annexes.pdf.

[2] See the *First Report on the Liquidity of the Secondary Market of Italian Government Bonds*, for further details on existing liquidity metrics (available at: https://www.dt.mef.gov.it/en/debito_pubblico/presentazioni_studi_relazioni/archivio_presentazioni/elem_0010.html).

2.1 The 2006-2023 period

The analysis of the 2006-2023 period provides a long-term view of the quoting activity of market makers. In this regard, 2006 is selected as a benchmark year in the investigation of the liquidity conditions in the wholesale market for Italian government bonds prior to the 2007-2008 financial crisis. To keep the long-run analysis as simple as possible, we consider only the 10-year BTP[3].

In the pre-2008 period, the government bond market experienced excellent liquidity conditions. The main negative events in terms of short-term liquidity reduction that were detected during the 2006-2023 period refer to: the 2008 crisis with the default of Lehman Brothers, the European sovereign debt crisis in the 2010-2012 period, the volatility that is related to political instability following the 2018 elections and the outbreak of the Covid-19 pandemic in Europe in February 2020.

At a glance, the analysis of all the liquidity indicators selected reveals an improving trend in the wholesale market liquidity conditions for Italian government bonds during 2023. It is a gradual phenomenon with no peaks. This comes after a worsening trend in liquidity conditions started in the second half of 2021.

The Figure 1 shows the evolution of the VWBA spread (on the left vertical axis) and the difference between the VWBA spread and the best bid-ask spread (on the right vertical axis). The VWBA spread decreases in 2023 reaching very low levels that are comparable to the pre-2008 ones. The difference between the VWBA spread and the best bid-ask spread reflects potential differences in primary dealers' behaviour in quoting activity, distinguishing between the dealers quoting on the best prices and the dealers quoting on the following prices. The fact that in 2023 this difference decreases means that the improvement of the quoting activity offered by dealers is homogeneous among the various market makers (or even stronger for those market makers not particularly competitive), as opposed to 2022 where there is greater divergence between the more competitive dealers and the more conservative ones[4].

In that sense, the year 2023 shows positive liquidity conditions not only at the best, but also on the middle and on the tails of dealers. The higher confidence in providing better liquidity conditions in 2023 from the whole group of primary dealers might have been determined by several factors: (i) a reduced volatility in the Italian credit risk component during 2023 compared to 2022[5]; (ii) a decreasing uncertainty about the interest rates strategy of the ECB, supported by a disinflationary process after the peak reached in the second half of 2022; (iii) a greater competition induced by a larger number of Specialists[6].

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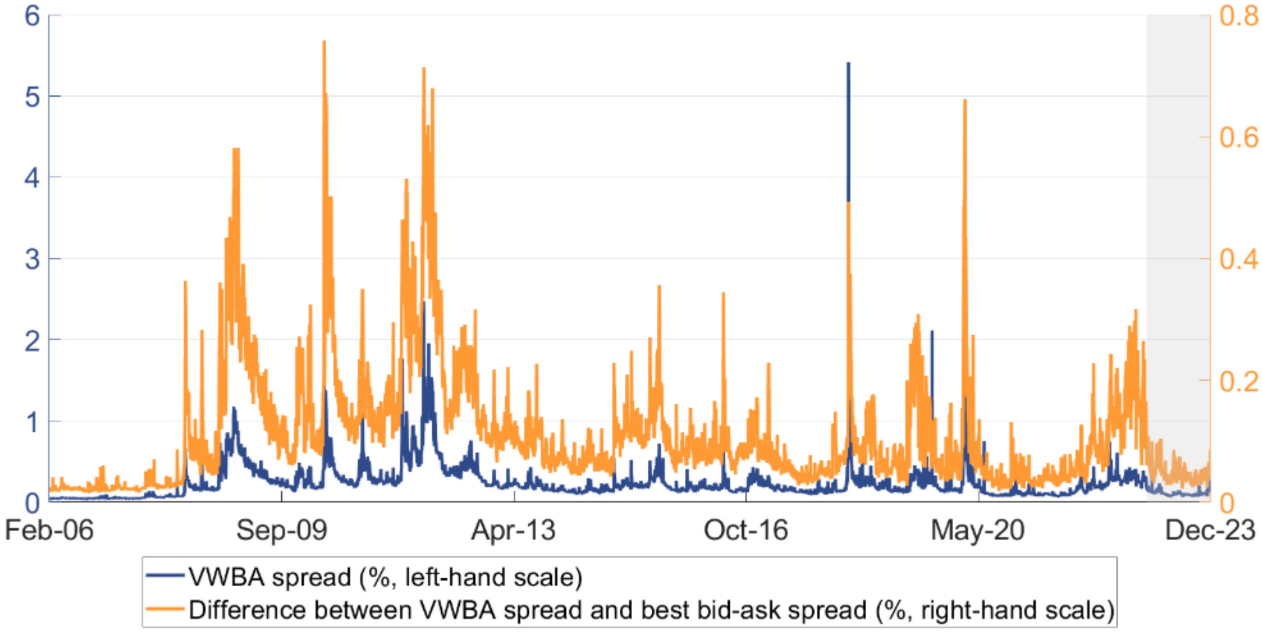
[3] For an extended long-run analysis, see the *First Report on the Liquidity of the Secondary Market of Italian Government Bonds* (available at: https://www.dt.mef.gov.it/en/debito_pubblico/presentazioni_studi_relazioni/archivio_presentazioni/elem_0010.html).

[4] However, the available database does not allow for a precise identification of this effect, which is beyond the scope of this Report.

[5] During 2023, the trading range of the 10-year BTP-Bund spread has been about 50 basis points while in 2022 it was around 125 basis points.

[6] Three new banks joined the Public Debt Specialist community during 2022 (in May, June and July) and one new bank joined during 2023 (in May). See the updates of the list of specialised banks provided by the MEF during 2022-2023 at https://www.dt.mef.gov.it/en/debito_pubblico/specialisti_titoli_stato/elenco_specialisti_in_titoli_di_stato/index.html. The accreditation process provides for a minimum period of six months, a phase in which the Candidate Specialist shall perform quoting and trading activities comparable to other primary dealers and on which the Treasury relies its assessment to accept (or reject) the application for accreditation as an Italian Public Debt Specialist. See the Specialists Evaluation Criteria Decree, available at: https://www.dt.mef.gov.it/export/sites/sitodt/modules/documenti_en/debito_pubblico/normativa_spalla_destra/Specialists_Decree_-_Selection_and_Evaluation_of_Specialists_in_Government_Bonds_xof_Nov_2011_and_amendments_of_Dec_2021x.pdf.

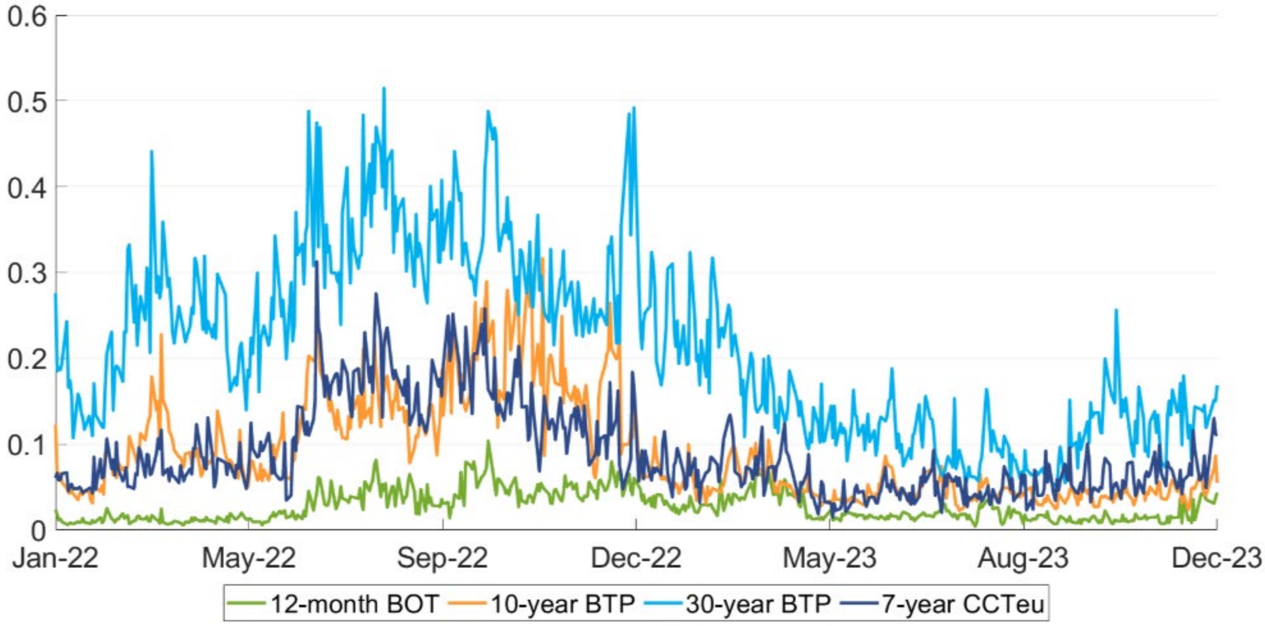
Figure 1: 10-year BTP



Notes: The graph shows on the left vertical axis the volume-weighted bid-ask (VWBA) spread in % (blue line), calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond, and on the right vertical axis the difference between VWBA spread and best bid-ask spread in % (orange line), the latter calculated as the difference between the best ask and the best bid against the mid-price of the bond, for the 10-year BTP on a daily basis. The grey area points out the last year.

The Figure 2 shows that the greater homogeneity in the quoting activity of primary dealers is a phenomenon present in almost all segments (as an example, we consider the 12-month BOT, 10-year BTP, 30-year BTP and 7-year CCTeu). In particular, the downward trend of the difference between the VWBA spread and the best bid-ask spread observed in 2023 is even more pronounced in those segments which showed a greater level in 2022 (e.g., 30-year BTP). This effect provides a first clear evidence that the improvement in the overall market liquidity conditions observed in 2023 concerned the whole group of Italian bonds and it was not limited to the most liquid bonds or segments.

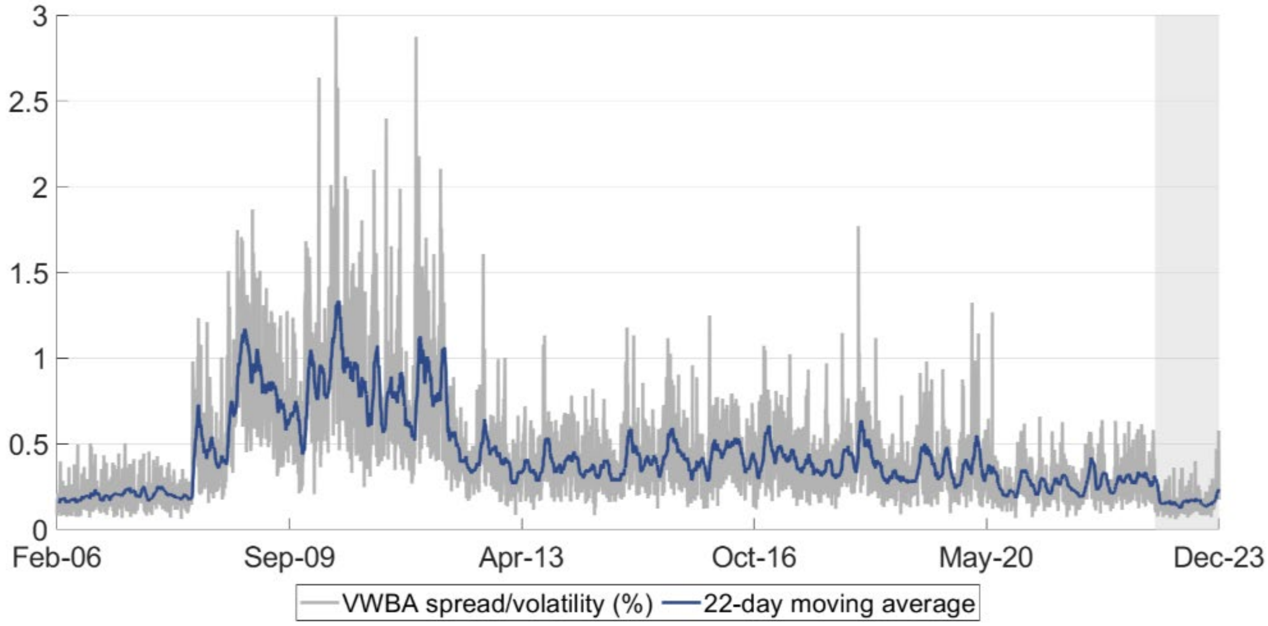
Figure 2: Difference between VWBA spread and Best Bid-Ask spread (%)



Notes: The graph shows the difference between the volume-weighted bid-ask (VWBA) spread and the best bid-ask spread in % for the 12-month BOT, 10-year and 30-year BTP, and 7-year CCTeu on a daily basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The best bid-ask spread is calculated as the difference between the best ask and the best bid against the mid-price of the bond.

The Figure 3 shows the evolution of the VWBA spread/volatility ratio and its one-month moving average. Normalising the VWBA spread by volatility, we observe in 2023 a significant improvement in liquidity conditions, in line with pre-2008 levels. This indicator allows us to compare VWBA spreads under different volatility regimes and the downward correction observed in 2023 corroborates the idea that the market liquidity conditions significantly improved last year. This effect was probably driven by stronger competition among primary dealers.

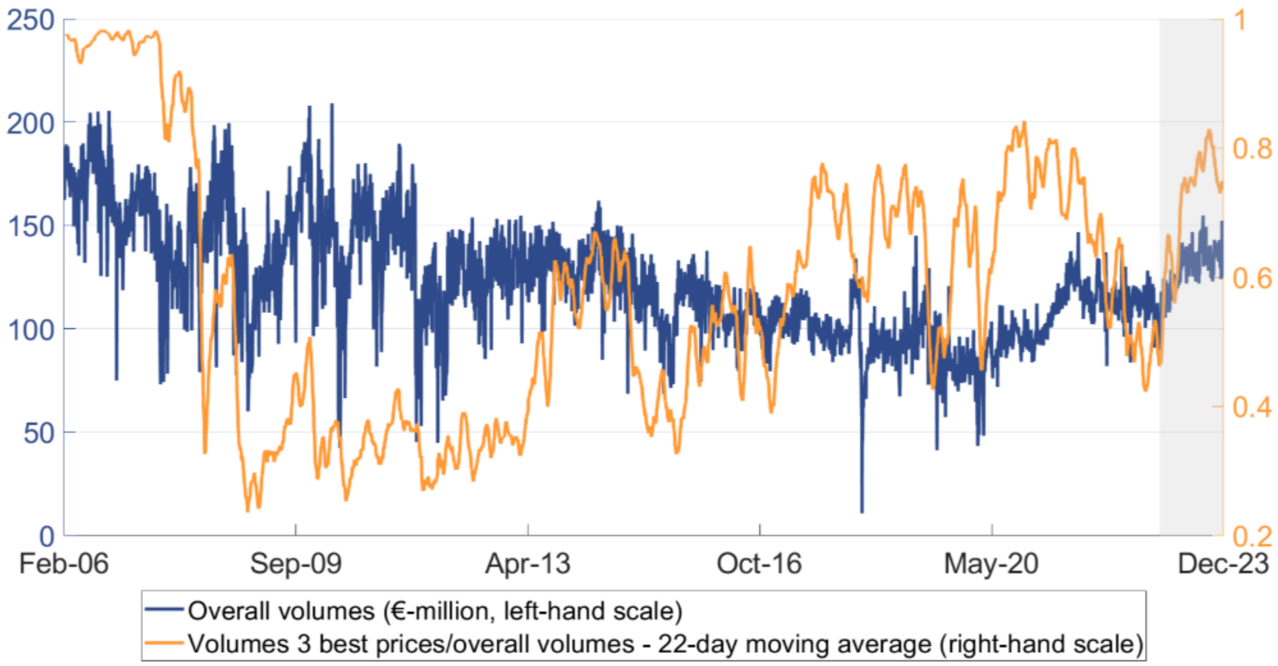
Figure 3: 10-year BTP



Notes: The figure shows the daily evolution of the volume-weighted bid-ask (VWBA) spread to volatility ratio in % (dark grey line) and its one-month moving average (blue line). The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The volatility of the bond is the daily variation between the minimum and maximum mid-price. The grey area points out the last year.

Lastly, Figure 4 shows the overall quoted volumes (on the left vertical axis) and the one-month moving average of the quoted volumes related to the three best prices as a percentage of the overall quoted volumes (on the right vertical axis). Both indicators of the quoting book depth increase in 2023. In particular, the increase of the total quoted volumes may be due to the entry of new Specialists during 2022-2023, although the total quoted volumes remain stable in 2022 reflecting a reduction in the average quantity quoted by each primary dealer. More importantly, the proportion of the quoted volumes associated with the three best prices reaches again a level higher than 80%, in line with the most liquid periods since the outbreak of the financial crisis in 2008.

Figure 4: 10-year BTP



Notes: The figure shows on the left vertical axis the overall quoted volumes by averaging bid side and ask side in million (blue line) and on the right vertical axis the one-month moving average of the quoted volumes related to the three best prices as a share of the overall quoted volumes by averaging bid side and ask side (orange line) for the 10-year BTP on a daily basis. The grey area points out the last year.

2.2 The ECB interest rate hikes in the 2022-2023 period

This section provides an in-depth look at the evolution of liquidity indicators over the 2022-2023 period in their relationship with restrictive monetary policies adopted by the ECB. Due to the global inflation shock experienced in 2021-2022 period, central banks of several developed and emerging countries changed their monetary policy stance in the last two years. In the Eurozone, the ECB has reduced the monetary accommodation of the last decade by rising the reference interest rates by 450 basis points in 2022-2023 period and through other operations that reduced the amount of extra-liquidity in the financial system. In this section, we provide some evidences about the effects of these measures on the liquidity conditions of the Italian government bonds on MTS Italy.

In particular, we focus on two multidimensional indicators on the 10-year BTP: the VWBA spread (Figure 5) and the slope (Figure 6). Notwithstanding many caveats (especially the differences in terms of market microstructure and of macroeconomic conditions), we also propose a comparison with the 2006-2008 period, which is characterised by the previous most relevant ECB's monetary policy tightening. Hence, we aim to compare the market liquidity conditions during the two most relevant rate hike cycles in the last two decades.

The Figures 5 and 6 show on the right vertical axis: the interest rates on the deposit facility, the Interest Rate Swap (IRS) EU 6m-fwd-6m, which is a market measure of markets' expectations about money market rates 6-month ahead, and its min-max monthly variation versus the monthly average.

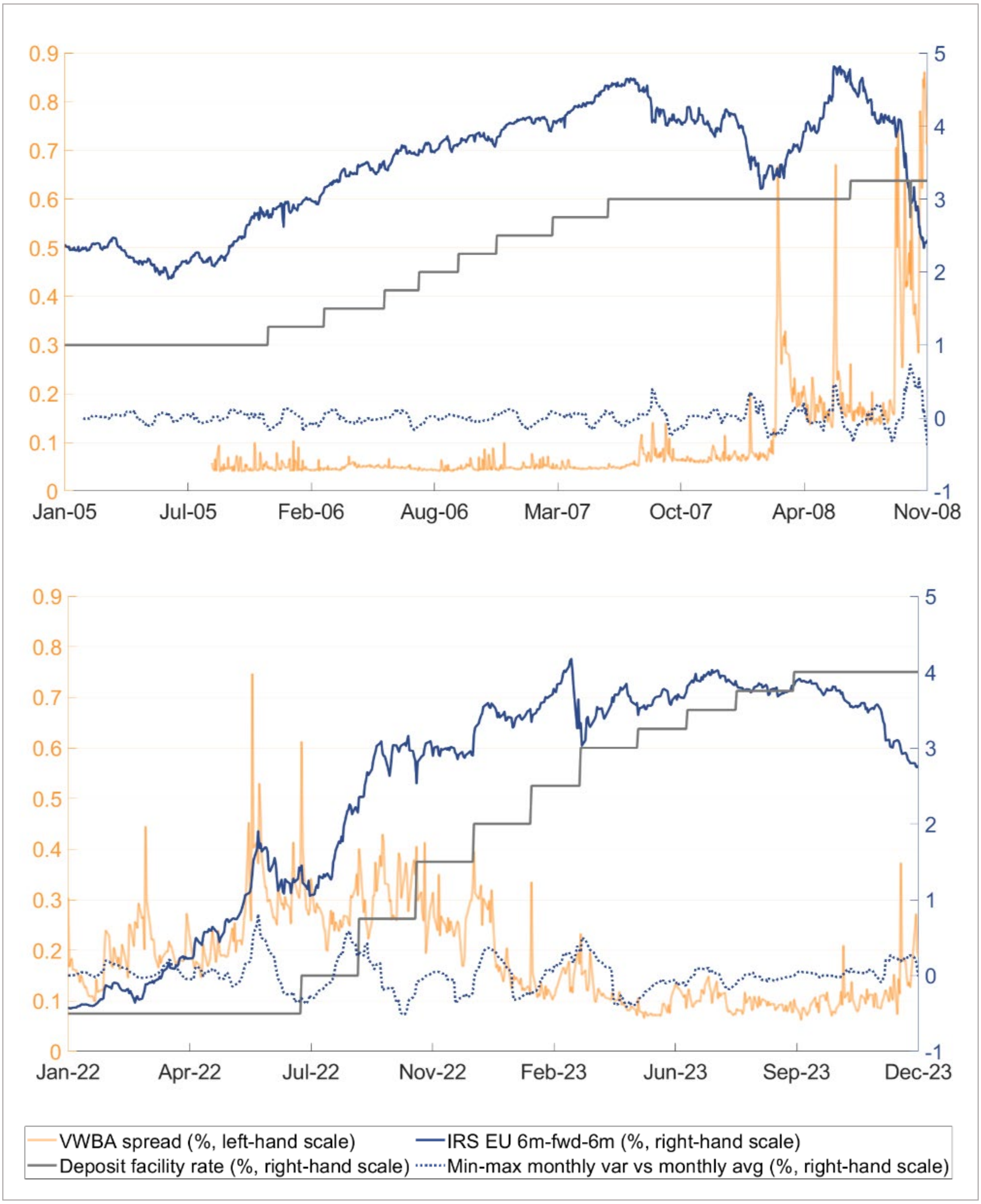
Regarding the latter, being a measure of daily volatility of market expectations on money market rates, the more it varies (independent of the direction), the more liquidity providers on MTS Italy platform deal under uncertainty. When financial market uncertainty increases, market makers need to quote wider bid-ask spreads to remunerate the liquidity provision service given a context characterised by higher risks.

The micro-structural liquidity began to gradually deteriorate in the second half of 2021, especially on the multidimensional indicators (see Figure A.1 in Appendix), along with the increase in Italian and European government bond yields and in market volatility. Indeed, market players anticipated the beginning of a period characterized by restrictive monetary policies adopted by Western central banks, well before the interest rate hike cycle actually started (the first 25 basis points hike decided by the ECB was in July 2022).

During the 2022, the VWBA spread and the slope worsen whenever the IRS EU 6m-fwd-6m moves signaling a change in the rate expectations. In that period, the high correlation of the dynamics of liquidity conditions with the volatility measure in market expectations on the rates strategy set by the ECB was clear. Later in 2023, primary dealers have not experienced large changes in the rate expectations (as shown by the stabilisation of the IRS EU 6m-fwd-6m and of the related volatility measure), thus favouring the liquidity conditions offered on the quoting book of the inter-dealer market. The deterioration events in the VWBA spread happened in February-March 2023 may be due to the crisis of regional banks in US and Credit Suisse in Europe, as reflected in the reduction of the IRS EU 6m-fwd-6m and of the volatility measure of rates expectations.

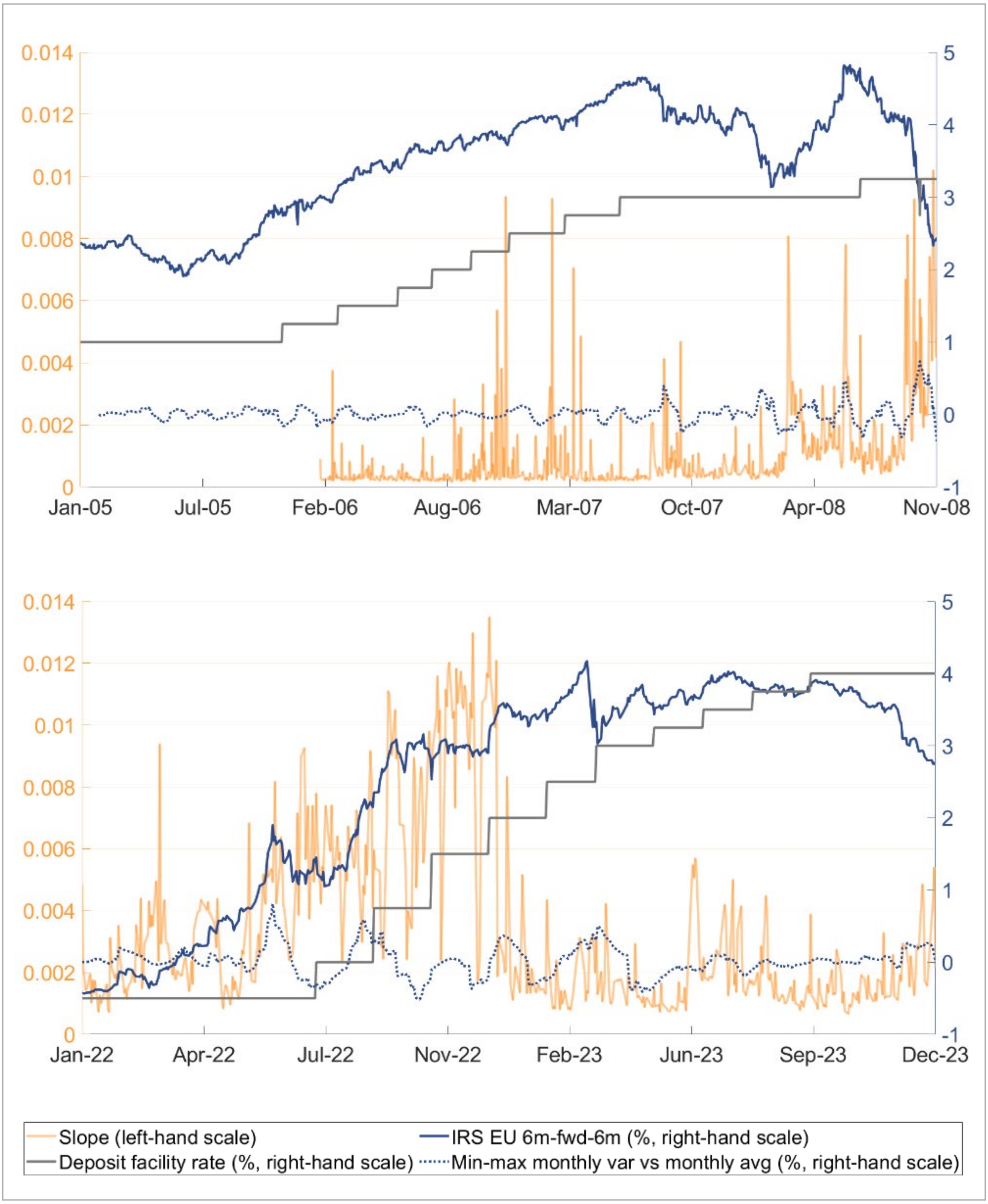
During the 2006-2008 period, market operators slightly anticipated the rate hike cycle (as shown by the increase in the IRS EU 6m-fwd-6m) and the actual adoption of restrictive monetary policies did not affect significantly the VWBA spread, while some liquidity deterioration events were more evident in the slope in 2007. However, in 2006-2008 period, the main relevant deterioration in the market liquidity conditions was observed in February-March 2008. In that case, it was not driven by central banks' expectations but due to the well-known financial stability problems occurred in the US banking system with the outbreak of the financial crisis. Conversely, as already observed, in the 2022-2023 period, the deterioration of the market liquidity conditions was mainly related to the pronounced increase of the volatility measure of rates expectations. In other words, while in 2006-2008 the deterioration of liquidity was apparently driven by growing economic uncertainty linked to the beginning of the Great Recession and due to the increasing concerns about global financial stability, in the period 2022-2023 it was mainly linked to the capacity of central banks to face an impervious global inflationary process.

Figure 5: 2006-2008 vs. 2022-2023 – VWBA spread (%)



Notes: The top and bottom figures show on the left vertical axis the volume-weighted bid-ask (VWBA) spread in % (orange line), calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond, for the 10-year BTP, on a daily basis. On the right vertical axis, it is shown the interest rate swap (IRS) EU 6m-fwd-6m in % (solid blue line), its min-max monthly variation versus the monthly average in % (dashed blue line), and the deposit facility rate in % (grey line).

Figure 6: 2006-2008 vs. 2022-2023 – Slope



Notes: The top and bottom figures show on the left vertical axis the slope (orange line), calculated as the ratio of the difference between the best and worst bid (ask) and the overall quoted volumes excluding those relating to the best bid (ask) by averaging bid side and ask side, for the 10-year BTP, on a daily basis. On the right vertical axis, it is shown the interest rate swap (IRS) EU 6m-fwd-6m in % (solid blue line), its min-max monthly variation versus the monthly average in % (dashed blue line), and the deposit facility rate in % (grey line).

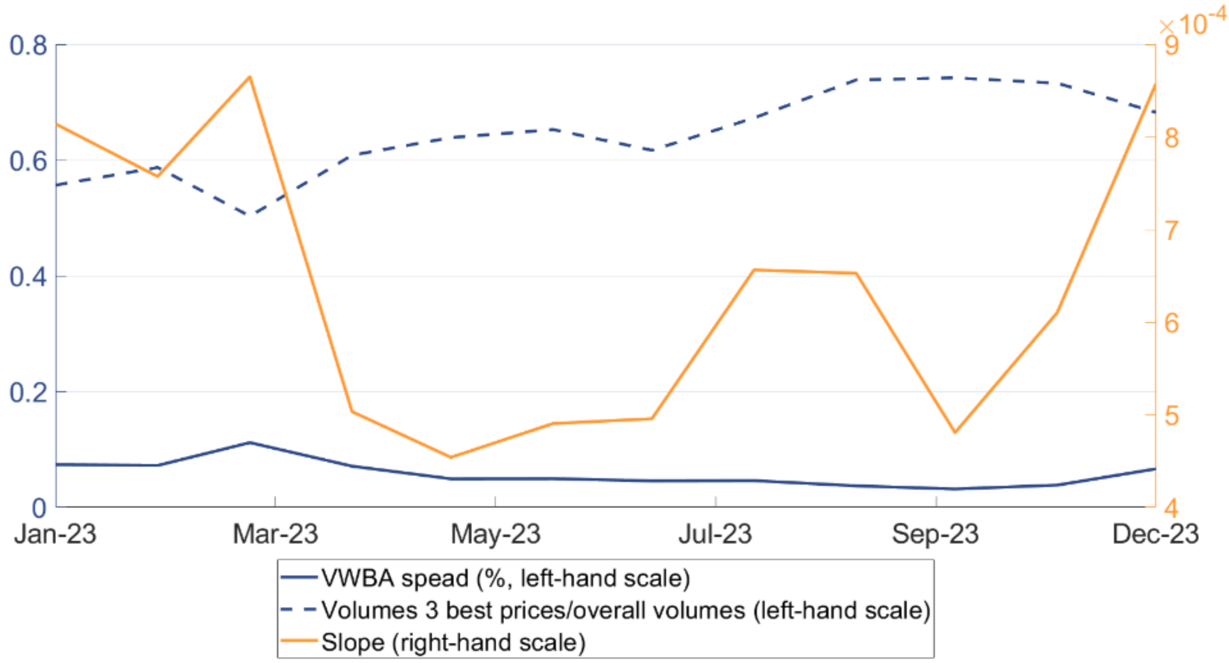
2.3 Security segments in 2023

In this section, we present an analysis of the liquidity conditions in 2023 for each of the segments on which the Treasury operates through on-the-run issues.

BOT

As regards the 6-month and 12-month BOTs, we observe a general trend characterised by improving liquidity conditions during 2023. More specifically, the Figure 7 shows the VWBA spread and the quoted volumes associated with the three best prices as a percentage of the overall quoted volumes (on the left vertical axis) and the slope (on the right vertical axis) for the 12-month BOT. All the indicators show a steady improvement of the liquidity conditions during April-November period, with a worsening observed in March and December. While the worsening at the end of the year might be mainly referred to a seasonality effect for the holidays period, the deterioration observed in March is intuitively linked to the crisis of regional banks in US and Credit Suisse in Europe that triggered a generalised risk-off mood in global markets, higher volatility and a higher risk aversion attitude of financial intermediaries. In any case, after these negative events and the prompt intervention of the FED and regulators, the liquidity measures under analysis showed a slight improvement, particularly evident in the case of the slope, a multi-dimensional measure that measures the marginal cost for the execution of orders (sell or buy) at the worst prices compared to the best market prices and suggests a generalised recovery of primary dealers' confidence in offering good liquidity conditions on MTS Italy.

Figure 7: 12-month BOT

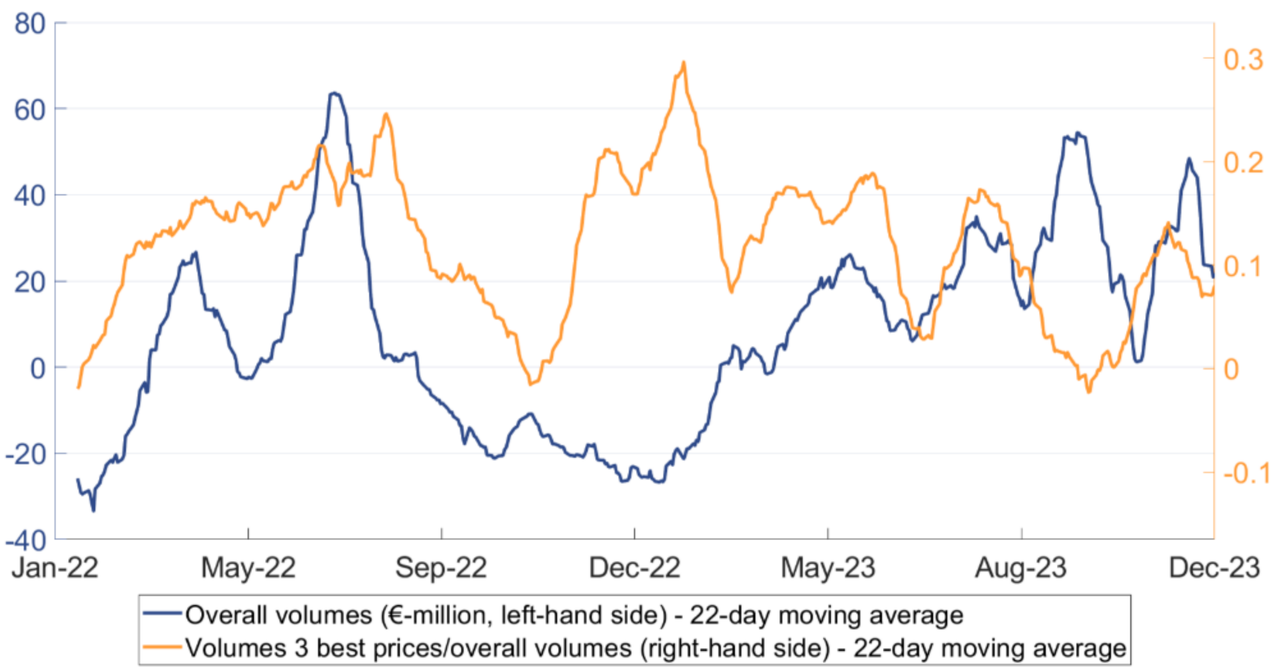


Notes: The figure shows on the left vertical axis the volume-weighted bid-ask (VWBA) spread in % (solid blue line) and the quoted volumes associated with the three best prices as a share of the overall quoted volumes by averaging bid side and ask side (dashed blue line) and on the right vertical axis the slope (orange line) for the 12-month BOT, on a monthly basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The slope is calculated as the ratio of the difference between the best and worst bid (ask) and the overall quoted volumes excluding those relating to the best bid (ask) by averaging bid side and ask side. As an example, $4 \times \mathbf{10^{-4}}$ corresponds to 0.0004.

Trying to assess whether some structural differences in the primary dealers' quoting behavior existed in 2023 between 6-month BOT and 12-month BOT, Figure 8 shows the one-month moving average of the difference between two indicators computed for the mentioned segments: the overall volumes (on the left vertical axis) and the quoted volumes associated with the three best prices as a percentage of the overall quoted volumes (on the right vertical axis). While the former shows a clear upward trend in 2023, the latter shows a slight downward correction over the year, meaning that the overall quoted volumes for the 6-month BOT have increased more over time than for the 12-month BOT, but the dynamics of the ratio of volumes that are quoted on the three top prices for the two segments stabilizes around 10%.

The phenomena depicted in Figure 8 may reveal higher confidence in providing better liquidity conditions from the whole group of primary dealers for the 6-month BOT in 2023, which in turn was also linked to important changes to the issuance policy for the 6-month BOT introduced by the Italian Treasury, aiming at guaranteeing greater liquidity to this segment[7]. Another important factor driving the trend in the BOT segment is the flat or inverted yield curve, making the 6-month BOT more attractive than the 12-month BOT (also evident in the high demand of retail investors for the 6-month BOT).

Figure 8: Difference between 6-month BOT and 12-month BOT



Notes: The figure shows on the left vertical axis the one-month moving average of the difference in the overall quoted volumes by averaging bid side and ask side in million between the 6-month and 12-month BOT (blue line) and on the right vertical axis the one-month moving average of the difference in the quoted volumes associated with the three best prices as a share of the overall quoted volumes by averaging bid side and ask side between the 6-month and 12-month BOT (orange line).

[7] See the *2023 public debt management guidelines* edited by Directorate II of the Department of the Treasury (available at: https://www.dt.mef.gov.it/export/sites/sitodt/modules/documenti_en/debito_pubblico/presentazioni_studi_relazioni/Guidelines-for-public-debt-management-2023.pdf).

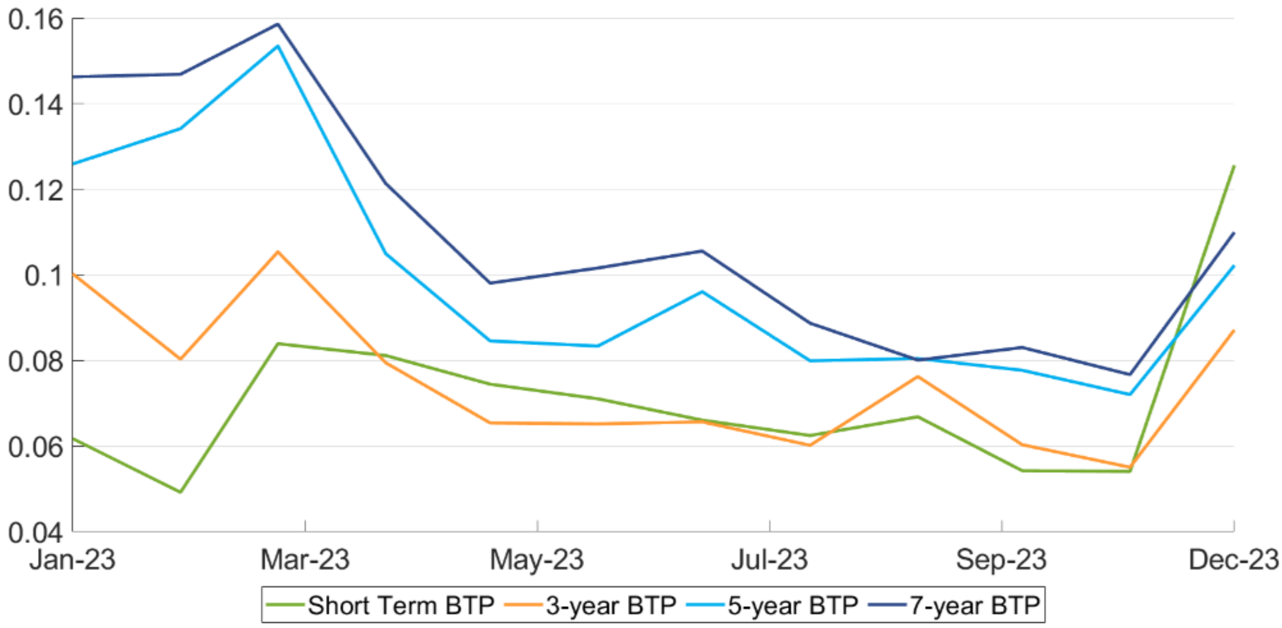
< 10-year BTP

Splitting BTPs according to their maturity smaller or greater than 10 years, a clear converging trend towards better liquidity conditions across several segments emerges.

As for BTPs with a maturity of seven years or less, we analyse the liquidity indicators on the short-term (2-year), 3-year, 5-year and 7-year BTPs. As the duration of the line increases, worse liquidity conditions emerge, however the improvement observed during 2023 is stronger as the duration of the line increases. In particular, the Figure 9 shows a convergence of the VWBA spreads to more similar liquidity levels among different sectors. The first quarter of the year is experiencing the worst liquidity conditions, then the liquidity indicators greatly improve over time but conclude with a negative peak (particularly high for the Short-Term BTP), arguably related to the holiday period in December.

The segments (in pairs) seem to experience highly correlated liquidity conditions and show very similar values of the metrics. Therefore, the Short-Term BTP and the 3-year BTP, on the one hand, and the 5-year BTP and the 7-year BTP, on the other hand, appear to be perceived as very similar by market makers.

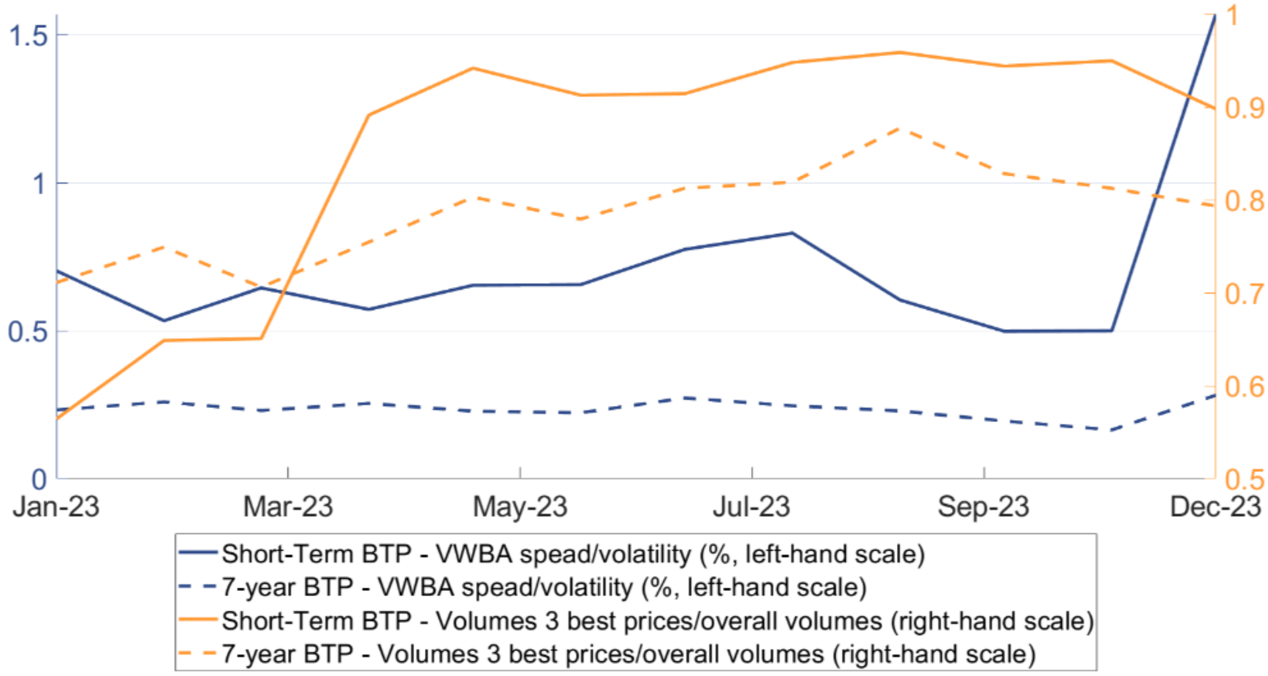
Figure 9: Volume-Weighted Bid-Ask spread (%)



Notes: The figure shows the volume-weighted bid-ask (VWBA) spread in % for the short-term, 3-year, 5-year, and 7-year BTP, on a monthly basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond.

The Figure 10 shows the ratio VWBA spread/volatility (on the left vertical axis) and the quoted volumes associated with the three best prices as a percentage of the overall quoted volumes (on the right vertical axis) for the Short-Term BTP and the 7-year BTP. Comparing the two segments, the longer BTPs have more stable liquidity conditions, while the shorter BTPs have more volatile liquidity conditions: compared to other segments, the Short-Term BTP shows a greater deterioration of liquidity conditions during negative market phases and a slower recovery to better liquidity conditions. One possible reason might be related to larger volatility induced by uncertainty regarding the ECB interest rate strategy on the short-term part of the interest rate curve.

Figure 10: Short-Term BTP and 7-year BTP



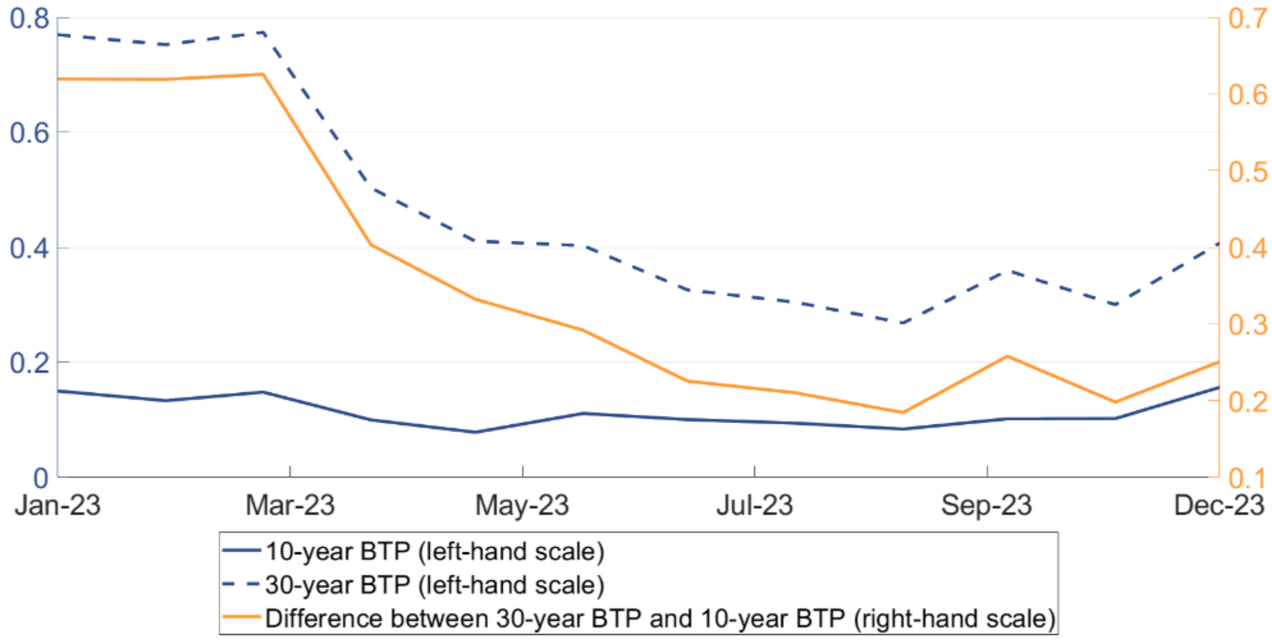
Notes: The figure shows on the left vertical axis the volume-weighted bid-ask (VWBA) spread to volatility ratio in % (solid blue line for the short-term BTP and dashed blue line for the 7-year BTP) and on the right vertical axis the quoted volumes associated with the three best prices as a share of the overall quoted volumes by averaging bid side and ask side (solid orange line for the short-term BTP and dashed orange line for the 7-year BTP), on a monthly basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The volatility of the bond is the daily variation between the minimum and maximum mid-price.

≥ 10-year BTP

For BTPs with a maturity of ten years or more, here we focus on 10-year, 30-year and 50-year BTPs. In Appendix, we also analyse 15-year and 20-year BTPs, which metrics have similar levels and trends. Historically, the 10-year BTP line performs better and sharply differs from the liquidity conditions of the 15-year, 20-year and 30-year BTPs, which in turn show structurally better liquidity conditions than the 50-year BTP. These structural differences may be ascribable both the longer duration of the considered bonds and to differences in terms of soft regulation through the Specialists' evaluation criteria defined by the Treasury (e.g., the minimum amount required for evaluation purposes in the case of 10-year BTPs is higher than for BTPs with a longer maturity). However, in 2023 some of these differences were significantly reduced.

The Figure 11 shows the difference between the 30-year BTP and the 10-year BTP (as benchmark) for the VWBA spread (on the right vertical axis) in 2023: it decreases over time as a signal of convergence. This trend may signal higher confidence among primary dealers that shrink the bid-ask spread on securities with higher duration risk. Moreover, the fact that this convergence is related to the VWBA spread, a multidimensional measure, suggests that the higher improvement observed in the 30-year BTP in relative terms vs. the 10-year BTP is related to the quoting behaviour of the whole group of primary dealers. Lastly, in terms of timing, it is interesting to note that this convergence started in April, substantially aligned with the beginning of a positive market phase for BTP in terms of credit risk re-pricing. Indeed, during the second quarter of 2023 the average BTP-Bund spread decreased by about 25 basis points, from about 190 basis points in March to about 165 basis points in June.

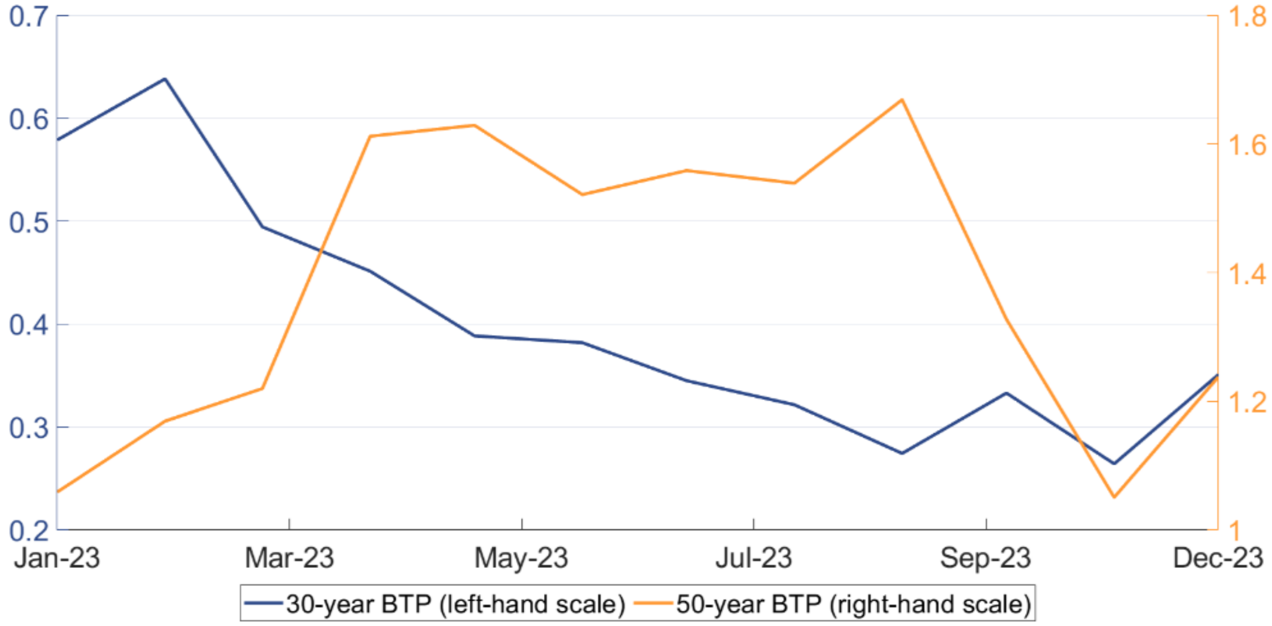
Figure 11: Volume-Weighted Bid-Ask spread (%)



Notes: The figure shows on the left vertical axis the volume-weighted bid-ask (VWBA) spread in % (solid blue line for the 10-year BTP and dashed blue line for the 30-year BTP) and on the right vertical axis the difference in VWBA spread in % between the 30-year and 10-year BTP (orange line), on a monthly basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond.

The Figure 12 shows the ratio VWBA spread/volatility for the 30-year BTP (on the left vertical axis) and the 50-year BTP (on the right vertical axis). The indicator for the 50-year BTP worsens in the mid-year months. Possible explanations of this phenomenon may be the less activity on the 50-year BTP segment, the poor demand and supply for these bonds, but also reduced reactions of primary dealers to adjust bid and ask prices in the face of a decreasing volatility regime on this segment. In fact, the best bid-ask spread and VWBA spread of the 50-year (showed in Figure A.4 in Appendix) showed a slight, quite homogeneous improvement over the year, meaning that the deterioration of the VWBA spread/volatility measure has been driven by a significant reduction in the volatility of prices of this bond that has not been followed by a sufficient narrowing of bid-ask spreads.

Figure 12: Volume-Weighted Bid-Ask spread/Volatility (%)

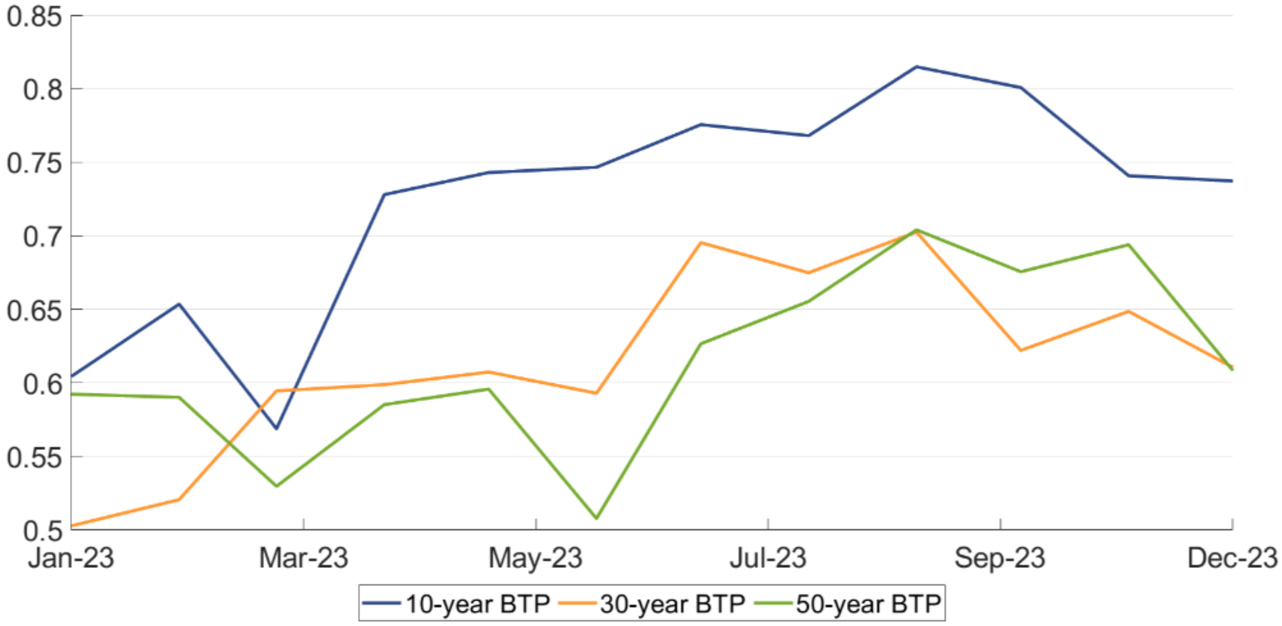


Notes: The figure shows the volume-weighted bid-ask (VWBA) spread to volatility ratio in % for the 30-year BTP on the left vertical axis (blue line) and for the 50-year BTP on the right vertical axis (orange line), on a monthly basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The volatility of the bond is the daily variation between the minimum and maximum mid-price.

Lastly, Figure 13 shows the quoted volumes associated with the three best prices as a percentage of the overall quoted volumes for the 10-year, 30-year and 50-year BTPs. The indicator shows improving trends for all the segments analysed over 2023, except in the last quarter of the year. The upward trend in the concentration of volumes on the best prices is sharper as the duration of bonds decreases.

Therefore, during 2023, BTPs with maturities longer than 10-year reveal an improvement of liquidity conditions in terms of both the tightness of quoting book (i.e., narrower bid-ask spread) and the relative depth (i.e., higher concentration of volumes quoted on the three top prices).

Figure 13: Volumes 3 best prices/overall volumes - average Bid/Ask



Notes: The figure shows the quoted volumes associated with the three best prices as a share of the overall quoted volume by averaging bid side and ask side for the 10-year, 30-year, and 50-year BTP, on a monthly basis.

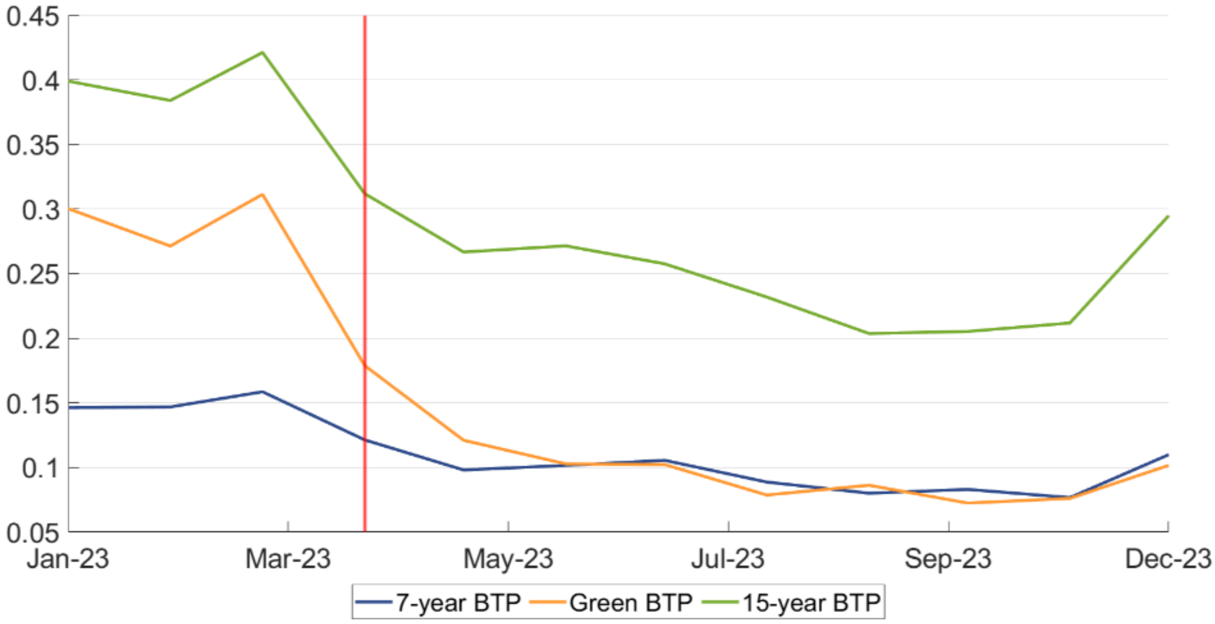
Green BTP

Green BTPs, one of the main innovations in the Italian Treasury's offerings in recent years, were issued to fund specific investments and programs of the State budget, in line with the goal of achieving climate neutrality by 2050 and, more generally, with the objectives set by the European Green Deal[8]. In March 2021, the Treasury offered the first green bond maturing in April 2045 (with a maturity of 24 years, i.e., different from the benchmark lines of the traditional BTPs). Then, the Treasury issued, in September 2022, a second green bond maturing in April 2035 (with a maturity of approximately 12 and a half years) and, in April 2023, a third green bond maturing in October 2031 (with a maturity of approximately 8 and a half years).

These government bonds are regularly listed on MTS Italy with the same rules applied to market makers and primary dealers for traditional BTPs. In terms of liquidity conditions, green bonds show a trend consistent with traditional bonds with similar maturities. The Figure 14 shows that the green benchmark bond was replaced with the new issue in April 2023. Therefore, the liquidity indicators (specifically, the VWBA spread) from April onwards converge towards the 7-year BTP levels.

[8] See the *Framework for the issuance of Sovereign Green Bonds* of the Italian Ministry of Economy and Finance (available at: https://www.dt.mef.gov.it/export/sites/sitodt/modules/documenti_en/debito_pubblico/presentazioni_studi_relazioni/documentazione_btp_green/Framework_for_the_issuance_of_Sovereign_Green_Bonds.pdf).

Figure 14: Volume-Weighted Bid-Ask spread (%)

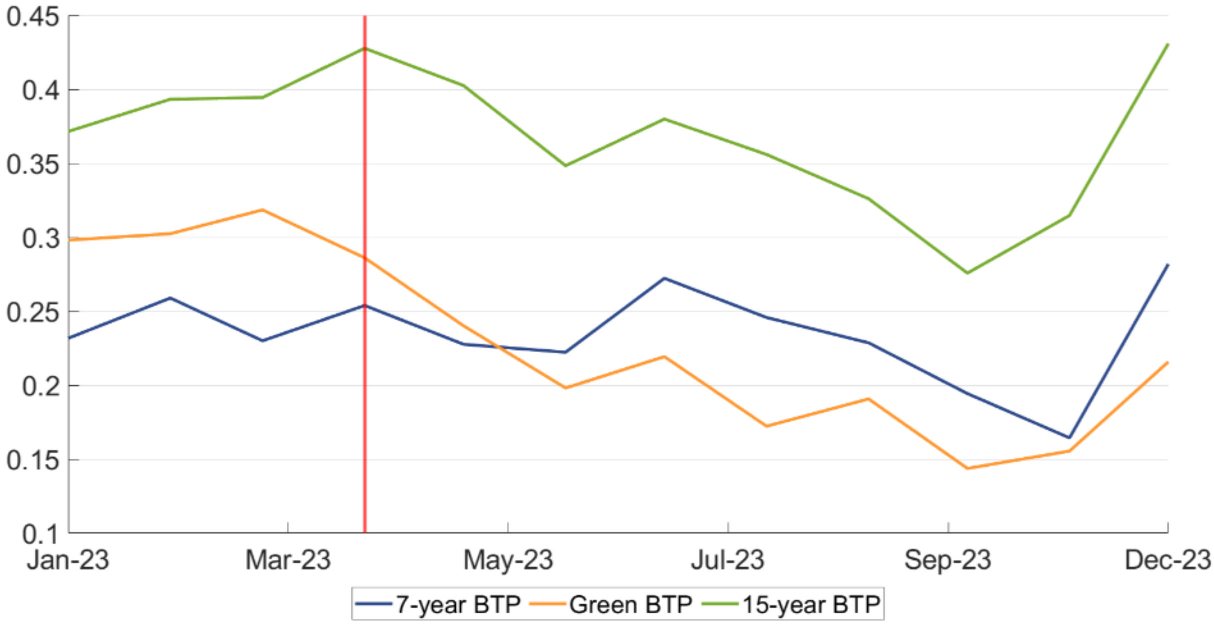


Notes: The figure shows the volume-weighted bid-ask (VWBA) spread in % for the 7-year and 15-year BTP, and the Green BTP, on a monthly basis. The vertical red line refers to April 2023 when the green benchmark bond was replaced with a new issue. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond.

In general, liquidity indicators for Green BTPs suggest a steadily better quality of the quoting book compared to those of traditional BTPs (or liquidity conditions consistent with those of traditional BTPs), although the Treasury did not set particular incentives. This is even more apparent taking into account the volatility of the bond: the VWBA spread/volatility for Green BTPs suggests a tighter range of quotations compared to traditional bonds (Figure 15).

The described dynamics highlight how the good liquidity conditions of the Green BTPs (also in traded volumes, see Figure 28) are driven by the growing activity and interest from the investors in green bonds.

Figure 15: Volume-Weighted Bid-Ask spread/Volatility (%)



Notes: The figure shows the volume-weighted bid-ask (VWBA) spread to volatility ratio for the 7-year and 15-year BTP, and the Green BTP, on a monthly basis. The vertical red line refers to April 2023 when the green benchmark bond was replaced with a new issue. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The volatility of the bond is the daily variation between the minimum and maximum mid-price.

BTP€i

Italian public debt is mostly issued through fixed-rate bonds (about 78%), while about 22% is issued through floating-rate instruments[9]. Among them, the Italian Treasury issues Euro-zone inflation-indexed securities with on-the-run lines with 5-, 10-, 15- and 30-year maturities.

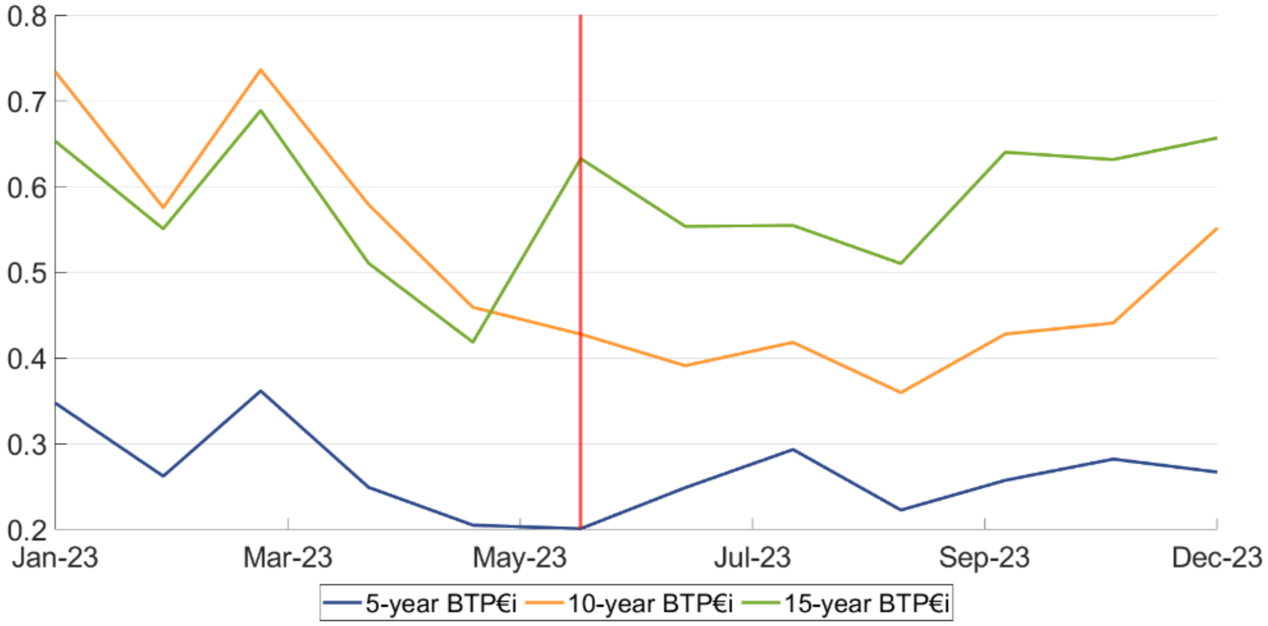
In general, the BTP€i segment is structurally characterised by worse liquidity conditions compared to nominal BTPs[10]. Then, the BTP€i segment experienced stronger improving trends in liquidity levels during 2023.

The Figure 16 shows the VWBA spread evolution for the 5-year, 10-year and 15-year BTP€i benchmark bonds (we recall that in May a new 15-year BTP€i benchmark was launched by the Treasury). The liquidity indicators (specifically, the VWBA spread) from May onwards move away from the 10-year BTP€i levels. Vice versa, the 10-year BTP€i maintained the tighter quoting book conditions after the strong improvement observed in the previous months. Also, the 5-year BTP€i shows a slight improvement of the liquidity conditions over the year.

[9] See the statistics regarding the issuance of Government securities and public debt outstanding, available at: https://www.dt.mef.gov.it/en/debito_pubblico/dati_statistici/index.html.

[10] The comparison of the metrics' levels between the BTP€i benchmarks and the related nominal BTPs with the same maturity clearly reveals the structural difference between the two segments. For example, the 10-year BTP€i the average VWBA spread in 2023 ranged about between 0.4%-0.7%, and for the 10-year BTP between 0.1%-0.2%.

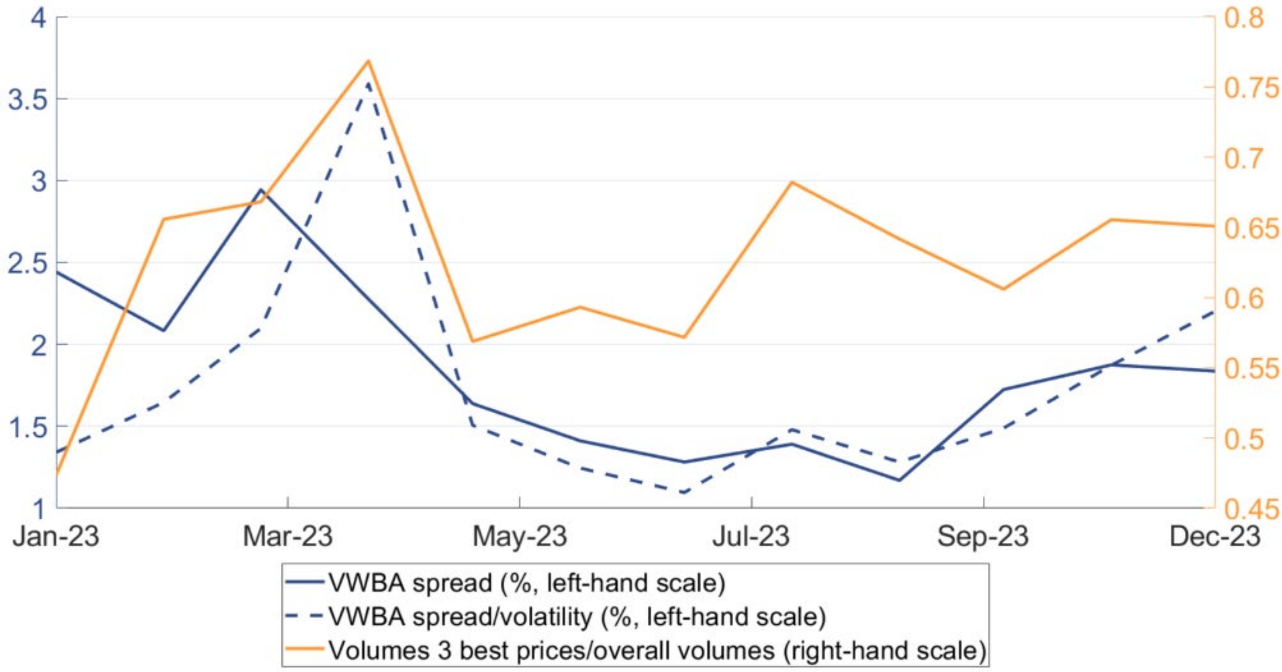
Figure 16: Volume-Weighted Bid-Ask spread (%)



Notes: The figure shows the volume-weighted bid-ask (VWBA) spread in % for the 5-year, 10-year, and 15-year BTP€i, on a monthly basis. The vertical red line refers to May 2023 when a new 15-year BTP€i benchmark was launched by the Italian Treasury. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond.

The 30-year BTP€i (Figure 17) also shows marked worsening of liquidity conditions in March 2023 like the other maturities but to a larger extent. This is particularly evident in the ratio VWBA spread/volatility (on the left vertical axis). In contrast, during those months the quoted volumes associated with the three best prices as a percentage of the overall quoted volumes improve arguably due to a wider bid-ask spread condition that ensures primary dealers to quote on the three best prices with enough confidence.

Figure 17: 30-year BTP€i



Notes: The figure shows on the left vertical axis the volume-weighted bid-ask (VWBA) spread in % (solid blue line) and the VWBA spread to volatility ratio in % (dashed blue line) and on the right vertical axis the quoted volumes associated with the three best prices as a share of the overall quoted volumes by averaging the bid side and ask side (orange line), for the 30-year BTP€i, on a monthly basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The volatility of the bond is the daily variation between the minimum and maximum mid-price.

CCTeu

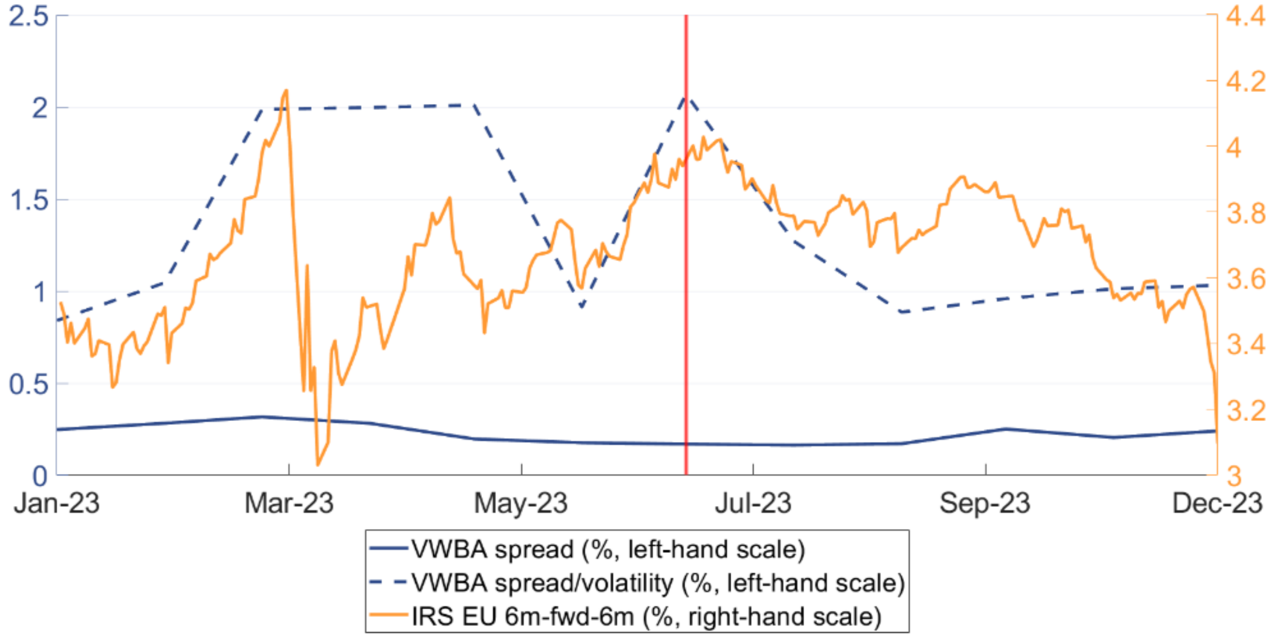
The CCTs-eu, which are indexed to the 6-month Euribor, belong to the floating-rate issuances. Until 2017, the segment was considered a single benchmark with a 7-year maturity. In recent years, due to the specific conditions of the financial markets and the different dynamics experienced in the demand for floating-rate securities, the Treasury started redefining the segment as a multi-benchmark one (i.e., similar to the BTP€i segment), with three on-the-run lines: 3-year, 5-year and 7-year[11]. Here we focus on the 5-year and 7-year lines. The 3-year CCTeu expired in December 2023 without any replacement and shows tighter bid-ask spread and higher quoted volumes compared to the other two lines (see the Figure A.7 in Appendix). In 2023, the Treasury renewed the 5-year benchmark by issuing in March the new CCTeu maturing in October 2028 and the 7-year benchmark in July with the new CCTeu October 2031.

The Figure 18 shows the evolution of the VWBA spread and the VWBA spread/volatility measures for the 7-year CCTeu (the vertical red line indicates when the new benchmark was issued in July). The analysis highlights a substantial stability of both the measures: their levels turn out to be the same at the beginning and end of the year. The VWBA spread/volatility ratio shows two similar peaks in March-May period and in July, aligned with the upward correction observed in the IRS EU 6m-

[11] Specifically, in the context of the 7-year line, it is worth noting that in 2021 the Treasury issued a new 7-year CCTeu (maturing in April 2029), replacing the previous on-the-run CCTeu (maturing in April 2026), which in turn became the benchmark bond for the 5-year maturity.

fwd-6m, a market measure of traders' expectations about money market rates 6-month ahead (mainly related to the upcoming ECB's rates decisions). The negative effect on the liquidity measure in March lasted for three months, confirming the well-known asymmetric relationship that exists between the time requested for a worsening of liquidity measures and the longer period necessary to restore better liquidity conditions. As regard the VWBA spread, the indicator shows a slight improvement, particularly during mid-year months probably due to the rolling of the new CCTeu.

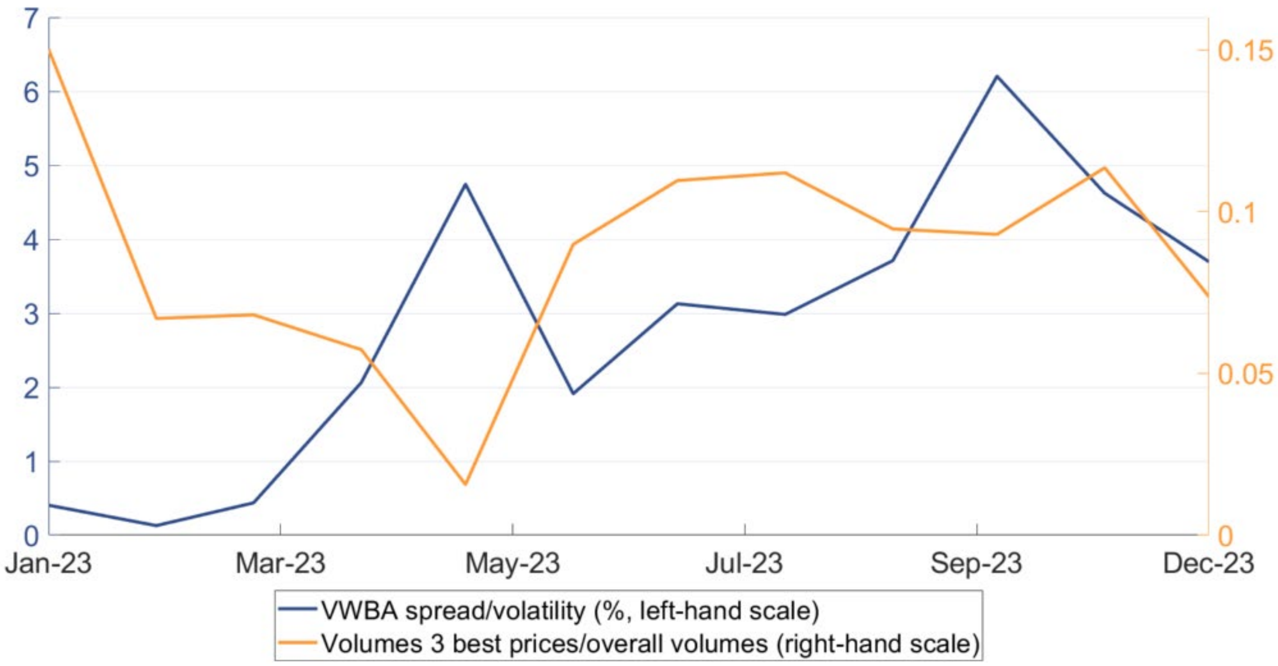
Figure 18: 7-year CCTeu



Notes: The figure shows on left vertical axis the volume-weighted bid-ask (VWBA) spread in % (solid blue line) and the VWBA spread to volatility ratio in % (dashed blue line) for the 7-year CCTeu on a monthly basis, and on the right vertical axis the interest rate swap (IRS) EU 6m-fwd-6m in % (orange line). The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The volatility of the bond is the daily variation between the minimum and maximum mid-price.

In Figure 19, we compute the difference between 5-year CCTeu and 7-year CCTeu for two liquidity measures: the VWBA spread/volatility (on the left vertical axis) and the quoted volume at the three best prices as a percentage of the overall quoted volumes (on the right vertical axis). In the face of the higher rate volatility in the mid-year months, the VWBA spread/volatility has increased over time with peaks in May and October, highlighting the worsening of liquidity conditions for the 5-year CCTeu compared to the 7-year CCTeu. The quoted volumes associated with the three best prices as a percentage of the overall quoted volumes show a higher concentration on the three top prices for the 5-year CCTeu arguably due to the wider bid-ask spread on that benchmark. In the second half of the year, the 5-year CCTeu showed an improvement in relative terms vs. the 7-year CCTeu of the quoted volume at the best prices.

Figure 19: Difference between 5-year CCTeu and 7-year CCTeu



Notes: The figure shows the differences between the 5-year and 7-year CCTeu in terms of the volume-weighted bid-ask (VWBA) spread to volatility ratio in % on the left vertical axis (blue line) and the quoted volumes associated with the three best prices as a share of the overall quoted volumes by averaging the bid side and ask side on the right vertical axis (orange line), on a monthly basis. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The volatility of the bond is the daily variation between the minimum and maximum mid-price.

3. Trading

In this section, we analyse the trading activity carried out on the MTS Italy platform through the database containing all concluded contracts, with information concerning the identification of the security and the operators (particularly, we distinguish two types of operator: the price maker or filler vs. price taker or aggressor), the market side (buy or sell, from the perspective of the price taker who trades, i.e., the aggressor), the price and yield of the contract, the date and time with microsecond accuracy. In general terms, measuring the trading activity in the wholesale secondary market is the second dimension in order to assess the micro-market liquidity conditions. The greater the traded volumes, the greater the liquidity is expected to be.

To assess different aspects of trading activity, the analysis focuses on three different dynamics: in Section 3.1, we analyse the trend of monthly volumes that are traded on the platform and the breakdown by flow size of the volume trend in 2023 compared to the previous year; in Section 3.2, we analyse the quoting activity of market makers in the light of fast market trends and medium-sized trading flows, thanks to the interaction between the quoting activity database and the information on the trading of securities on the platform; finally, in Section 3.3, we focus on the algorithmic trading, and specifically on basket trades and auto-hedging strategies.

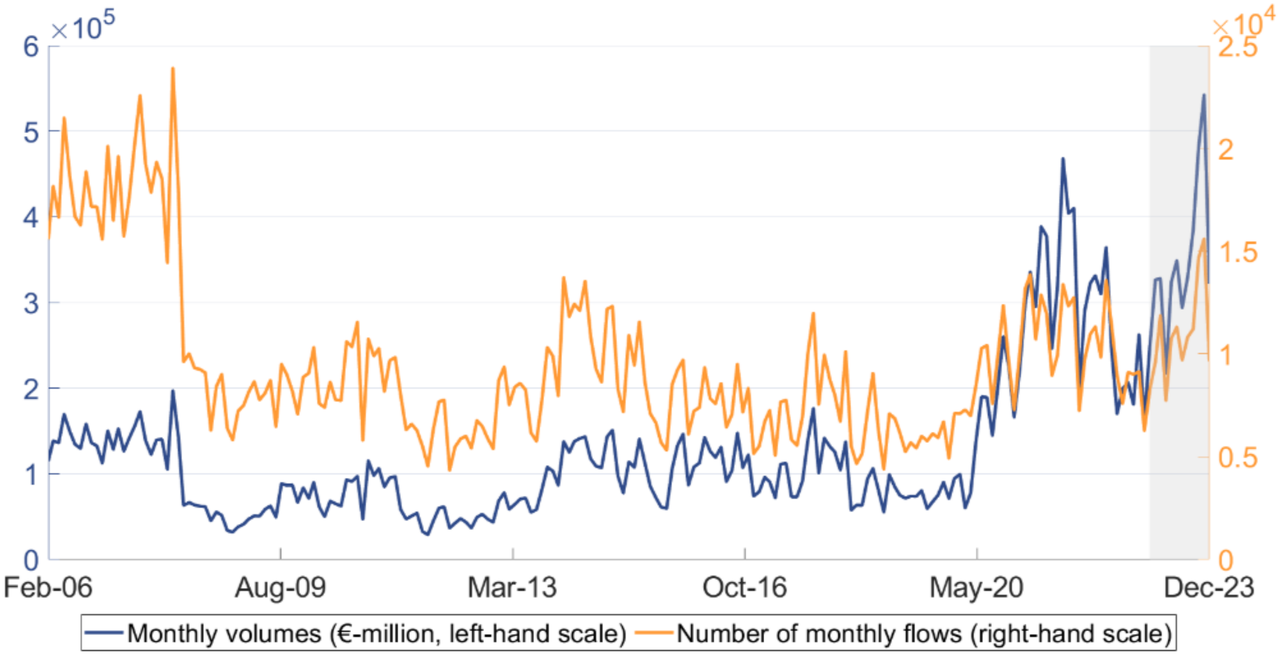
3.1 Trend in trading volumes

We analyse trading volumes on the MTS Italy platform by subdividing the database by category of security and the related residual maturity in order to take due account of the different risks associated with trading the various instruments (e.g., the longer financial duration). Specifically, we divide Italian government bonds into: BOTs and BTPs with residual maturity of one year or less, BTPs with residual maturity between one year and two and a half years (2-year BTPs), BTPs with residual maturity between two and a half and four years (3-year BTPs), BTPs with residual maturity between four and six years (5-year BTPs), BTPs with residual maturity between six and eight years (7-year BTPs), BTPs with residual maturity between eight and twelve years (10-year BTPs), BTPs with residual maturities between twelve and seventeen and a half years (15-year BTPs), BTPs with residual maturities between seventeen and a half and twenty-five years (20-year BTPs), BTPs with residual maturities longer than twenty-five years (30-year BTPs), Green BTPs, BTPs with Euro-zone inflation-indexed coupons (BTP€i) and bonds with floating coupons indexed to the 6-month Euribor benchmark (CCTeu).

The Appendix analyses the performance of the following four metrics for each of the segments outlined above: (a) monthly volumes; (b) average size of filler-side flows; (c) average size of aggressor-side flows; (d) number of monthly flows. The analysis below focuses on the main stylized facts, highlighting both short-term and long-term dynamics inherent in government bond trading activity.

Focusing on the overall trading volumes on the MTS Italy platform (Figure 20), the monthly volumes sharply increased starting from April 2020, reaching the peak at the end of 2023, thus fully recovering from the decline in 2022. The peak observed at the end of last year represents the record high for the monthly traded volumes on the platform (€542 billions). In 2023 the number of monthly flows increased as well and in this case the peak, that is observed in November (15,6 thousand of monthly flows), is the record high of the last fifteen years (since 2008).

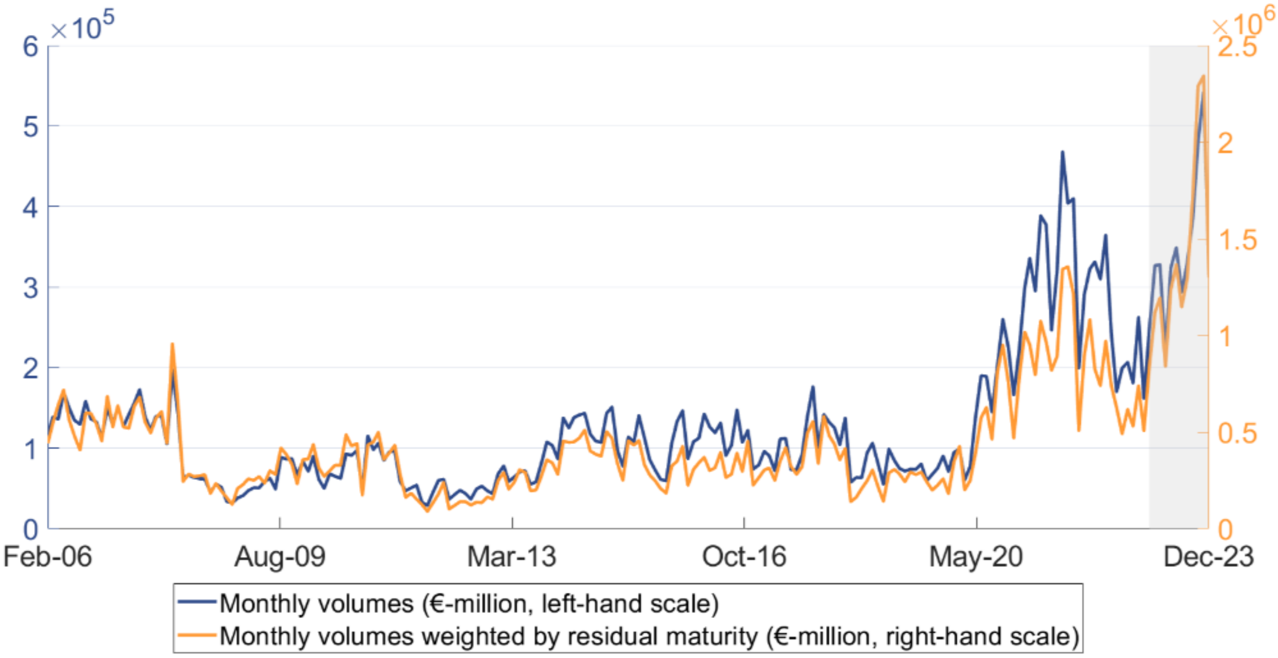
Figure 20: All segments



Notes: The figure shows on the right vertical axis the monthly traded volumes in million (blue line) and on the right vertical axis the number of monthly flows (orange line) for all segments (BOT, CTZ, BTP, BTP€i, and CCTeu of different maturities). As an example, €1 million $\times \mathbf{10^5}$ of monthly volumes corresponds to €100 billions and $1 \times \mathbf{10^4}$ monthly flows correspond to 10 thousands. The grey area points out the last year.

In Figure 21, we compute the monthly volumes weighted by residual maturity (on the right vertical axis), in order to analyse the trend in monthly traded volumes taking into account a proxy of the duration risk of securities. In this way, we are able to give more weight to traded volumes with longer residual maturity (i.e., with higher risk). The increase in the traded volumes in 2023 mentioned above is even more evident if one looks at the volumes weighted for their residual maturity. In fact, the peak reached at the end of the 2023 almost doubled the previous peak in 2021 (while the peak in traded volumes reached in 2023 in only slightly higher than the previous peak). In that sense, the increase in traded volumes experienced in 2023 is also representative of a relevant increase of the traded risk in the market.

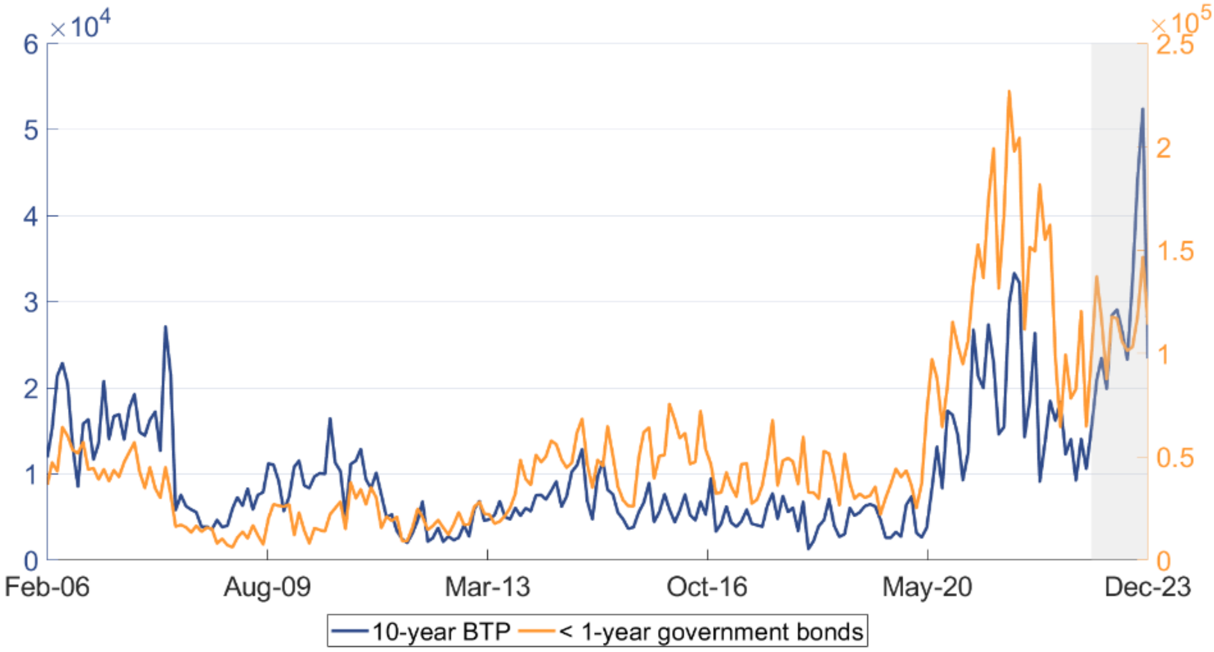
Figure 21: All segments



Notes: The figure shows on the left vertical axis the monthly traded volumes in million (blue line) and on the right vertical axis the monthly volumes weighted by residual maturity in million (orange line) for all segments (BOT, CTZ, BTP, BTP€i, and CCTeu of different maturities). The monthly volumes weighted by residual maturity are calculated as the monthly sum of volumes by residual maturity of the bond traded. As an example, €1 million × $\mathbf{10^5}$ corresponds to €100 billions and €1 million × $\mathbf{10^6}$ corresponds to €1 trillion. The grey area points out the last year.

Now we focus on the 10-year BTPs and the government bonds with a residual maturity of less than one year. The Figure 22 shows that the monthly volumes increased in 2023 for both segments: the 10-year BTPs reached the highest peak ever; the volumes of short-term government bonds increased compared to 2022, significantly exceeding the pre-Covid 19 levels though remaining still below the 2020-2021 peaks.

Figure 22: Monthly volumes (€-million)

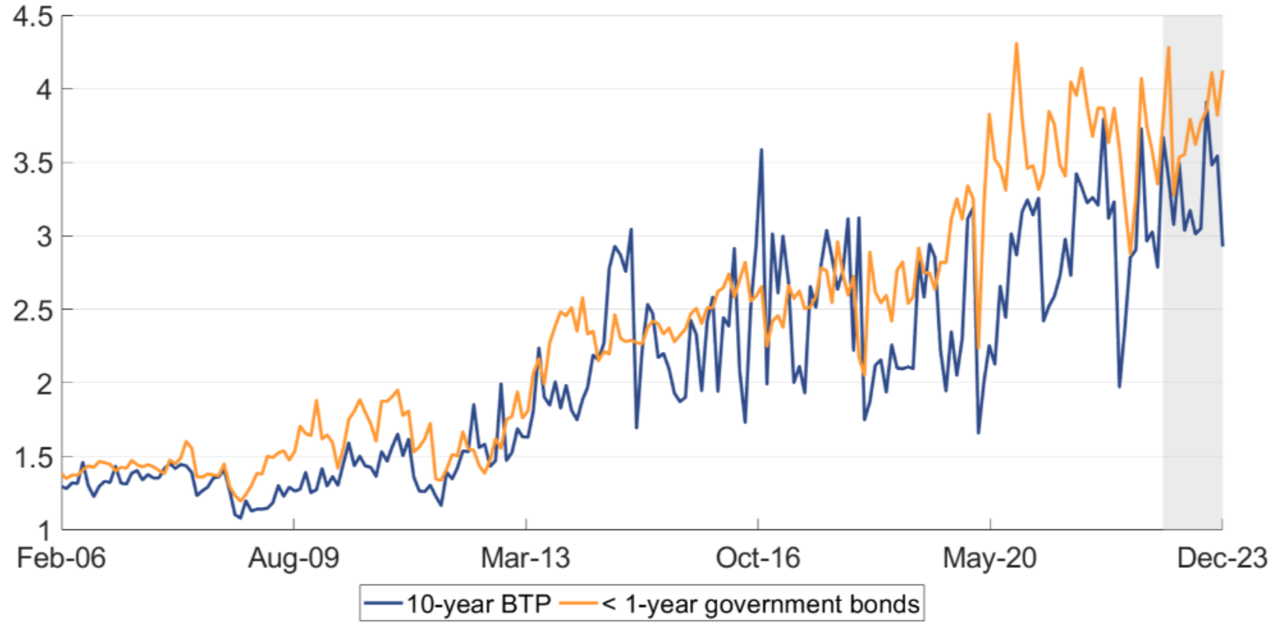


Notes: The figure shows the monthly traded volumes in million for the 10-year BTP on the left vertical axis (blue line) and for government bonds with a residual maturity of less than one year on the right vertical axis (orange line). As an example, €1 million × $\mathbf{10^4}$ corresponds to €10 billions and €1 million × $\mathbf{10^5}$ corresponds to €100 billions. The grey area points out the last year.

By analysing the ratio between the average size of aggressor-side flows and the average size of filler-side flows, we assess two factors driving the trend in trading volumes: how much liquidity primary dealers offer in quoting activity and how much liquidity primary dealers exploit. This ratio increases over time for both segments, but it is quite stable in 2023 (Figure 23).

In this context, we can highlight the strong interdependence between the choices made by market makers in terms of quoting strategies and the execution strategies of trading flows. In other words, the larger the average size of filler-side contracts (that is closely related to the average quantity quoted by primary dealers), the larger is the average size of aggressor-side flows, with direct effects on an increase in trading activity itself.

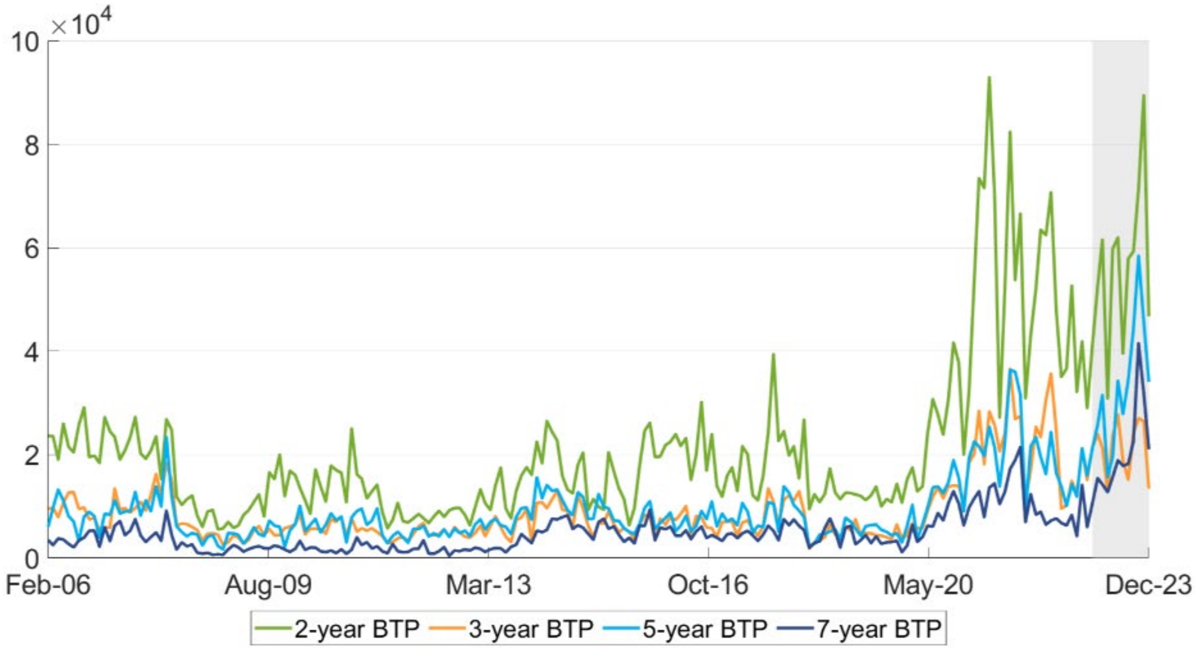
Figure 23: Average volume aggressor side/filler side



Notes: The figure shows the ratio between the monthly average volume of aggressor-side flows and the monthly average volume of filler-side flows for the 10-year BTP and government bonds with a residual maturity of less than one year. The grey area points out the last year.

Similarly, the segment of BTPs with a maturity of less than 10 years shows a general upward trend in volumes in 2023 recovering from the decline in 2022 and their intensity fluctuates roughly between the two levels just presented for bonds with a maturity of less than one year and for 10-year bonds (Figure 24). As the duration of bonds increases, we note a weaker absolute growth of overall volumes that are traded on the platform. The trend in volumes is heterogenous during 2023, with a positive peak in trading activity in the last quarter of the year.

Figure 24: Monthly volumes (€-million)



Notes: The figure shows the monthly traded volumes in million for the 2-year BTP, 3-year BTP, 5-year BTP, and 7-year BTP. As an example, €2 million × $\mathbf{10^4}$ correspond to €20 billions. The grey area points out the last year.

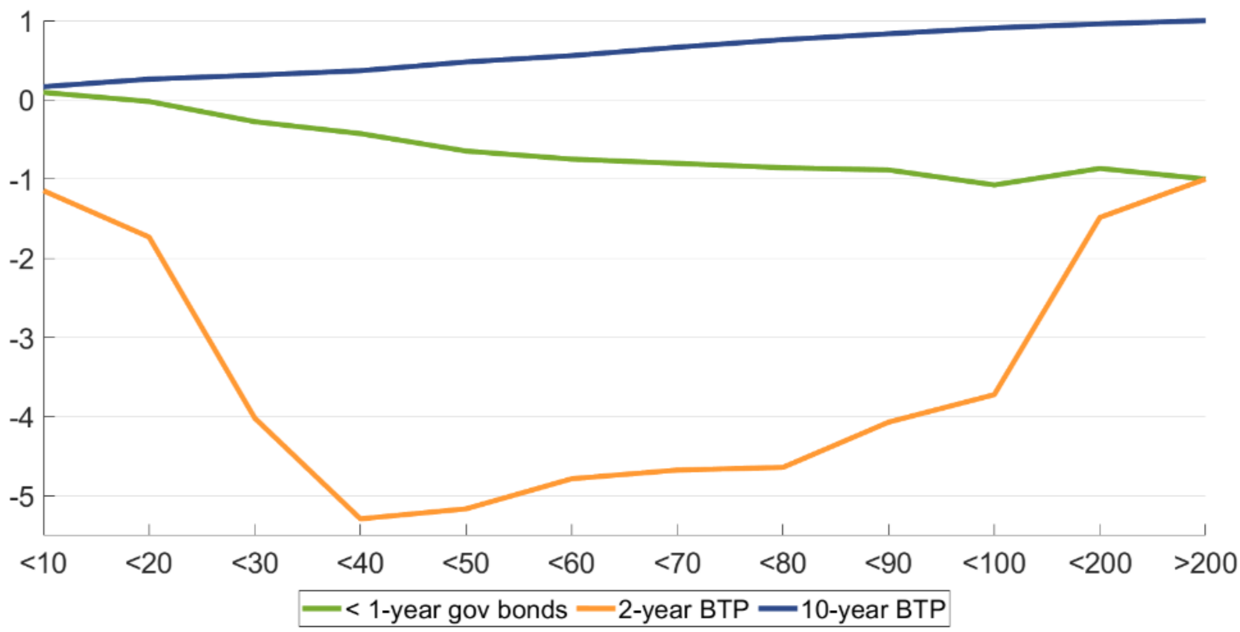
To investigate which categories of "flow size" contribute most to define the volume trend (comparing 2023 vs. 2022) we develop a different analysis. Specifically, we define the following categories for different flow sizes (on the aggressor side): flows up to €10, €20, €30, €40, €50, €60, €70, €80, €90, €100 millions; flows between €100 and €200 millions; flows above €200 millions. For each category, we examine whether and to which extent it contributes to the trend in volumes in 2023 compared to 2022.

The Figure 25 shows this analysis for 10-year BTPs, 2-year BTPs and <1-year Italian government bonds, that are selected to represent the general trends observed for all the segments (for more details, see the Figure A.13 in Appendix).

As regards 10-year bonds, the increase in volumes in 2023 compared to 2022 is essentially homogenous across the various categories of flow size. On the other hand, bonds with maturity of up to one year show a reduction in the size of aggressor-side flows in 2023 compared to 2022, but still quite homogeneous across the various flow size categories.

As regards bonds with intermediate maturities between the government bonds with maturity of up to one year and the 10-year BTP, a big exception refers to the 2-year bond segment. Indeed, the reduction in the size of aggressor-side flows is related to the lower trading activity on flows up to €40 millions. In particular, flows up to €10 millions explain the overall reduction in volumes and flows between €10 and €40 millions contribute a lot to the reduction. However, there is a net positive contribution in terms of traded volumes by larger flow sizes of at least €80 millions (as shown by the positive slope).

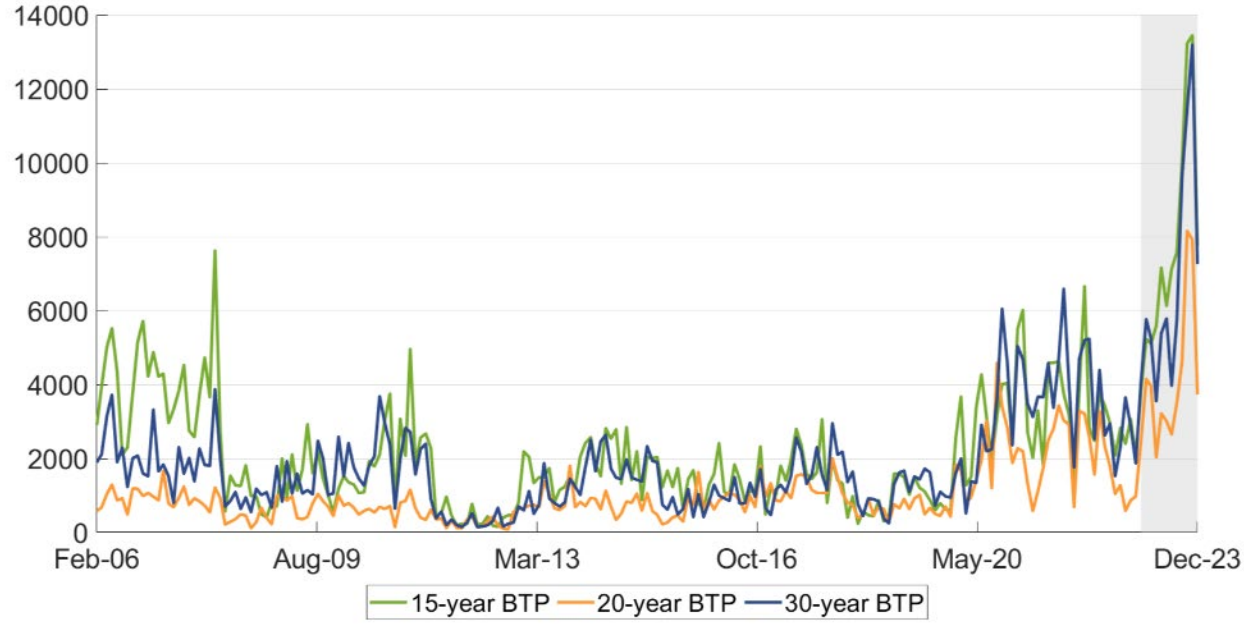
Figure 25: Analysis by volume categories (2023 vs. 2022)



Notes: The figure shows on the horizontal axis the volume categories in million and on the vertical axis the relative cumulative sum (with respect to the total sum), summing up either to 1 or to -1, of the difference between the total volumes of aggressor-side flows for each volume category in 2023 and in 2022 for the government bonds with a residual maturity of less than one year, 2-year BTP, and 10-year BTP. The positive slope denotes an increase in volumes in 2023 compared to 2022 and the negative slope denotes a decrease in volumes in 2023 compared to 2022.

As for BTPs with maturities above 10 years, the 15-year and 30-year show the most pronounced increase in trading volumes among all the segments analysed (Figure 26). The monthly volumes for 15-year, 20-year and 30-year BTPs reach the highest peak ever.

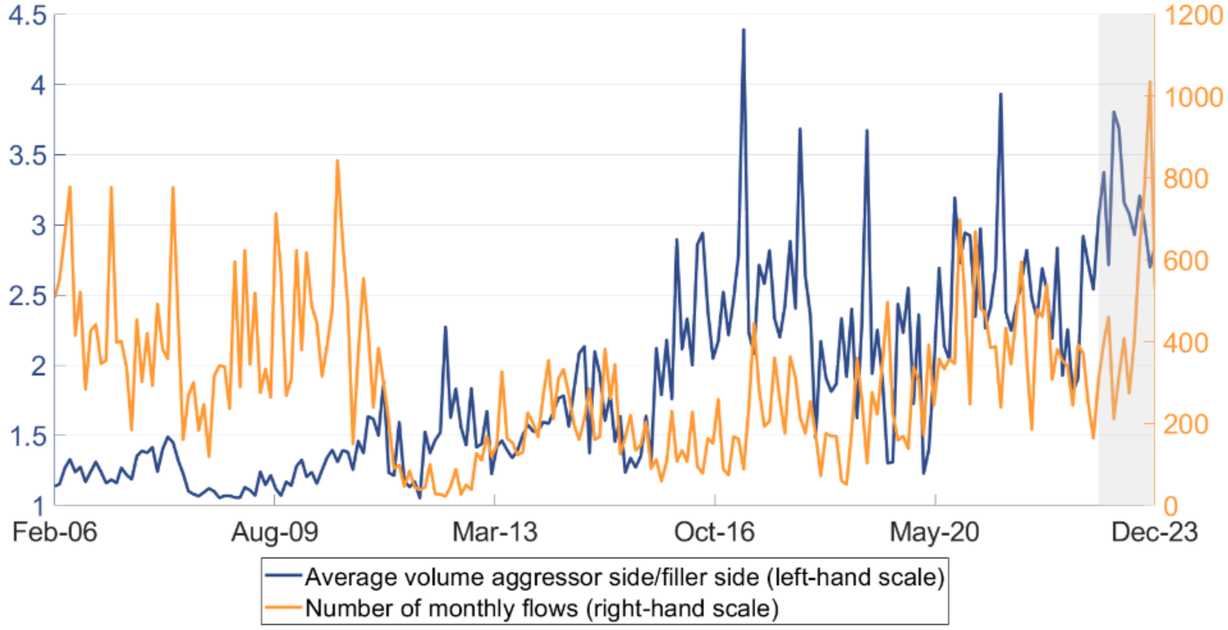
Figure 26: Monthly volumes (€-million)



Notes: The figure shows the monthly traded volumes in million for the 15-year BTP, 20-year BTP, and 30-year BTP. As an example, €2.000 millions correspond to €2 billions. The grey area points out the last year.

Focusing on the 30-year BTP, we try to analyse how this record high in traded volume in 2023 was reached. Figure 27 shows the ratio between the average size of aggressor-side flows and the average size of filler-side contracts (on the left vertical axis) and the number of monthly flows (on the right vertical axis) for the 30-year BTP. The former decreases in 2023 as a consequence of the decreasing size of aggressor-side flows in relative terms vs. the average size of the filler-side contracts, while the latter increases strongly in 2023. In order words, assuming the perspective of the aggressor, all the other things equal (e.g., the average quoted quantity from the filler side), the record high in traded volumes in 2023 have arguably been reached through a different trading approach on MTS Italy by dealers: in order to execute a large-size flow, aggressors reduced the average size of each trading flow and increased the number of contracts that are necessary to trade the full size.

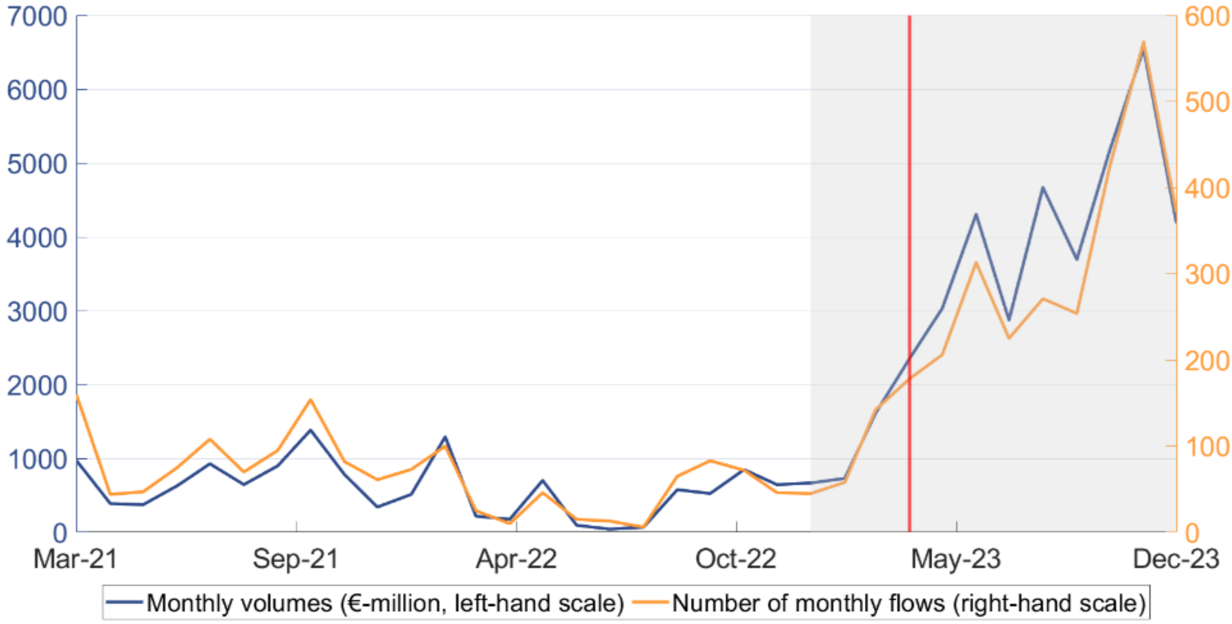
Figure 27: 30-year BTP



Notes: The figure shows on the left vertical axis the ratio between the monthly average volume of aggressor-side flows and the monthly average volume of filler-side flows (blue line) and on the right vertical axis the number of monthly flows (orange line) for the 30-year BTP. The grey area points out the last year.

Regarding the other segments, Figure 28 shows the monthly volumes (on the left vertical axis) and the number of monthly flows (on the right vertical axis) for the Green BTPs. In April 2023, the Treasury issued €10 billions of the new green bond with a maturity of approximately 8 and a half years. Even though an increasing trend was observed since March 2023, after the issuance of the new Green BTP both the traded volumes and the number of monthly flows increased significantly, reaching a peak for both the measures in November (at €6,5 billions as monthly traded volumes and almost 600 market flows).

Figure 28: Green BTP



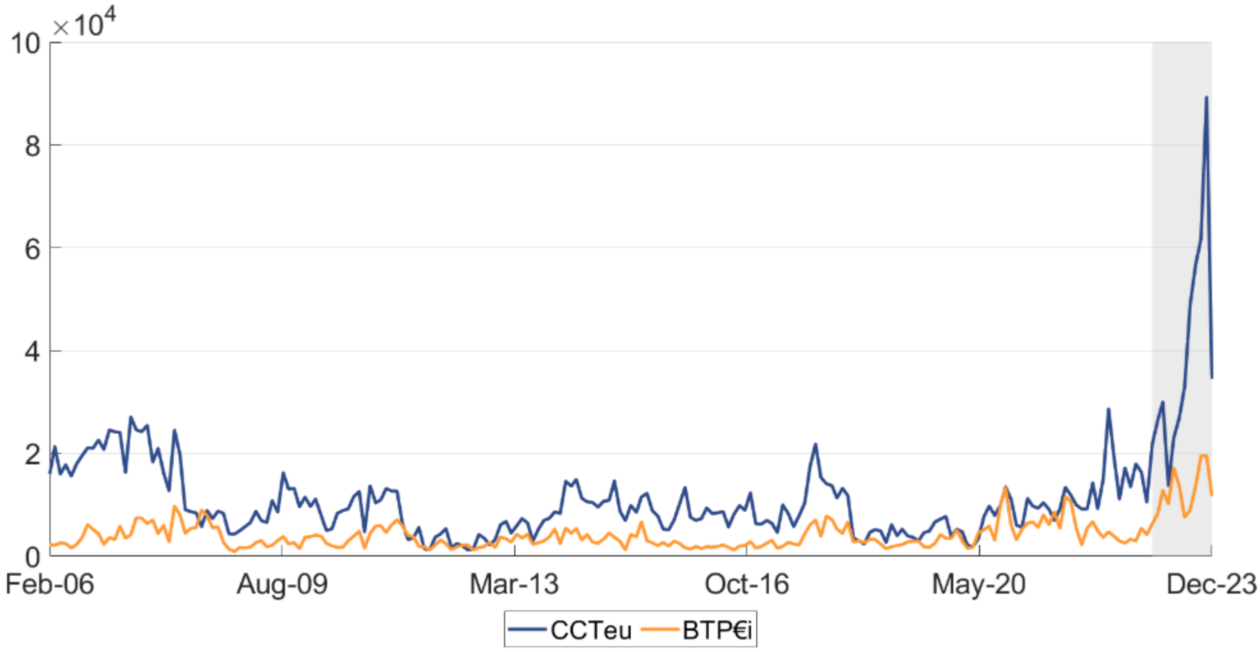
Notes: The figure shows on the left vertical axis the monthly traded volumes in million (blue line) and on the right vertical axis the number of monthly flows (orange line) for the Green BTP. The vertical red line refers to April 2023 when the Italian Treasury issued the new green benchmark bond. As an example, €1.000 millions of monthly volumes correspond to €1 billion. The grey area points out the last year.

Finally, in the case of the floating-rate segments, both CCTs-eu and BTPs€i show an upward trend in 2023 though with different intensity. The Figure 29 shows the evolution of the monthly volumes traded on the platform. In the case of CCTs-eu, traded volumes grow strongly throughout 2023, peaking at the end of the year, while the BTP€i segment shows a weaker increase in the traded volumes.

The macroeconomic environment may explain the different trading activity in the two segments: on the one hand, concerns about the ECB's monetary policy tightening process may operate as the main driver favouring trading activity in CCTs-eu; on the other hand, the risk of persistent high-inflation seems to drive the trading activity less than in 2022.

The peak in traded volumes for CCTs-eu may reflect the greater relative interest of the end-investor community in this segment compared to the inflation linkers. As a result of the interest in the CCTeu segment, in 2023 the Treasury issued in March the new CCTeu (maturing in October 2028) for €3.5 billions through an auction and in July the new CCTeu (maturing in October 2031) for €5 billions through a syndicate placement.

Figure 29: Monthly volumes (€-million)

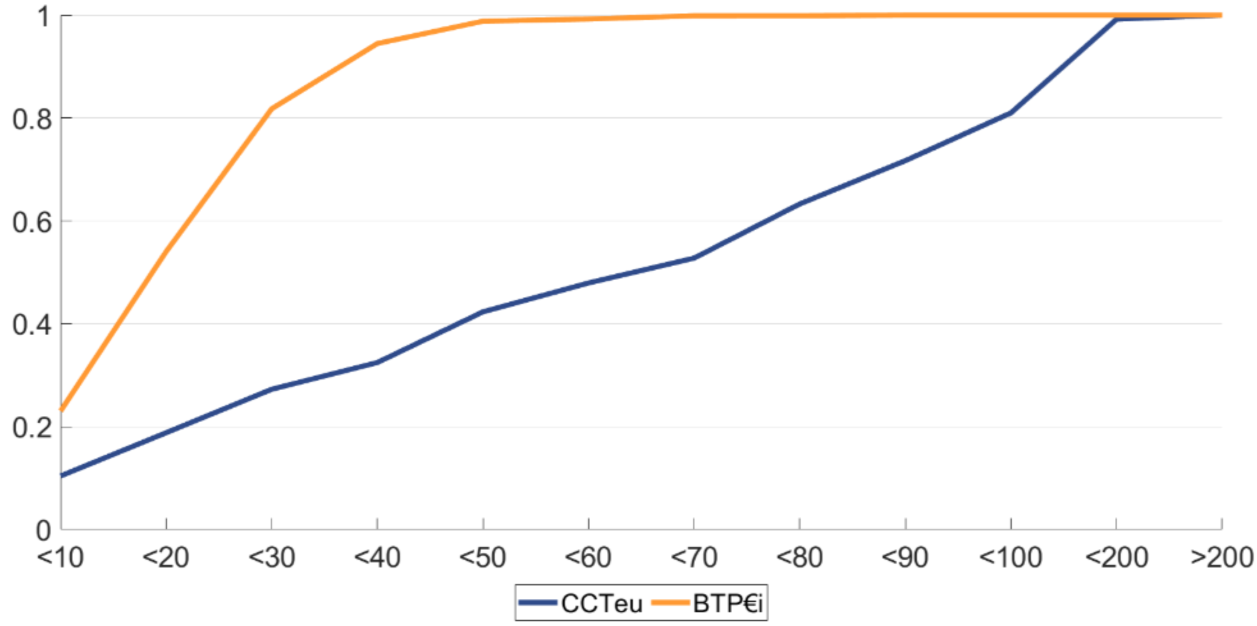


Notes: The figure shows the monthly traded volumes in million for the CCTeu and BTP€i. As an example, €2 millions × $\mathbf{10^4}$ correspond to €20 billions. The grey area points out the last year.

In Figure 30, we analyse the increase in traded volumes by flow size categories. As regards CCTs-eu, all categories of flow size up to €200 millions contribute to an increase in volumes in 2023 compared to the previous year. The increase in volumes is essentially homogenous across the categories of flow mid-size. However, 50% of the increase relates to the higher trading activity of flows between €70 millions and €200 millions. This suggests that the uncertain interest rate environment, depending on short- and medium-term monetary policy actions, has generated a growing interest in CCTeu bonds, which has led to an increase in trading activity through the execution of both small and large flows.

Finally, the increase in volumes in 2023 compared to 2022 for the BTP€i segment is almost entirely related to the increase in flows of up to €30 millions (80% of the increase is explained by the higher trading activity of flows up to €30 millions).

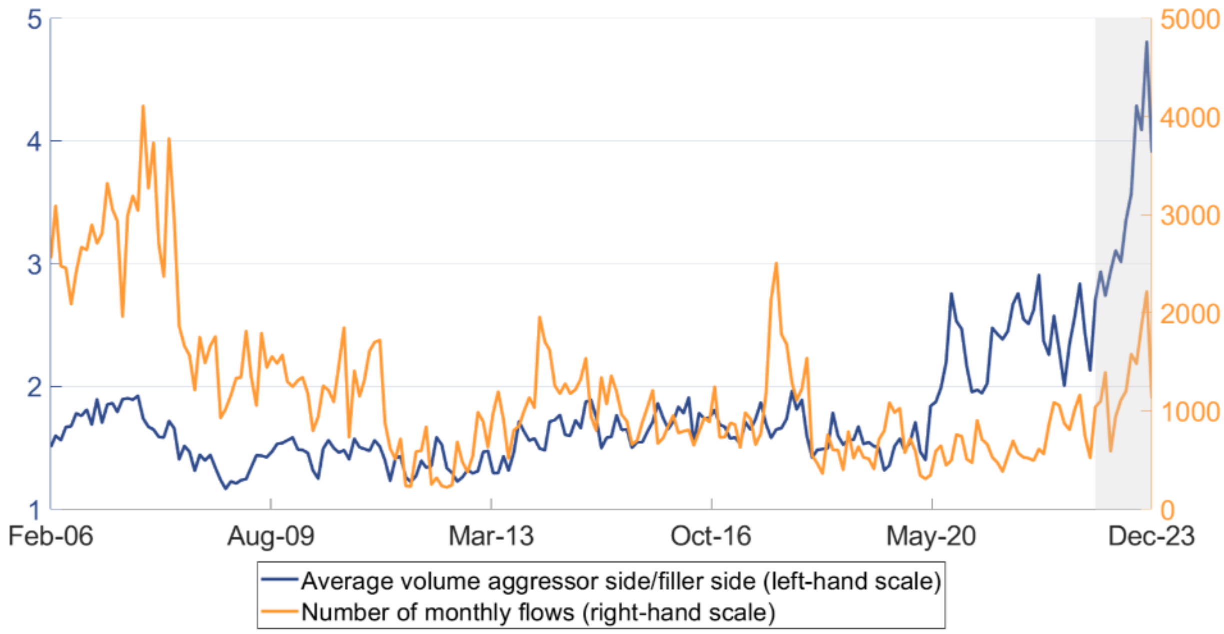
Figure 30: Analysis by volume categories (2023 vs. 2022)



Notes: The figure shows on the horizontal axis the volume categories in million and on the vertical axis the relative cumulative sum (with respect to the total sum), summing up to 1, of the difference between the total volumes of aggressor-side flows for each volume category in 2023 and in 2022 for the CCTeu and BTP€i. The positive slope denotes an increase in volumes in 2023 compared to 2022.

Lastly, Figures 31 and 32 show the ratio between the average size of aggressor-side flows and the average size of filler-side contracts (on the left vertical axis) and the number of monthly flows (on the right vertical axis) for the CCTeu and BTP€i segment, respectively. For CCTeu, both factors increase in 2023, contributing both in the growth of traded volumes: on the one hand, the increase in the average number of flows may reflect the higher interest of investors towards the CCTeu segment; on the other hand, the increase in the ratio between the average size of aggressor-side flows and the average size of filler-side contracts may reflect the larger exploitation of market liquidity and the generalized improvement of microstructure liquidity in the CCTeu segment.

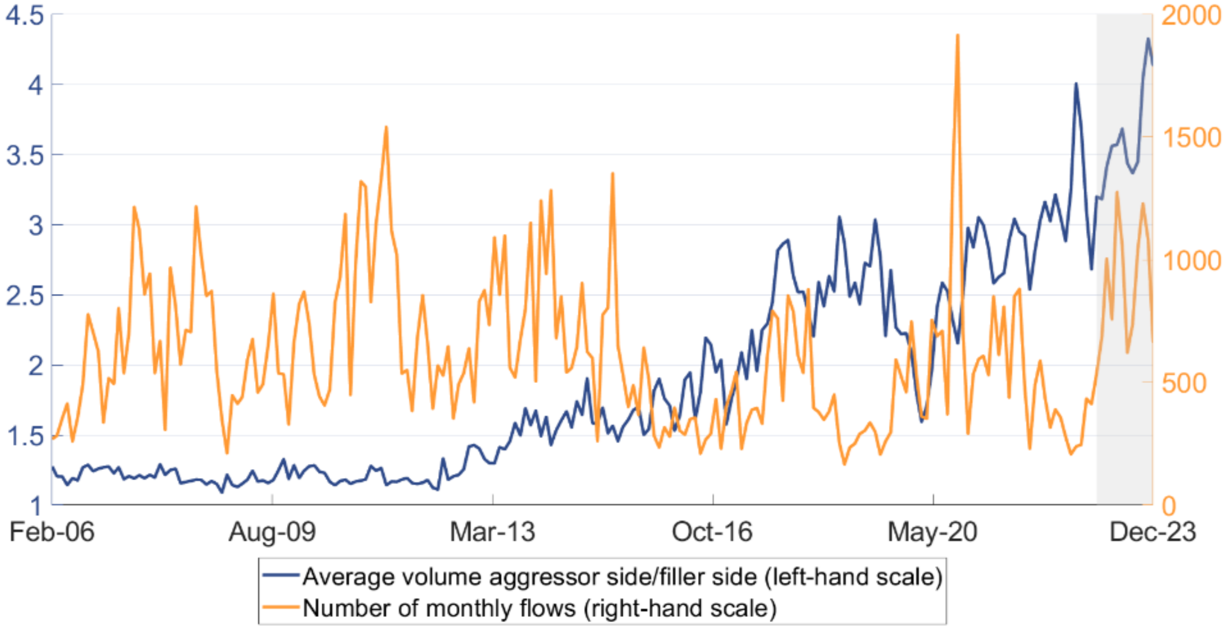
Figure 31: CCTeu



Notes: The figure shows on the left vertical axis the ratio between the monthly average volume of aggressor-side flows and the monthly average volume of filler-side flows (blue line) and on the right vertical axis the number of monthly flows (orange line) for the CCTeu. The grey area points out the last year.

As regard the BTP€i segment, Figure 32 shows less sharp upward trends compared to the CCTeu segment. The ratio between the average size of aggressor-side flows and the average size of filler-side contracts (on the left vertical axis) increases, reaching the historical highest level in November. On the contrary, the number of monthly flows (on the right vertical axis) increases steadily in 2023 compared to the previous two years, but still far from the historical record high. However, in 2023 the overall trading activity in the BTP€i segment showed significant improvement, especially in a macroeconomic context in which the European economies were facing a clear disinflationary process.

Figure 32: BTP€i



Notes: The figure shows on the left vertical axis the ratio between the monthly average volume of aggressor-side flows and the monthly average volume of filler-side flows (blue line) and on the right vertical axis the number of monthly flows (orange line) for the BTP€i. The grey area points out the last year.

3.2 The resilience of market makers against medium-sized trading flows and directional fast market phases

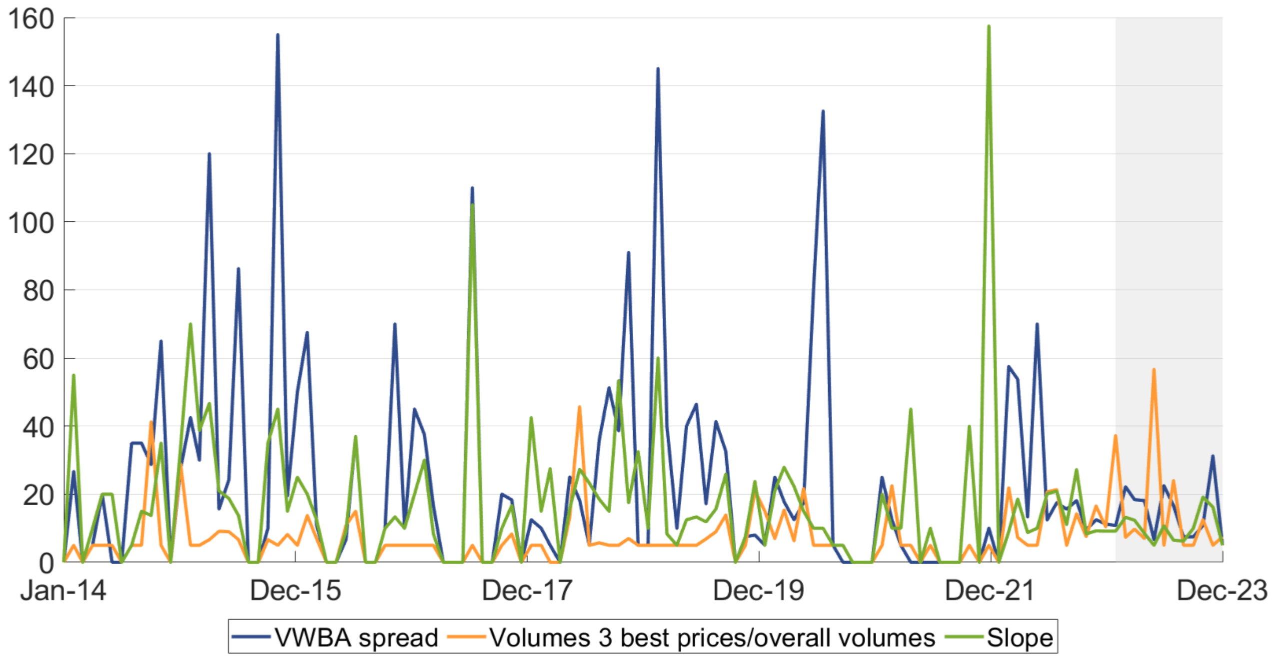
This Report has so far analysed the micro-liquidity dynamics by separating quoting activity from trading activity by market participants. As in the case of the first Report released last year, in this section we propose a combined analysis of the two different dimensions of market liquidity and activity (quoting and trading). We particularly aim at describing the impact on liquidity measures of the quoting activity of market makers against: (i) directional fast market phases; (ii) medium-sized trading flows on MTS Italy.

The purpose of this study is to assess the potential effect on market makers' quoting strategies when dealing with sudden changes in market volatility, which can lead to an increase in uncertainty as regards the fair value of the quoted financial asset (information asymmetries problem), and with selling or buying flows, which may both alter the level of inventory held by market makers (inventory management problem) and change the valuation of the bond's fair value if this flow is believed to be a valuable source of information to assess the fundamental value of the asset traded, assuming that the flow (which remains anonymous for market makers) in itself produces better information about the bond's intrinsic value (again, a problem linked to information asymmetries).

In the first part of the analysis, we evaluated how many minutes on average are needed for quoting conditions (evaluated through the various measures of liquidity proposed) to restore the same level of the half-hour prior to a fast market event (identified whenever the market records a variation in the yield to maturity, either positive or negative, of at least 3 basis points in the 5 minutes between two quoting book snapshots).

Figure 33 shows this analysis for the 10-year BTP segment for three selected liquidity measures (the VWBA spread, the quoted volumes on the three best prices in proportion to the total quoted volumes, the slope) in the last ten years. Firstly, the analysis does not detect any structural deterioration vs. previous years of the liquidity measures after phases of increasing market volatility. The two main negative peaks have been observed in May for the relative depth measure (when almost 60 minutes were necessary to reestablish similar liquidity condition, in terms of concentration of quoted volumes in the best three prices, after a volatility event) and in November for the VWBA spread measure (when it took more than 30 minutes to be back to a similar narrow bid-ask spread of the quoting book). In any case, from a general perspective, this analysis confirms the overall good liquidity conditions offered by primary dealers on MTS Italy, that seem not specifically affected by volatility events.

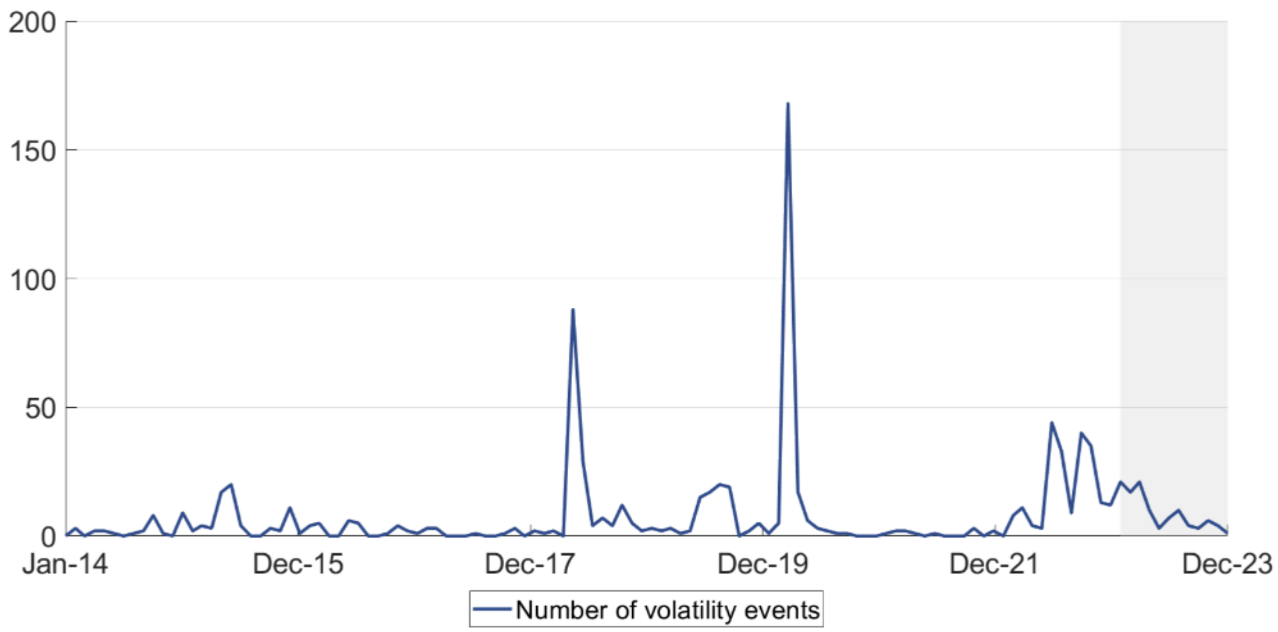
Figure 33: Effects on quoting liquidity measures of directional fast market phases



Notes: The figure shows on the vertical axis the minutes on average needed for the volume-weighted bid-ask (VWBA) spread, the quoted volumes associated with the three best prices as a share of the overall quoted volumes, and the slope to restore the same level of the half-hour prior to a fast market event for the 10-year BTP, on a monthly basis. The fast market event is defined as the variation in the yield to maturity, either positive or negative, of at least 3 basis points in the 5 minutes between two quoting book snapshots. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The slope is calculated as the ratio of the difference between the best and worst bid (ask) and the overall quoted volumes excluding those relating to the best bid (ask) by averaging bid side and ask side. The grey area points out the last year.

However, as shown in Figure 34, in 2023 a structural reduction of volatility events (defined as a 3 basis points variation of the yield to maturity in absolute terms in a 5-minute time span) took place: in 2023, the average number of volatility events has been 8.9 per month, while in 2022 was almost double (17 events per month). In that sense, from one side, the overall more stable market conditions could have had a role in positively affecting the resilience of primary dealers in offering good liquidity conditions; but also the opposite might be true: a more resilient quoting activity by primary dealers could have determined a structural reduction of idiosyncratic volatility in the BTP market. Further research is needed to identify the more convincing causal link, which may change over time as well.

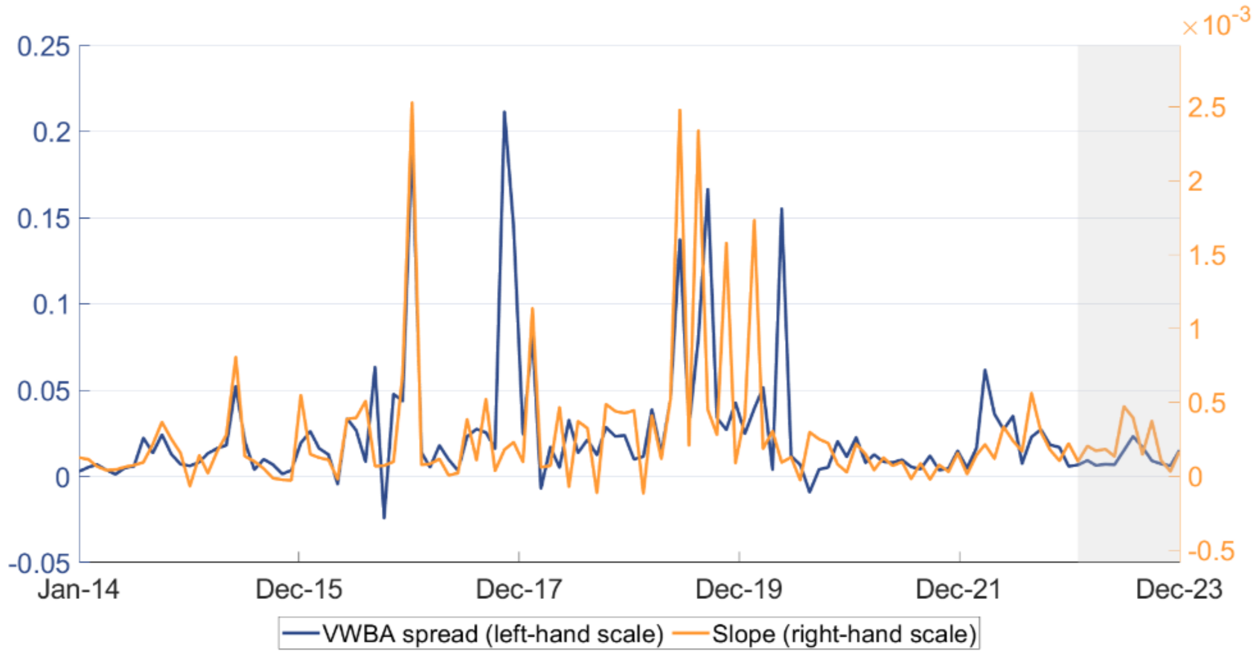
Figure 34: Number of volatility events



Notes: The figure shows the monthly number of volatility events, defined as a 3 basis points variation of the yield to maturity in absolute terms in a 5-minute time span. The grey area points out the last year.

The second part of the analysis tested the impact of a medium-sized trading flow (defined as a buying or selling flow between €15,000 and €45,000 of the DV01 duration risk index, that is defined as the change in the price of the bond against one basis point change in the yield to maturity), on the quoting activity of the primary dealers (Figure 35). Filtering market flows for the above-mentioned level of DV01 (from the aggressor perspective), we quantify the effect on the selected liquidity measures (i.e., VWBA spread and slope) of the 10-year BTP after 5 minutes the flow occurred. Also this analysis confirms the substantial stability of the quoting activity of primary dealers when they faced medium-size flows on MTS. For both the measures there is not any relevant deterioration during 2023, maintaining the average negative effect on the liquidity measures during the whole year below the 2022 levels: for example, in 2023 the VWBA spread was negatively affected in the 5 minutes after a medium-size flow by 0.015% of market price vs. 0.023% observed in 2022.

Figure 35: Effects on quoting liquidity measures of medium-sized trading flows



Notes: The figure shows the variation after 5 minutes a medium-sized trading flow occurred of the volume-weighted bid-ask (VWBA) spread on the left vertical axis (blue line) and of the slope on the right vertical axis (orange line) for the 10-year BTP, on a monthly basis. The medium-sized trading flow is defined as a buying or selling flow between €15 000 and €45 000 of the DV01 duration risk index. The VWBA spread is calculated as the difference between the average prices weighted by the quoted volumes associated with each price for ask side and bid side against the mid-price of the bond. The slope is calculated as the ratio of the difference between the best and worst bid (ask) and the overall quoted volumes excluding those relating to the best bid (ask) by averaging bid side and ask side. As an example, $1 \times \mathbf{10^{-3}}$ corresponds to 0.001. The grey area points out the last year.

3.3 Algorithmic trading: basket trades and auto-hedging strategies

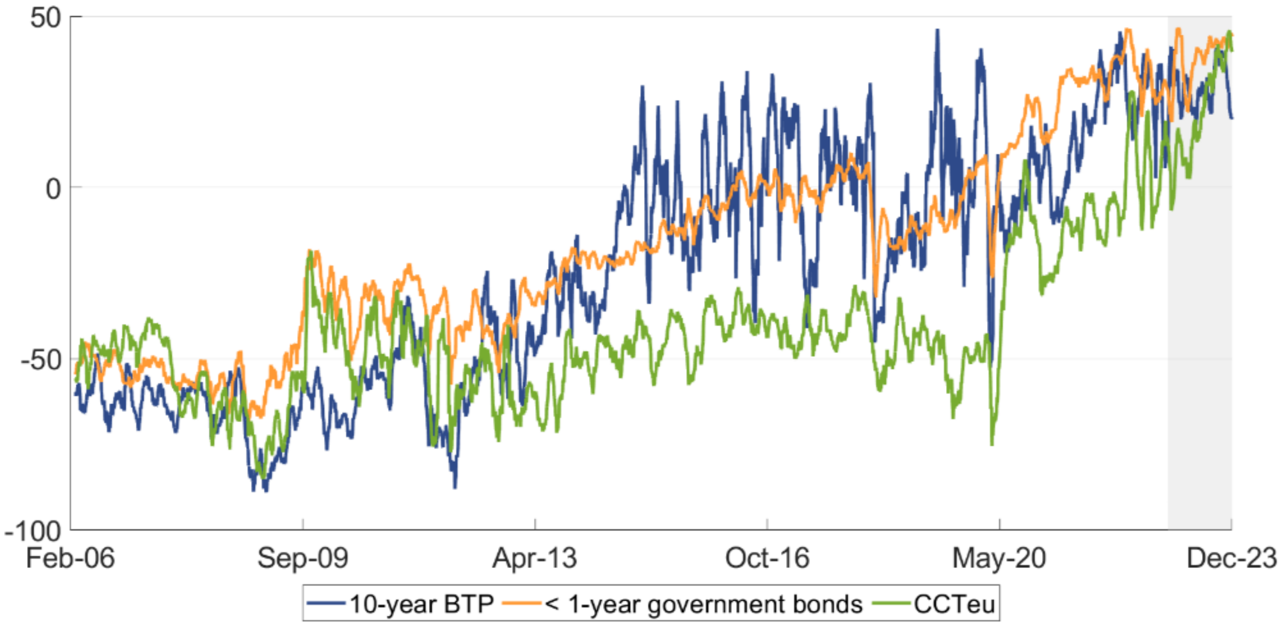
Over the last decade, an ever-increasing availability of technological tools has characterised the activity of financial operators, making their activity on markets more efficient and effective. As for market makers, in addition to automated quotation systems, automated trading systems have also become widespread over time. These tools have been developed by banks, on the one hand, to allow for greater speed in updating quotations (given market movements, news and market-mover events, buying and selling flows, etc.) and, on the other, for the execution of orders according to specific algorithms that optimise the trading strategy and the time taken to send orders to the market and execute them. In light of these developments, the human action has become increasingly focused on defining and updating quoting and trading strategies according to the trader's preferences in terms of overall portfolio positioning and on individual securities and based on their expectations of market trends, thus paying more attention to algorithmic trading systems.

In this section we analyse two phenomena of algorithmic trading, closely linked to the technological evolution of recent years: (i) the block or basket trades, i.e., the possibility of making large trading flows by carrying out transactions on multiple securities (typically with close maturities) almost simultaneously; (ii) the possibility of adopting auto-hedging strategies, through which market makers, following the closure of one or more contracts entered on the quotations offered to the market, instantly enter one or more contracts having opposite sign (buy or sell) in order to minimise the time spent to hedge the risk taken on the previous flow.

As for the execution of basket trades, first, we analyse the trend in the daily proportion of large flows (so-called large trades) on the overall traded volumes; second, we analyse the number of securities involved in the individual executed flows. In both cases, as the size analysed increases, so do the execution risks, typically managed by primary dealers with tools and technological processes developed in recent years.

As regards the analysis of the trend in large trades, the Figure 36 shows the difference between the proportions of daily traded volumes in flows above €100 millions and in flows up to €10 millions for the following government bond segments: bonds with a maturity of less than one year, 10-year BTPs and CCTs-eu. The analysis reveals a persistent upward trend across all selected segments in the proportion of daily traded volumes in flows above €100 millions, which frequently involve multiple securities. Indeed, the trend started with a negative index in 2006 (which means that the proportion of flows up to €10 millions was greater compared to flows above €100 millions) and then has become positive in recent years. In 2023 the environment characterised by tight bid-ask spread and good liquidity conditions in terms of quoting (as seen in Section 2) has encouraged the execution of large trades. The difference between the proportions of daily traded volumes in flows above €100 millions and in flows up to €10 millions has largely increased for CCTs-eu in 2023, while this difference was already large for government bonds with a maturity of less than one year and 10-year BTPs in 2022.

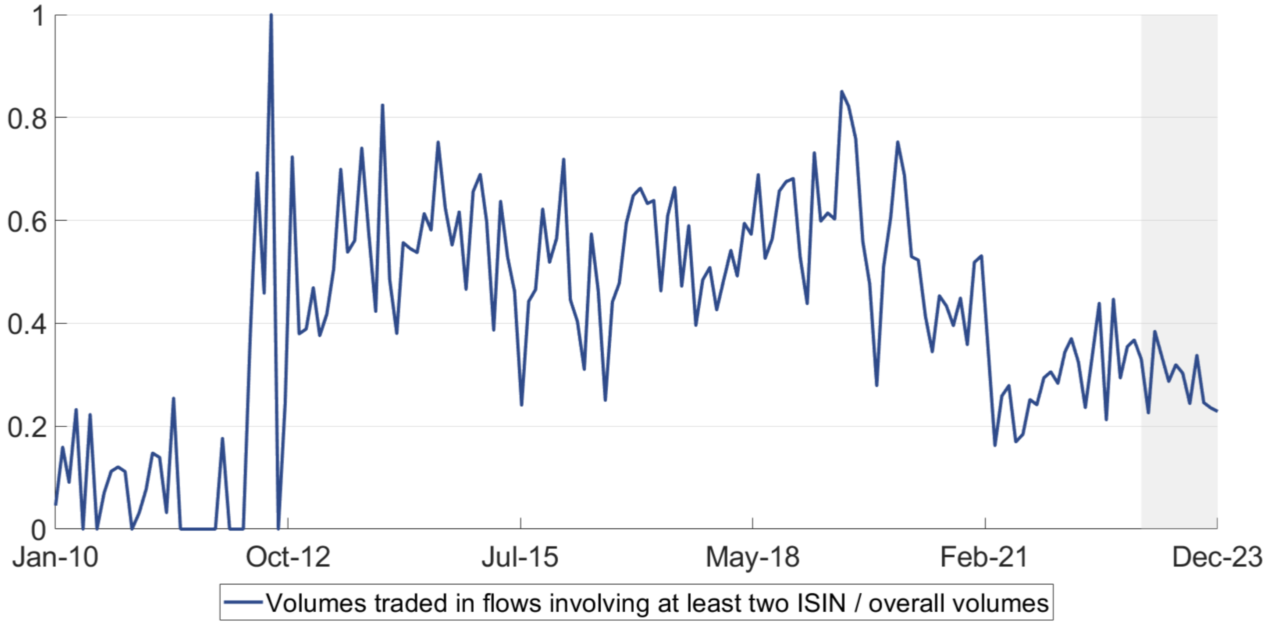
Figure 36: Difference between the daily shares of trading volumes executed in flows above €100 millions and up to €10 millions (%)



Notes: The figure shows the difference between the proportions of daily traded volumes in flows above €100 millions and in flows up to €10 millions out of the overall traded volumes in % for the 10-year BTP, government bonds with a residual maturity of less than one year, and CCTeu. The grey area points out the last year.

In this regard, considering only flows of size above €100 millions, the Figure 37 shows the monthly average of the daily proportion of the volumes traded in flows involving two or more securities out of the total volumes traded, which fluctuates almost in the same range as the previous two years remaining below the levels recorded in the 2012-2019 period[12].

Figure 37: Trading flows larger than €100 millions on multiple securities

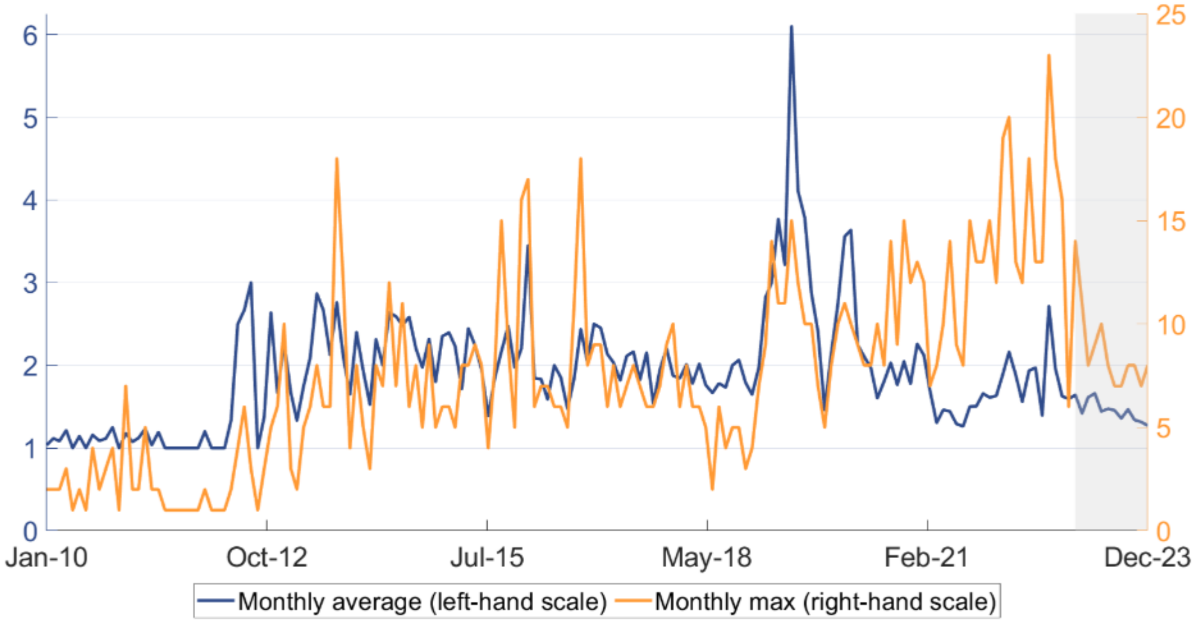


Notes: The figure shows the monthly average of the daily proportion of the volumes traded in flows involving two or more securities out of the total traded volumes for trading flows above €100 millions. The grey area points out the last year.

Consistently, the Figure 38 shows the monthly trend of the average number of securities involved in a single flow (on the left vertical axis) and the monthly maximum number of securities involved in a single flow (on the right vertical axis). The average number of securities involved in large flows does not show any peculiar trend either over the last decade or during 2023. The maximum number of securities involved in a single flow stabilises around 7 securities in 2023, after the all-time high reached in September 2022 with 23 securities involved (and in general a 2021-2022 period in which the maximum monthly data was structurally higher than 10 securities). The limitation in the execution of basket trades may be affected by the beginning of a specific monitoring activity by the Italian Treasury in 2023.

[12] Here we aim to analyse the trend in large trades, which generate a greater effect on the market in terms of both the number of securities on which the contracts are executed and the size of the flows themselves, with a direct impact on primary dealers' inventories and in terms of signaling for all market participants. However, it is worth noting that the execution of orders on multiple securities is also associated with flows smaller than €100 millions in size.

Figure 38: Trading flows larger than €100 millions on multiple securities

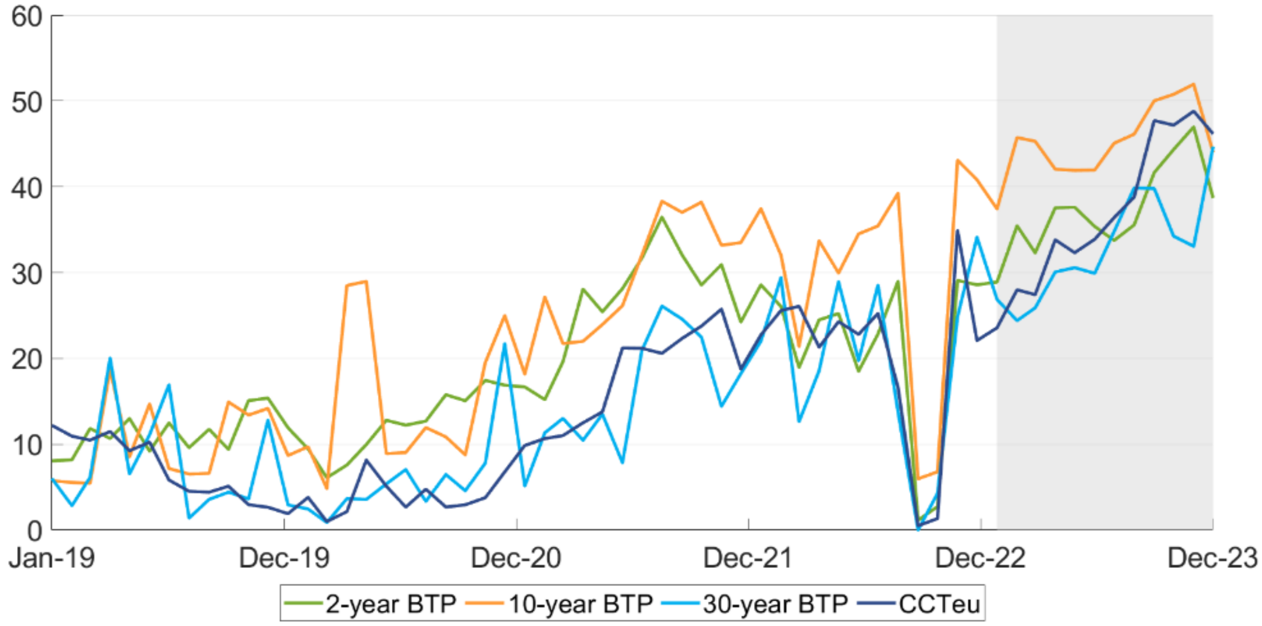


Notes: The figure shows on the left vertical axis the monthly average number of securities involved in a single flow (blue line) and on the right vertical axis the monthly maximum number of securities involved in a single flow (orange line) for trading flows above €100 millions. The grey area points out the last year.

As for auto-hedging strategies, Figure 39 shows the proportion of monthly volumes generated by auto-hedging activity out of the total volumes traded on the inter-dealer platform for the following government bond segments: 2-year BTP, 10-year BTP, 30-year BTP and CCTeu. In 2023 the analysis reveals a growth in the volumes generated by such trading strategies across all the considered segments, in line with the trend observed in the previous two years. All the segments reach the highest peak ever. In particular, the index for the 10-year government bond segment exceeds 50% which is consistent with the idea that in this area liquidity discovery is more pronounced compared to other areas.

The positive correlation between the traded volumes generated by auto-hedging activity and the above-mentioned good liquidity conditions in terms of quoting activity in 2023 confirms the strong relationship among these two variables. There is no univocal conclusion as regards the effects of auto-hedging strategies on liquidity conditions on the MTS platform. The growth in auto-hedging activity affects the behavior of market makers by tightening the bid-ask spread. However, also the opposite relation is valid: thanks to tighter bid-ask spread the auto-hedging activity on MTS becomes more efficient in managing the liquidity risk for primary dealers. Finally, auto-hedging strategies have contributed to the growth in traded volumes in 2023 (as discussed in Section 3.1).

Figure 39: Monthly auto-hedging volumes as a percentage of total traded volumes (%)



Notes: The figure shows the proportion of monthly volumes generated by auto-hedging activity out of the total traded volumes in % for the 2-year BTP, 10-year BTP, 30-year BTP, and CCTeu. The grey area points out the last year.

4. Special section on the Repo market

The repurchase agreements (Repo) market plays an essential role to ensure the liquidity of the secondary market. Market participants use the Repo market either to borrow liquidity or to borrow a specific bond to accomplish their transactions in the secondary market. A repo where the buyer lends liquidity against a generic basket of securities is called "general collateral" repo, while when the contract requires a specific security to be delivered the transaction is called "special" repo. The "specialness" is defined as the premium of procuring a specific bond in the Repo market: the higher the specialness the higher the scarcity of the specific bond in the Repo market[13].

Therefore, liquidity conditions on the secondary market and specialness on the Repo market are intertwined. On the one hand, a more liquid bond with lower bid-ask spread allows market makers to hold the optimal level of inventories and not to have portfolio imbalances. Hence, primary dealers do not need to rely on the Repo market either to finance long positions or to cover short positions on this bond with an effect on the specialness. On the other hand, a more special bond means that this bond shows some shortage in the Repo market; in turn, market makers face some frictions trading such a bond in the secondary market, which arguably leads to worse liquidity conditions (e.g., wider bid-ask spreads).

The relation between bid-ask spread on the secondary market and specialness on the Repo market claiming the former as driver of the latter is explored in the literature, which documents the positive effect of the bid-ask spread on the secondary market on the level of specialness on the Repo market[14] (i.e., for a given bond a wider bid-ask spread implies higher level of specialness). In this special section of the Report, we aim at empirically investigating the inverse relation. First, we verify whether there is bidirectional causality between the two variables. Second, we carry out a novel exercise to study whether the specialness of a bond is a driver of the bid-ask spread.

To conduct the analysis, we used the database on the Repo segment of MTS Italy in the 2019-2023 period, with information including the ISIN of the underlying government bond, the type (general collateral or special), the maturity, the daily average rate and the volume of daily transactions. We compute the specialness as the difference between the general collateral rate and the special repo rate on a specific security, maturity and trading day. We select all securities for the various government bond segments (BOT, CTZ, BTP, BTP€i, CCTeu) and for each security we take the weekly average of bid-ask spread and the weekly average of specialness for "tomorrow-next" transactions[15].

[13] See for example, Corradin, S., and A. Maddaloni (2020). The importance of being special: Repo markets during the crisis. *Journal of Financial Economics*, 137, pp. 392-429.

[14] A comprehensive review of this literature is outside the scope of this Report, for a further discussion on this issue and further references see for example, Dufour, A., et al. (2020). Explaining repo specialness. *International Journal of Finance & Economics*, 25, pp. 172-196.

[15] We select the tomorrow-next maturity (i.e., repo transactions such that the initial trade of the bond is made on the next business day and the bond is then repurchased in the following business day), since transactions with this maturity account for most of the volumes in the Repo market. Our findings hold true even for spot-next maturity (i.e., repo transactions such that the initial trade of the bond is made on the contract date plus two business days and the bond is then repurchased in the following business day).

To study the bidirectional causality relation between the two variables, we perform a Granger-causality test in panel datasets[16]. We test two null hypotheses (H_0) in the 2019-2023 period and year by year: on the one hand, specialness does not Granger-cause bid-ask spread; on the other hand, bid-ask spread does not Granger-cause specialness. The p-value is used in hypothesis testing: the smaller the p-value, the more likely the null hypothesis of a statistical test is rejected. We find p-values approximately equal to zero for two standardized statistics ($\bar{Z}$ and $\tilde{Z}$) based on the Wald statistic[17]. The two different tests ($\bar{Z}$ and $\tilde{Z}$) were used to check the robustness of our results for each null hypothesis. The outcomes of the test reject the null hypothesis (i.e., the p-values are small enough to reject the null hypothesis) that specialness does not Granger-cause bid-ask spread and vice versa in favour of the alternative hypothesis at the conventional significance level of 1% (i.e., we expect to incorrectly reject a true null hypothesis only 1% of the time). Therefore, Granger-causality between the bid-ask spread and the specialness exists in both directions.

This result corroborates our idea that, for a given bond, a bidirectional causality relation exists between liquidity conditions in the secondary cash market and the specialness observed in the Repo market. Thus, any estimation of the effect of specialness on liquidity (or the reverse) must address the endogeneity problem that arises by bidirectional causality.

To estimate the effect of specialness on Repo market on liquidity conditions on secondary market, the exercise below exploits the Italian Treasury's activity on Repo as instrument to address the endogeneity problem. Starting from 24th of May 2021, the Italian Treasury launched a new tool for government cash management by carrying out operations on Repo market[18].

We estimate the Instrumental Variable (IV) panel regression. Our regression specification is[19]:

$$y_{it} = \beta_0 + \boldsymbol{\beta_1 X_{1\,it}} + \boldsymbol{\beta_2 X_{2\,t}} + \nu_i + u_{it}$$

where the dependent variable y_{it} is the bid-ask spread of bond *i* on week *t*. $X_{1\,it}$ contains the specialness of bond *i* on week *t* and its outstanding amount (which is time-varying and bond-specific and represents the total volume that has been issued until a certain date). $X_{2\,it}$ contains time-varying controls (period-specific components): the VIX as indicator of volatility on global financial markets and the difference between EURIBOR3M and ESTER3M as a measure of stress on European monetary markets. The bond fixed-effects ν_i account for all bond-specific characteristics, provided they are invariant over the considered time span[20].

[16] Lopez, L., and S. Weber (2017). Testing for Granger causality in panel data. *The Stata Journal*, 17(4), pp. 972-984.

[17] The Wald test is designed to detect causality at the panel level. The testing procedure of H_0 is finally based on $\bar{Z}$ and $\tilde{Z}$. Specifically, $\bar{Z}$ can be reasonably considered for panel datasets with a large number of securities and weeks, while $\tilde{Z}$ should be favoured for panel datasets with large number of securities but relatively small number of weeks. We select the number of lags to be considered in the testing procedure based on the Bayesian information criterion (BIC).

[18] See the press release about the launch of the Repo activity at: https://www.dt.mef.gov.it/en/news/2021/repo_17052021.html.

[19] We test for unit root (stationarity) across the panel using a Fisher-type test and we reject the null hypothesis that our main variables are non-stationary processes.

[20] The estimator we choose to consistently estimate the coefficient of interest depends on the assumption on the relationship between the unobserved fixed effect ν_i and the regressors $X_{1\,it}$. Random-effects (RE) estimator assumes no correlation between the unobserved fixed effect and the regressors, while fixed-effects (FE) estimator assumes no restrictions on the correlation between the unobserved fixed effect and the regressors. Therefore, the FE estimator is consistent under weaker conditions than the RE estimator, but the RE estimator is more efficient than the FE estimator when both estimators are consistent.

The specialness variable is endogenous (i.e., there is correlation with the error term), hence it is instrumented by the Italian Treasury's activity on Repo that is defined as the outstanding amount of weekly volumes of the operations on the Repo market for a specific security. Such a measure is a good instrument (i.e., there is correlation between the instrument and the specialness)[21] and, given the declared purposes of the Italian Treasury activity on the Repo market, it does not directly affect the bid-ask spread on the secondary market (i.e., it is exogenous with respect to secondary market liquidity conditions).

Our results are in line with practitioners' intuition. We find a positive relation between specialness on Repo and bid-ask spread on secondary market: the higher the specialness, the worse the liquidity conditions. Table 1 shows the results of our estimates using the FE estimator, first for our main variables and then adding the mentioned covariates[22]. In all cases, the estimated coefficient of specialness is positive and statistically significant, suggesting a role for specialness as a determinant of bid-ask spread. On average, a one basis point increase in specialness is associated with more than 1.5 basis point increase in bid-ask spread.

This special section of the Report brings to three main conclusions. First, we find a bidirectional causality between liquidity on the secondary market and specialness on the Repo market, which technically implies that any study of the impact of one measure on the other must address endogeneity problems (as we do in our analysis with an instrumental variable approach). Second, we provide sound evidence that a higher level of specialness in the Repo market negatively affects secondary market liquidity conditions (i.e., increases the bid-ask spread). Finally, we provide new evidence that the Italian Treasury's activity on the Repo market supports market makers by relaxing the frictions determined by the specialness of securities on the Repo market and, thus, indirectly improves liquidity conditions on the secondary market.

Table 1: Estimated coefficients of IV regressions with panel data

	Bid-ask spread				
Specialness	1.575*** (0.318)	1.637*** (0.377)	1.697*** (0.381)	1.672*** (0.404)	1.721*** (0.399)
Outstanding	No	Yes	Yes	Yes	Yes
VIX	No	No	Yes	No	Yes
EURIBOR3M-ESTER3M	No	No	No	Yes	Yes

Notes: Standard errors in parentheses. * p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01. Yes/No denotes which covariates are included.

[21] The F-test for the relevance of the instrument is greater than 20 suggesting that the chosen instrument is a strong one.

[22] We report the estimated coefficients for each specification of our regression. Standard errors are in parentheses and three stars denote statistical significance at 1%. Using the RE estimator instead of the FE estimator, the results do not change qualitatively: the estimated coefficients are lower (with lower standard errors) but they still denote a positive and statistically significant relationship between specialness and bid-ask spread. For example, the estimated coefficient using the RE estimator in our baseline specification (without adding the mentioned covariates) is 1.217 with standard error of 0.202 and three stars.

Appendix

As regards the quoting activity of market makers on the secondary market of Italian government bonds, the Report analyses the following six indicators of liquidity:

a. best bid-ask spread, a measure of liquidity ascribable to the tightness of the quoting book, which may calculate the cost to be borne when executing a buy or sell order against the mid-price of the bond;

b. volume-weighted bid-ask (VWBA) spread, a measure that calculates the average price weighted by the quoted volumes associated with each price for both sides of the market (bid and ask) against the mid-price of the bond. The VWBA spread is a multidimensional indicator of liquidity, i.e., it is able to capture changes in the quoting book by traders both in terms of quoted bid-ask spread and quoted volumes;

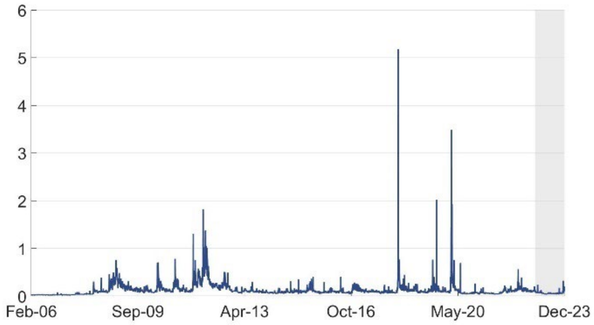
c. volume-weighted bid-ask spread in relation to the daily volatility of the bond (VWBA spread/volatility), a multidimensional liquidity measure capable of quantifying the extent of the variation in the VWBA spread justified by different market volatility rates and the extent relating to a more conservative market maker approach in terms of liquidity provision. The volatility index used for each bond is the daily variation between the minimum and maximum mid-price;

d. two indicators of quoting book depth: (i) the overall volumes quoted on the platform and (ii) the quoted volumes associated with the top three best prices as a percentage of the overall quoted volumes. This measure aims to calculate the proportion of volumes quoted at relatively competitive prices;

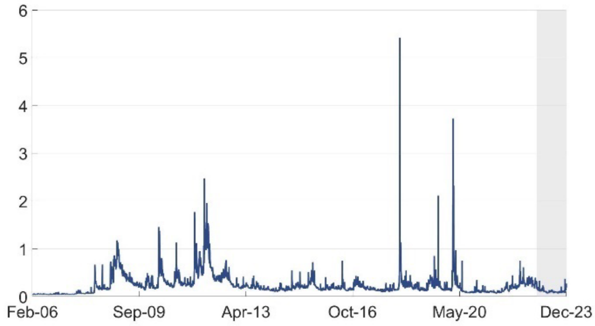
e. slope, a multidimensional indicator calculated as the ratio of the difference between the best and worst bid (ask) and the overall quoted volumes excluding those relating to the best bid (ask). This measure allows assessing the marginal cost for the execution of a sell (buy) order at the worst bid (ask) price compared to the best market price.

Figure A.1: 10-year BTP portfolio (2006-2023 period)

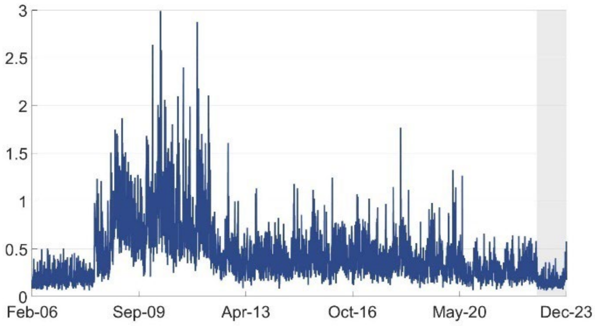
Best Bid-Ask Spread (%)



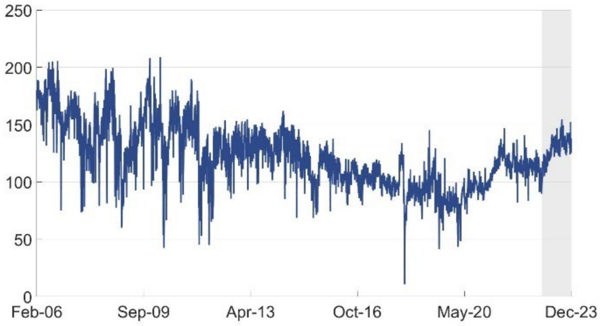
Volume-Weighted Bid-Ask Spread (%)



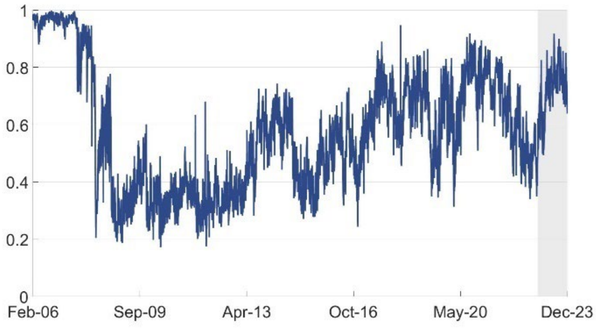
Volume-Weighted Bid-Ask Spread/Volatility (%)



Overall volumes - average Bid/Ask (€-million)



Vol. 3 best prices/overall volumes - average Bid/Ask



Slope - average Bid/Ask

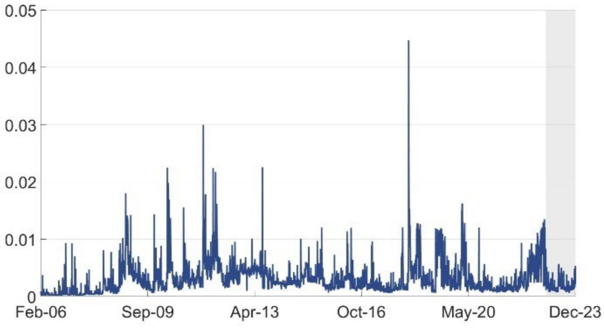


Figure A.2: BOT

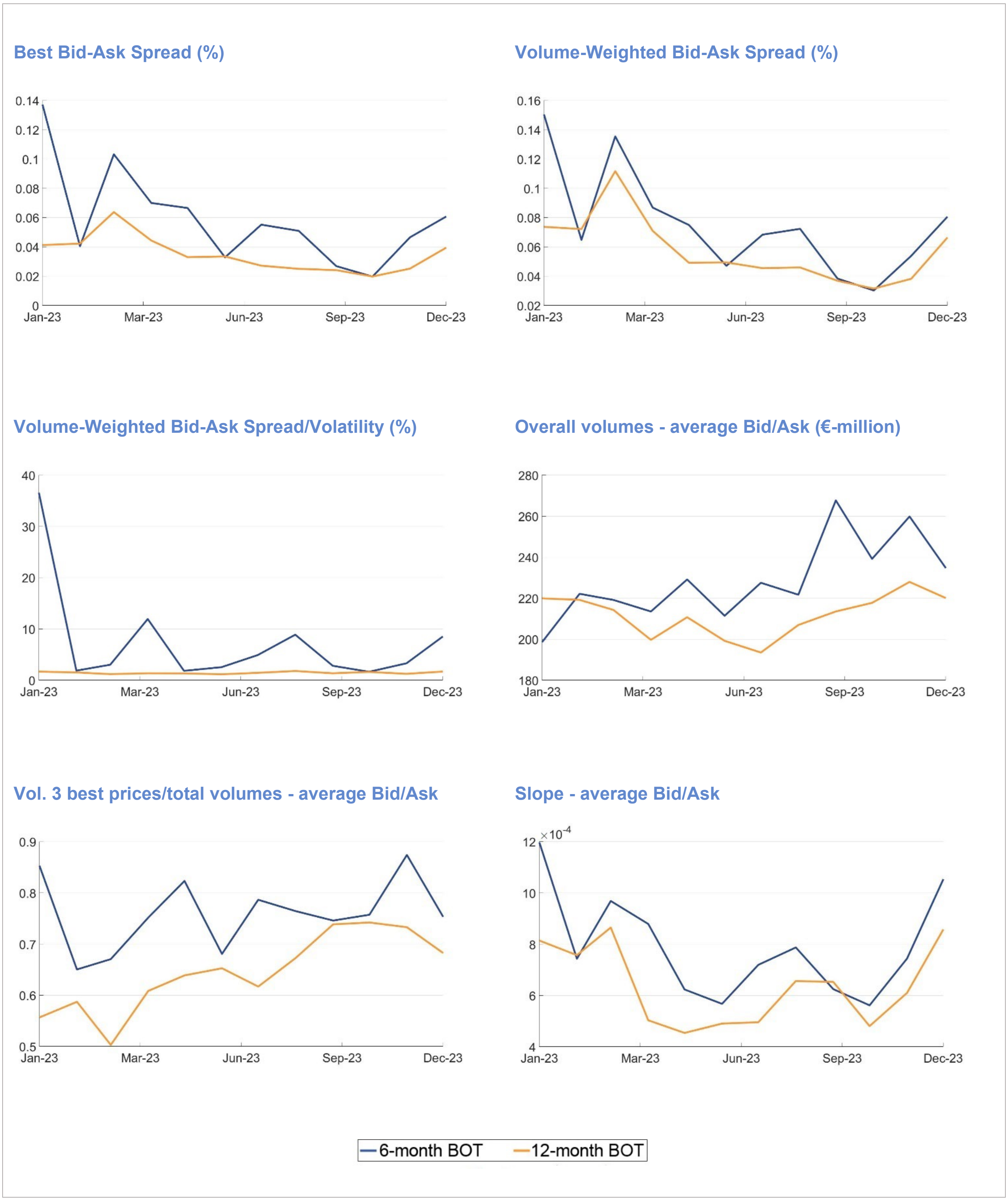


Figure A.3: < 10-year BTP

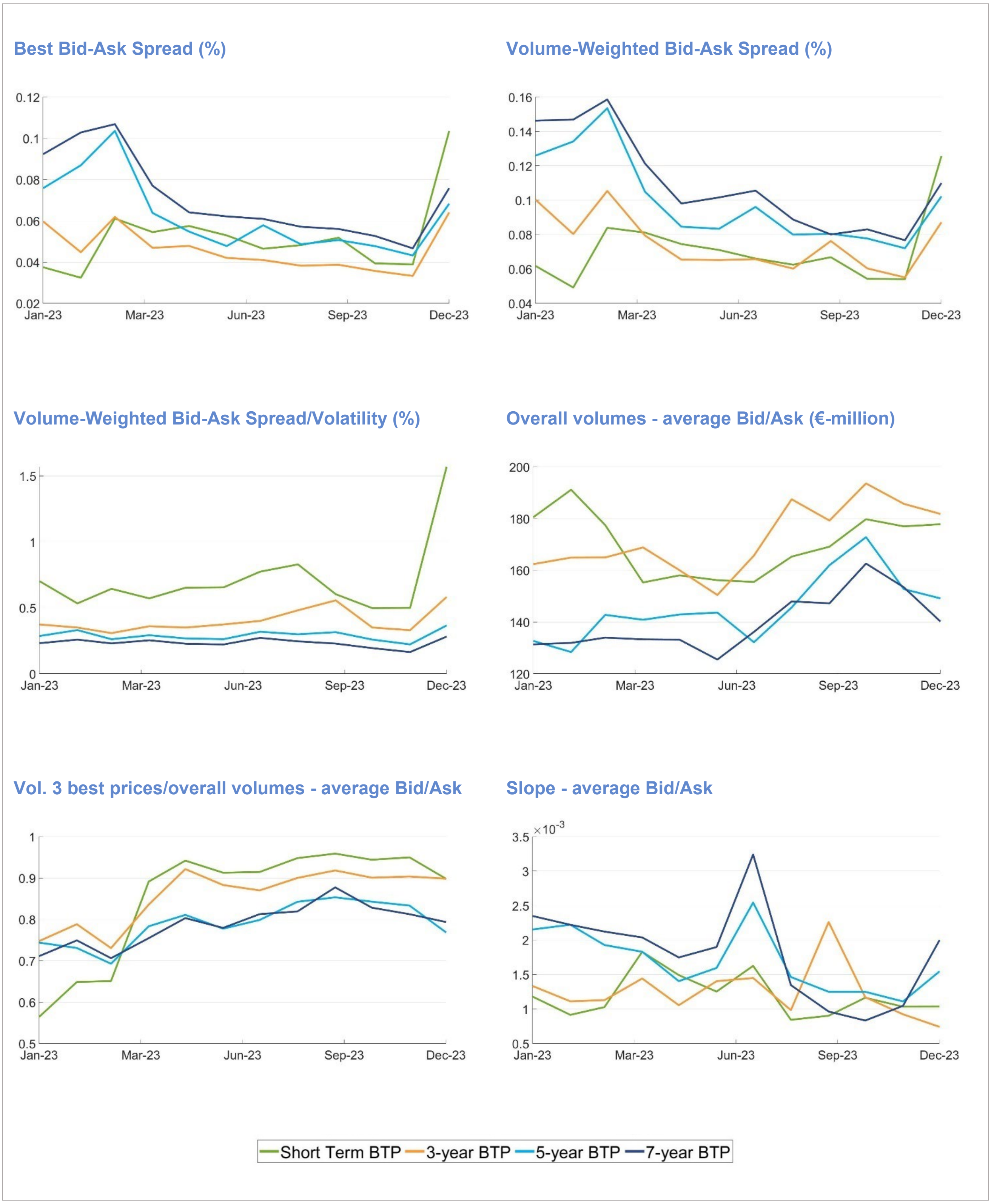


Figure A.4: ≥ 10-year BTP

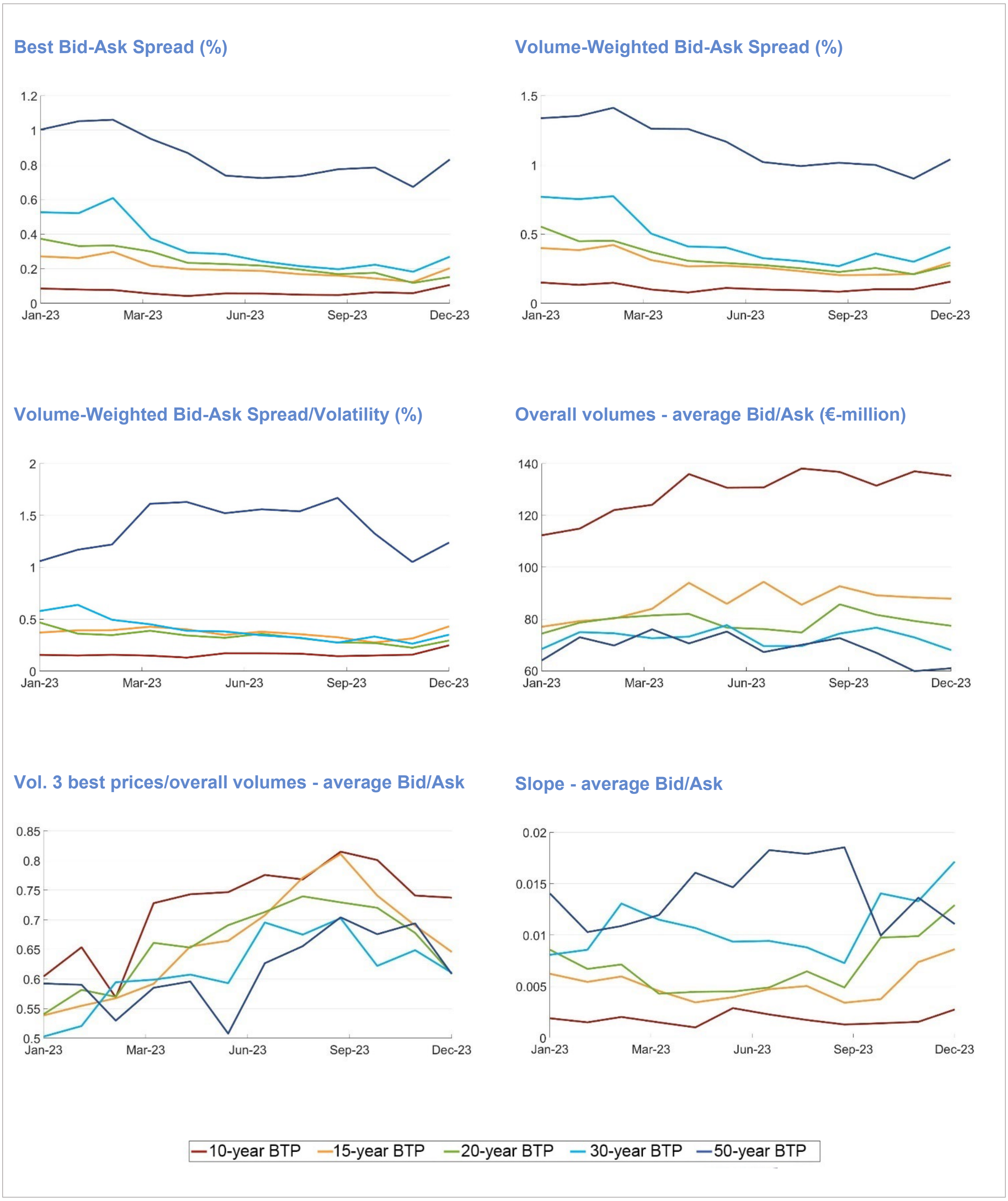


Figure A.5: Green BTP

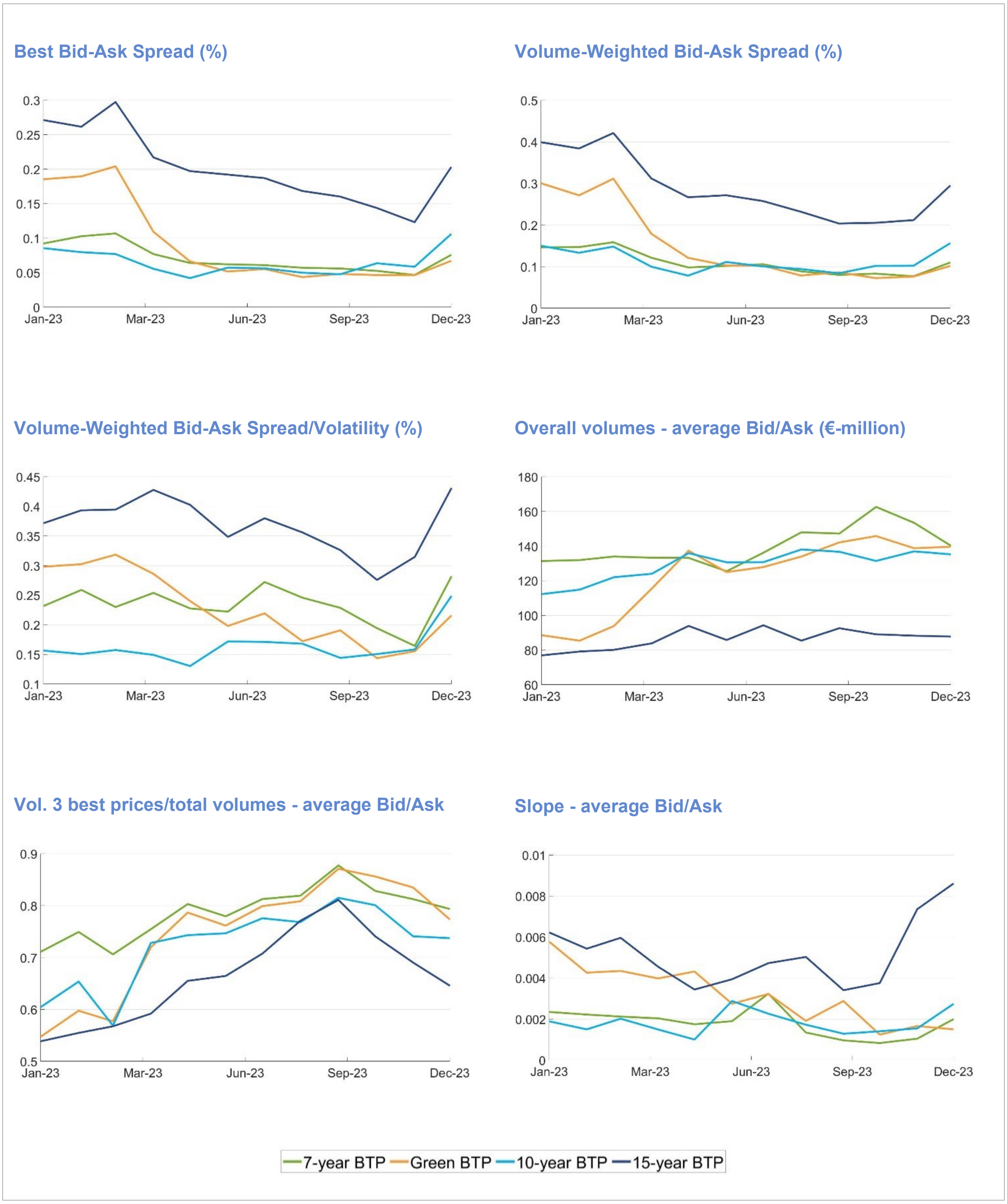


Figure A.6: BTP€i

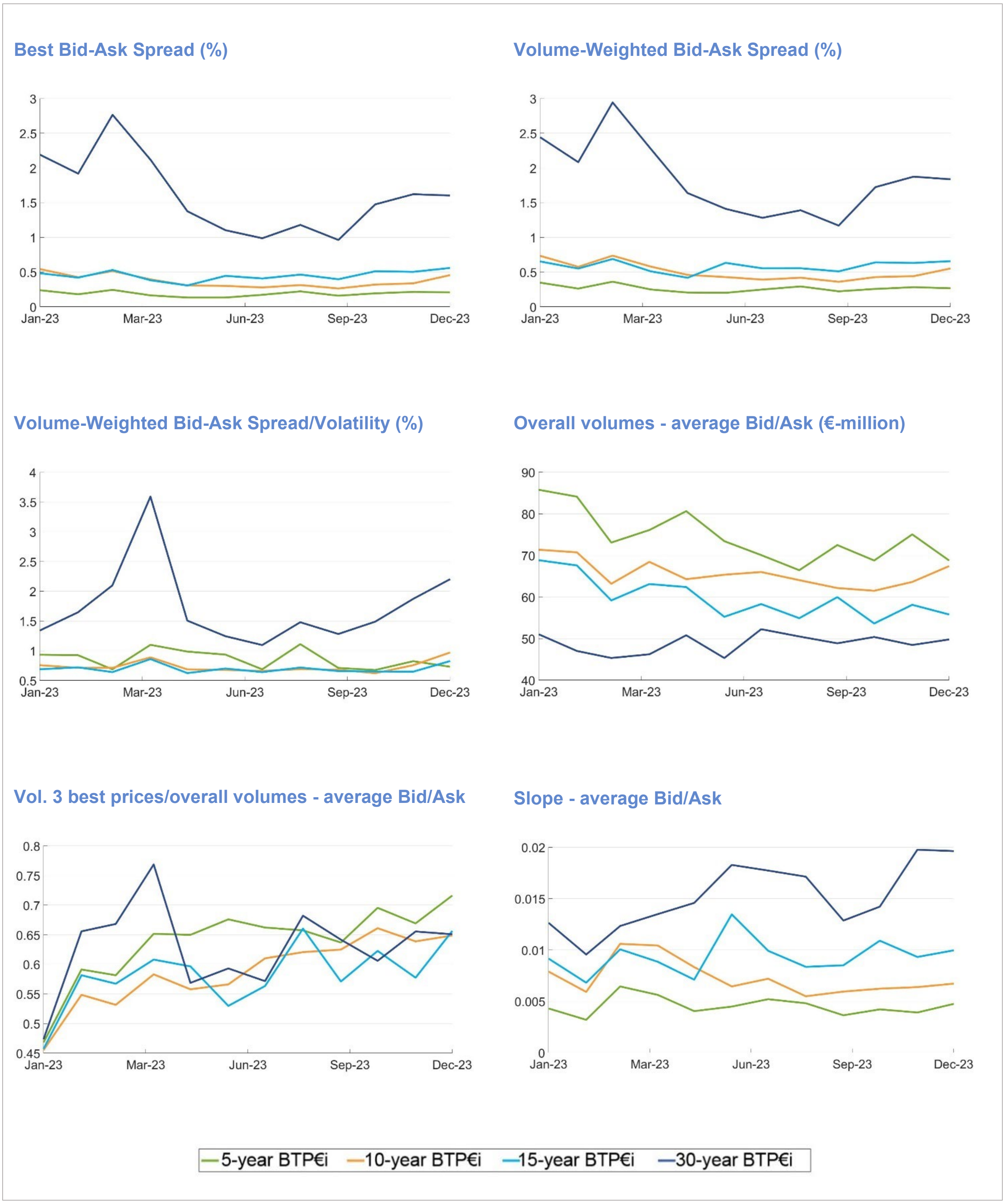
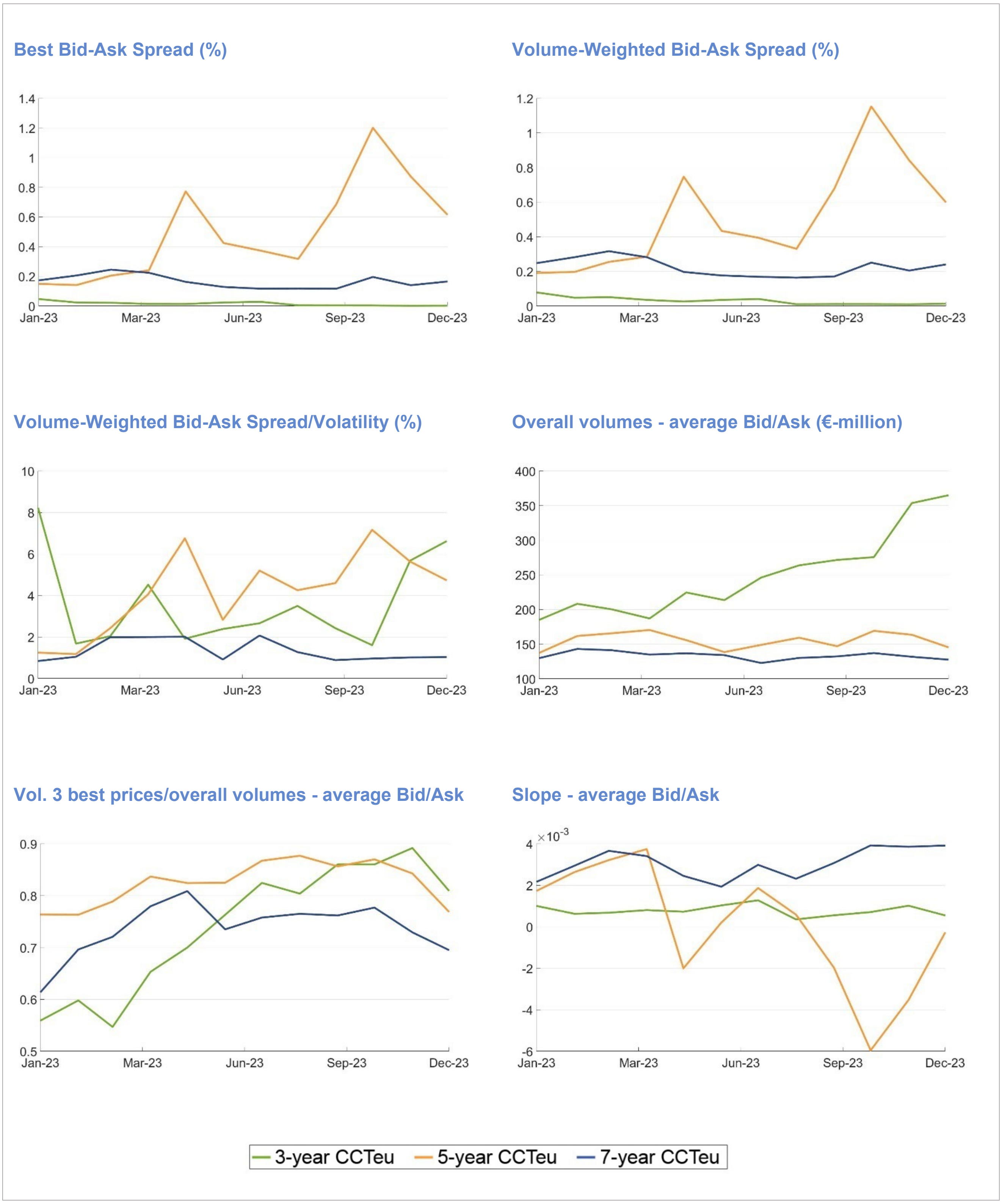


Figure A.7: CCTeu



As regard the trading activity on the secondary market of Italian government bonds, the Report analyses the following metrics: (a) monthly volumes; (b) average size of filler-side flows; (c) average size of aggressor-side flows; (d) number of monthly flows. The analysis of the average size (both from the aggressor and market liquidity providers' standpoint) and of the monthly number of flows allows investigating into the factors that mostly contribute to the trend in volumes.

Figure A.8: 10-year BTPs and < 1 year-government bonds

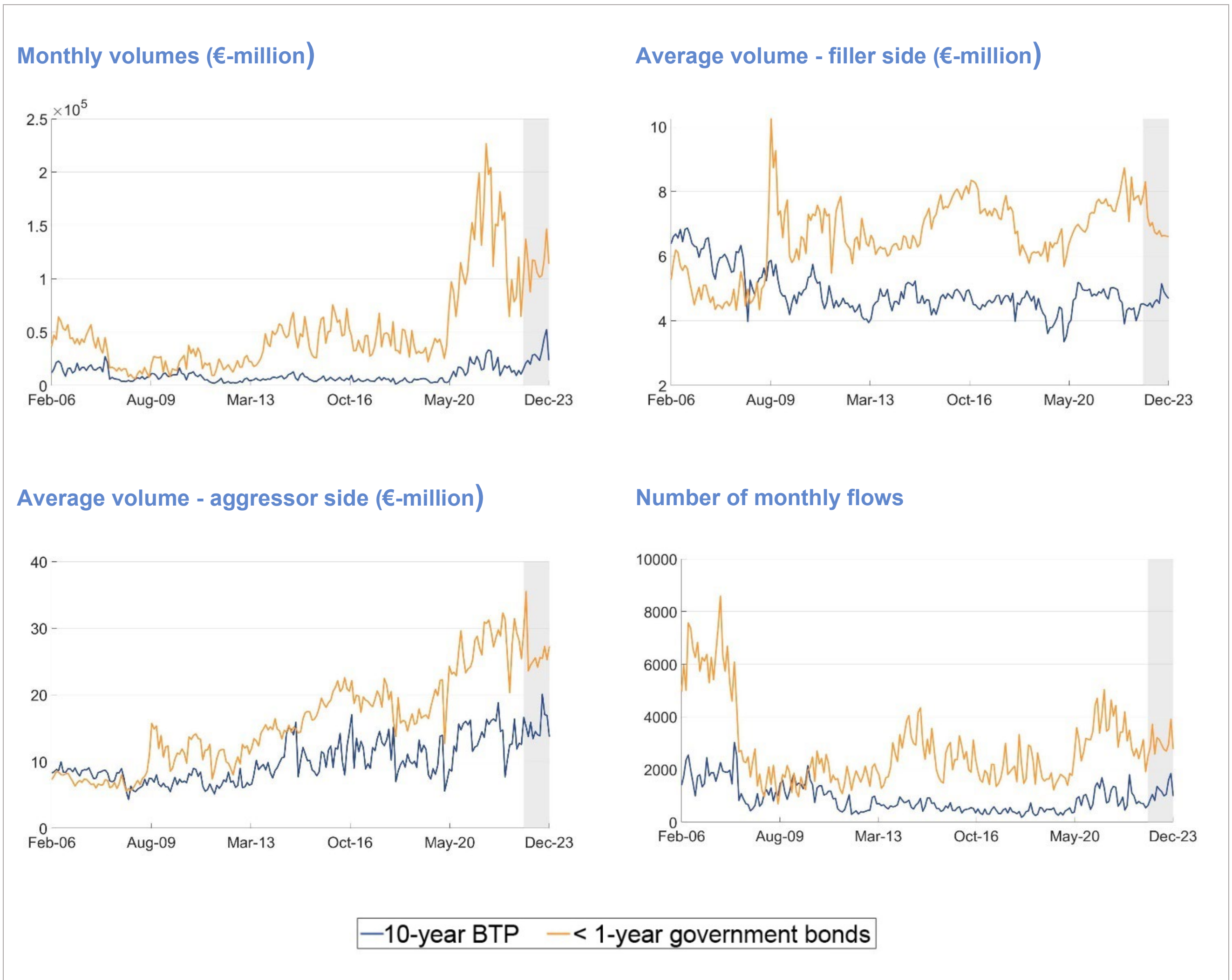


Figure A.9: < 10-year BTP

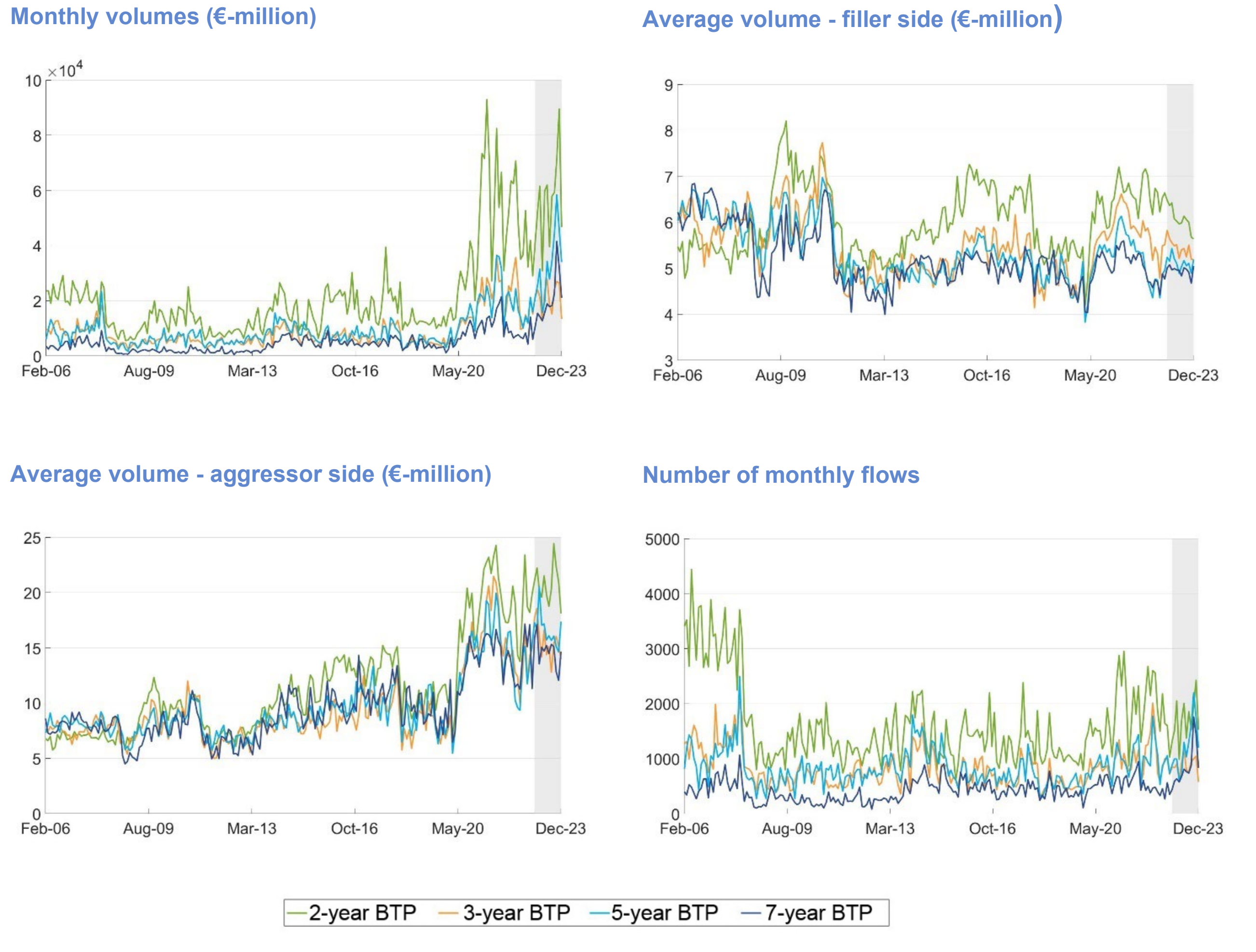


Figure A.10: > 10-year BTP

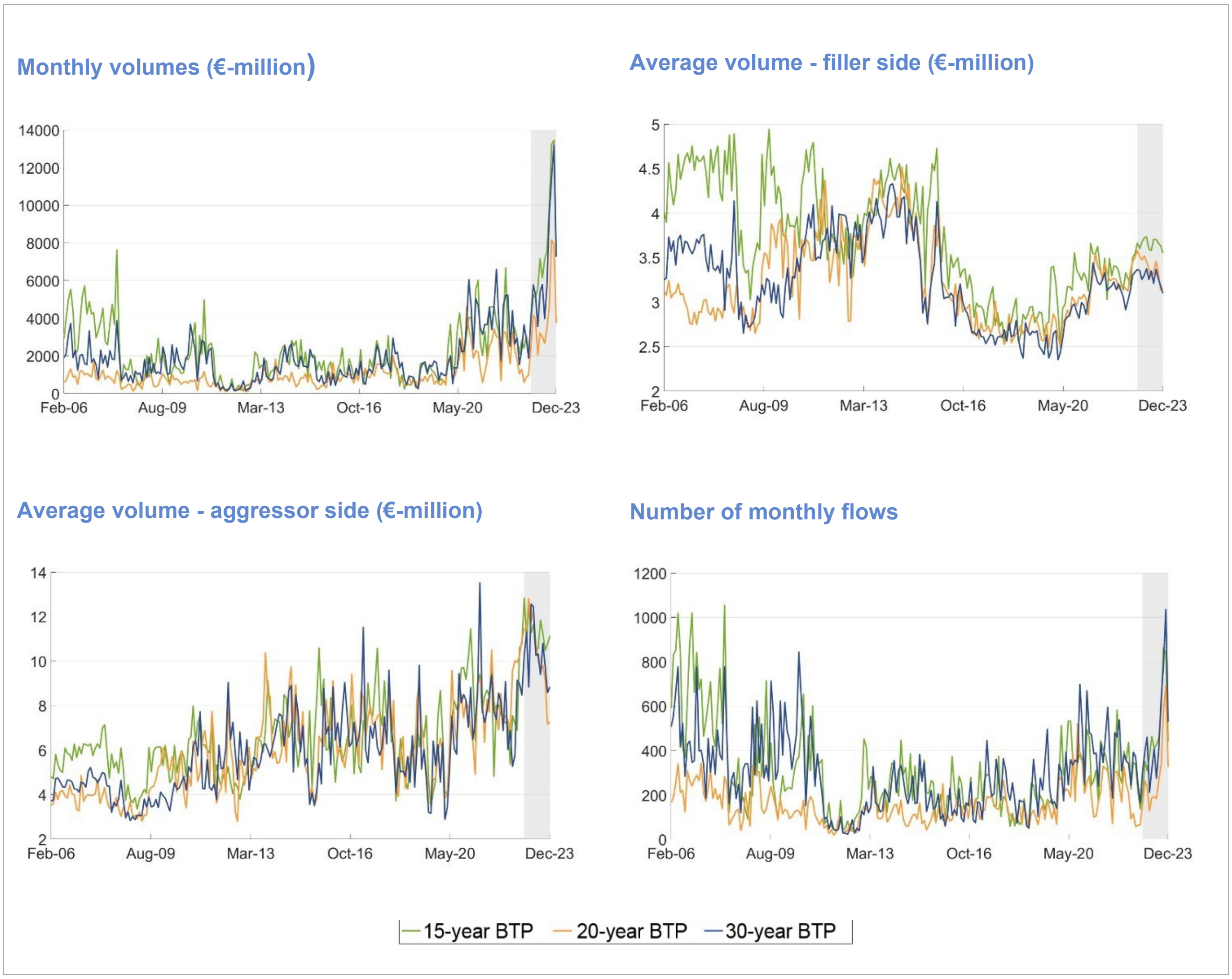


Figure A.11: Green BTP

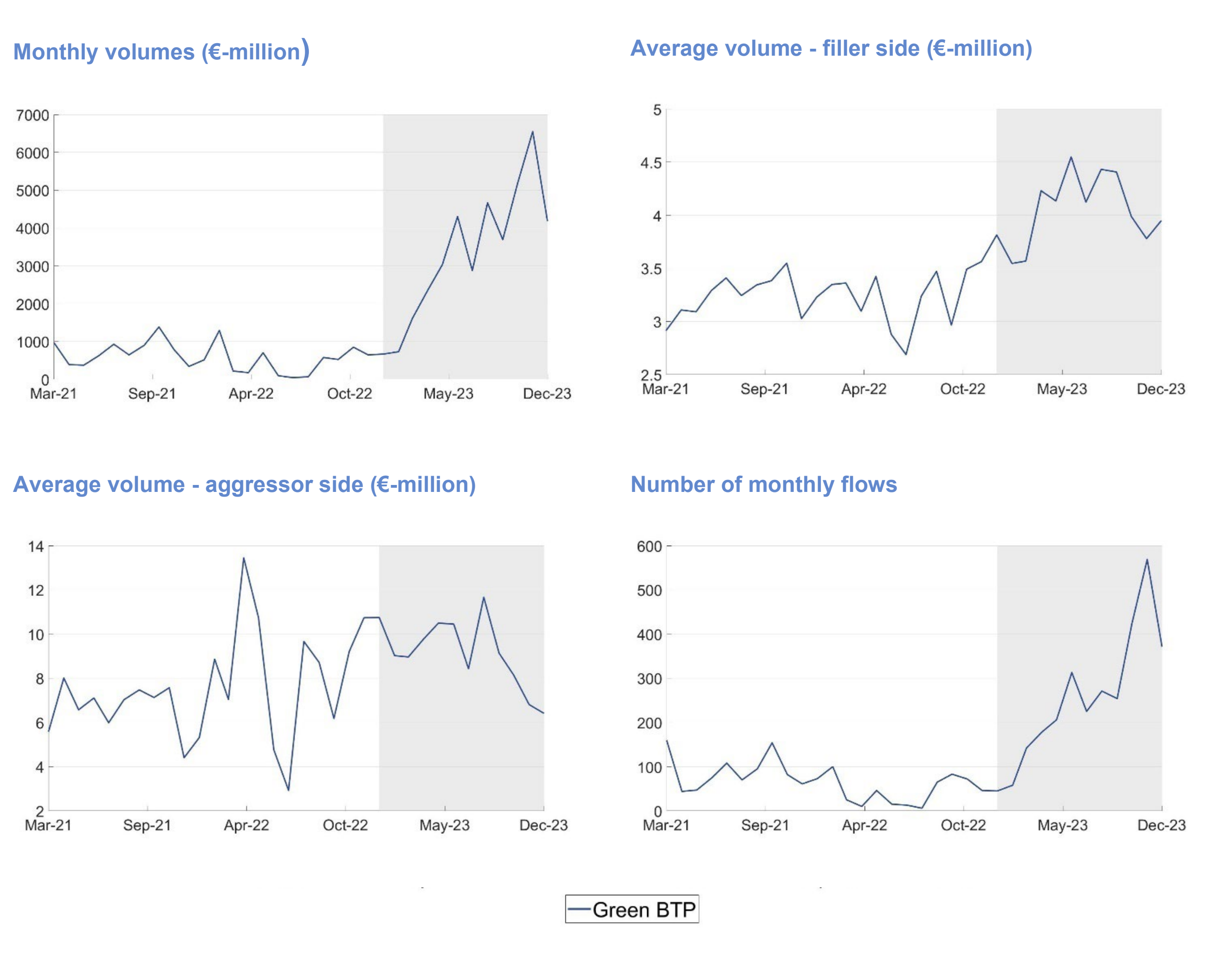


Figure A.12: CCTeu and BTP€i

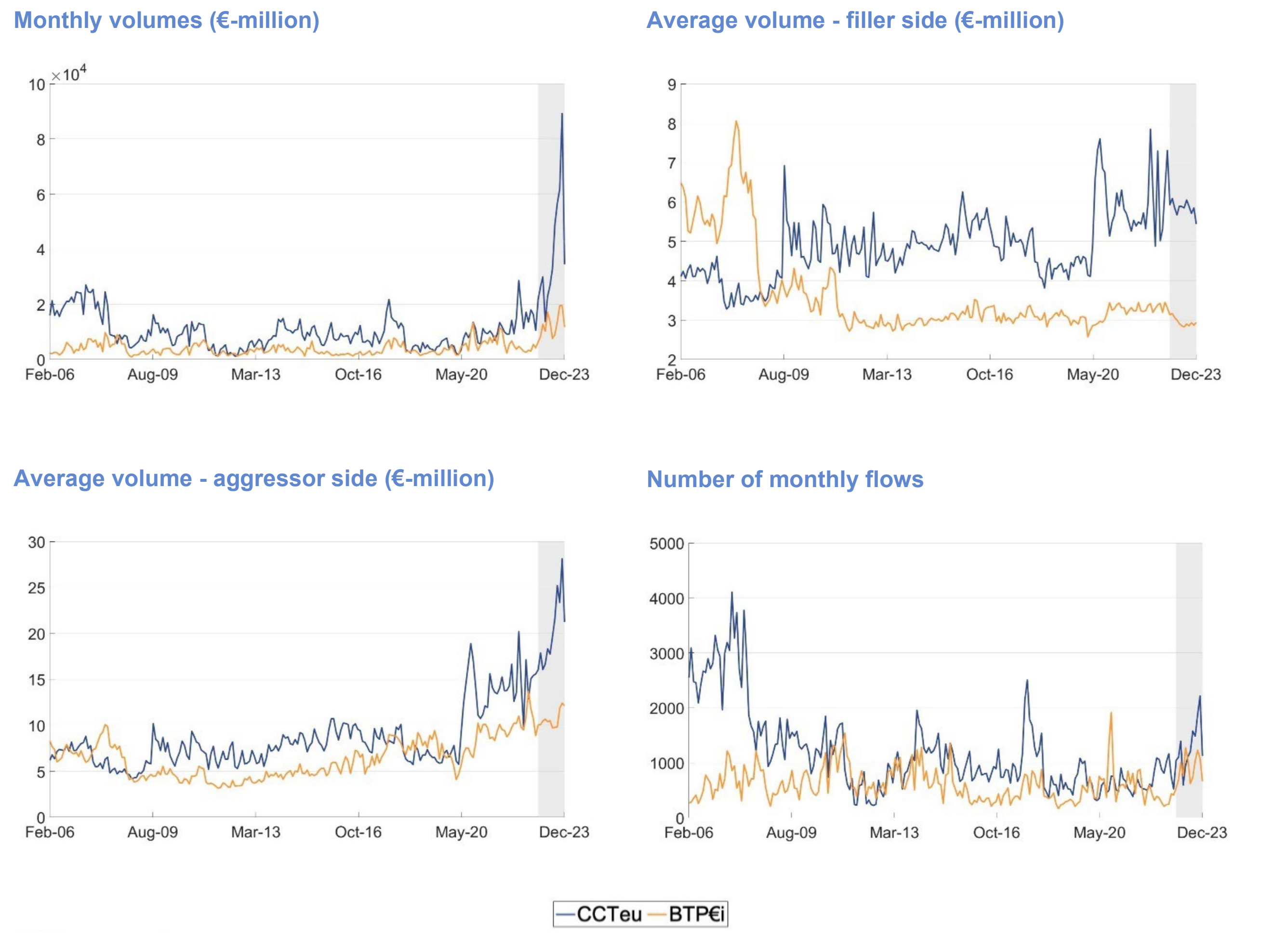
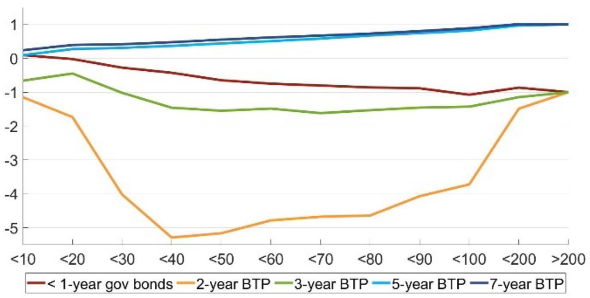
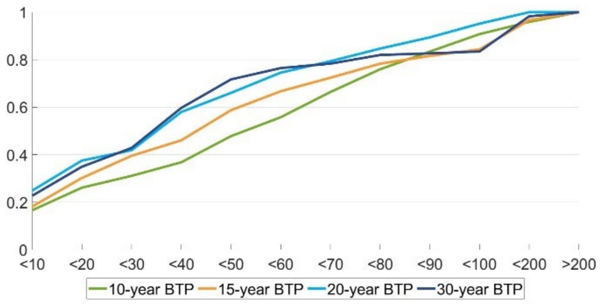


Figure A.13: Analysis by volume categories (2023 vs. 2022)

< 10-year Government bonds



≥ 10-year Government bonds



Floating-rate government bonds