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A joint study by Banca d'Italia and Bundesbank

by Puriya Abbassi, Michele Leonardo Bianchi, Daniela Della Gatta, Raffaele Gallo, Hanna Gohlke, Daniel Krause, Arianna Miglietta, Luca Moller, Jens Orben, Onofrio Panzarino, Dario Ruzzi, Willy Scherrieble, Michael Schmidt

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The German and Italian Government Bond Markets: The Role of Banks versus Non-Banks

Puriya Abbassi*, Michele Leonardo Bianchi, Daniela Della Gatta**, Raffaele Gallo**, Hanna Gohlke*, Daniel Krause***, Arianna Miglietta**, Luca Moller**, Jens Orben*, Onofrio Panzarino****, Dario Ruzzi**, Willy Scherrieble*, Michael Schmidt***

Abstract

Government bond markets play a critical role in the smooth functioning of the financial system, in the conduct and transmission of monetary policy and in the economy as a whole. Maintaining resilient government bond markets is fundamental for policymakers and authorities. This note examines the German and Italian government bond markets, with a special focus on liquidity and on the role played by banks vs. non-banks. To this end, the holding and market structure of the German and Italian government bond markets are analysed at the granular sectoral level. We also look at the trading activities of various market participants, including their role and resilience to shocks in the repo and futures market. This comprehensive analysis enhances the understanding of government bond market dynamics, investor behaviour, and liquidity, providing insights for policymakers and market participants.

JEL Classification: G10, G21, G23.

Keywords: government bonds, repo, futures, market structure, banks, non-bank financial intermediaries, financial stability.

Sintesi

I mercati dei titoli di Stato rivestono un ruolo fondamentale per il corretto funzionamento del sistema finanziario, per la conduzione e la trasmissione della politica monetaria, nonché per l'economia nel suo complesso. Il mantenimento di mercati dei titoli di Stato solidi rappresenta un obiettivo cruciale per i policymaker e le autorità competenti. La nota analizza i mercati dei titoli di Stato di Germania e Italia, con particolare attenzione alle condizioni di liquidità e al ruolo ricoperto da banche e non-banche. A tal fine vengono esaminate la struttura dei detentori e quelle dei mercati dei titoli di Stato tedeschi e italiani utilizzando dati a livello di categorie di investitori. Viene inoltre analizzata l'attività di negoziazione dei diversi partecipanti al mercato, anche in riferimento al loro ruolo e alla resilienza agli shock nei mercati repo e futures. Questa analisi consente di migliorare la comprensione delle dinamiche dei mercati dei titoli di Stato, del comportamento degli investitori e della liquidità, fornendo indicazioni sia per i policymaker sia per gli operatori di mercato.

* Deutsche Bundesbank.

** Banca d'Italia.

*** Deutsche Bundesbank until December 2023.

**** Banca d'Italia until June 2024.

CONTENTS

1 Introduction[1]

Government bond markets play a critical role in the smooth functioning of the financial system, in the conduct and transmission of monetary policy and in the economy as a whole. Maintaining resilient government bond markets is fundamental for policymakers and authorities.

Government bonds are the backbone of most fixed-income securities markets in both developed and developing countries, as they provide a benchmark yield curve for the pricing of other (risky) financial instruments. They are widely used by financial intermediaries to meet regulatory requirements since they have traditionally received favourable treatment in capital and liquidity regulations. Market participants may take synthetic positions on these assets in derivatives markets to conduct arbitrage strategies, to hedge against interest rate risk or to speculate on expected interest rate movements. They are also considered 'safe assets', at least in many advanced economies, due to the issuer's low credit risk. Furthermore, they are expected to maintain their value or even appreciate in market downturns. Based on these features, their use is particularly convenient as collateral to secure funding in interbank markets, as well as to collateralise transactions involving central counterparties (CCPs).

Since the global financial crisis (GFC), government bond issuance has increased substantially in many advanced economies (OECD, 2024). Government bond markets in these jurisdictions are typically characterised by high levels of liquidity, which is an essential ingredient of a modern and efficient financial system. However, sound liquidity conditions are not to be taken for granted. Although government bond markets are traditionally considered 'safe havens', on several recent occasions – such as the March 2020 'dash for cash' or the September 2022 Gilt crisis in the UK – they have in fact become focal points of turbulence, with severe dislocations and rapid deterioration in liquidity conditions. Resilient, liquid and well-functioning government bond markets are critically dependent, among others, on the existence of a stable and diversified investor base and robust market infrastructures. A number of structural changes that have occurred over the past decade may have contributed to making core government bond markets more sensitive to liquidity imbalances, particularly in times of stress (FSB, 2022). For example, market making in government bond markets has shifted from a bank-centric to a hybrid-model, in which non-bank financial intermediaries (NBFIs) play a much more important role (Eren and Wooldridge, 2021). At the same time, technological innovations have dramatically increased the speed at which trades can be executed. While these transformations have contributed to

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broadening participation to a wider range of participants, including those with more sophisticated (algo) trading and hedging strategies, it is likely that the sensitivity of government bond markets to shocks has increased. Indeed, these changes have taken place in a profoundly changed environment, with dealers' intermediation capacity reduced, and other non-bank liquidity providers not always ready to scaling up their market-making activities, particularly in times of stress. During turbulent periods, amplification channels may stem from the investment strategies adopted by intermediaries, as well as the margining practices implemented by CCPs, which may trigger procyclical effects adding up stress within financial markets.

Against this background, the Banca d'Italia and the Bundesbank launched a joint project on German and Italian government bond markets, with a special focus on liquidity and on the role played by banks *vs.* non-banks. Understanding the features of these markets more in detail – including for example the investor base, the behaviour of market participants, the interconnections – could provide useful insights from a financial stability perspective. For example, it may be important to understand if and how some characteristics of these markets may impact liquidity conditions, or may represent a shock amplification channel or may trigger contagion during volatile periods. On a similar vein, it is relevant to map the main players, as well as their investment behaviours, to gauge the potential impact of investor types on the provision of market liquidity. The analysis conducted in this note covers the cash, the repo and the futures segments. Such a perspective aims at gathering a comprehensive view of the whole market, given that the interlinkages across these three segments are relevant. To run our analyses, we build on a wide range of data sources, exploiting detailed bond-level data on both holdings and transactions across sectors and countries. In addition, we use granular transaction-by-transaction data on futures and repo trades.

Our main findings are the following: i) while Italian government bonds are mainly traded via a regulated electronic trading platform, German government bonds are mostly traded bilaterally; ii) German government bonds are mainly held by foreign investors, as well as investment funds (IFs) based in the euro area; in contrast, Italian government bonds are mainly held domestically (by domestic banks, households and insurers);[2] iii) NBFIs play an important role in both markets. Their behaviour is crucial for the mechanisms of price discovery and shock propagation in the financial system, which in turn can affect liquidity.

We also show that the investor base can influence liquidity on the repo market. Our analysis of the Italian government bond market shows that when government bonds are held by so-called 'inelastic investors', the interest rates on related repos are relatively low, meaning that premiums are paid for borrowing these bonds. Furthermore, our study also shows that dealer banks in both the German and Italian futures markets were acting as liquidity providers during the COVID-19 outbreak. Lastly, in an Appendix, a preliminary study conducted by Banca d'Italia colleagues assesses the impact of a yield curve shift on investors in Italian and German government bond markets (cash, repo, futures).

[2] In the analysis on the holding structure we focus on central government bonds and do not consider holdings by the Eurosystem.

The remainder of the paper is structured as follows. In Section 2, we provide an overview of the literature with a special attention to the importance of government bond markets from a financial stability perspective. In Section 3, we describe the main datasets used for the analyses. In Section 4, we present the institutional framework of the German and Italian government bond markets (cash, repo and futures segments). In Section 5 we describe the main results of the deep-dives conducted. Finally, in Section 6 we discuss our main findings and their policy implications.

2 On the importance of government bond markets from a financial stability perspective

Government bond markets represent a fundamental link in the effective functioning of the financial system, the conduct of monetary policy and the overall economy. They are also critical nodes from a financial stability perspective. The academic literature documenting the importance of these markets is extensive.

In normal times, government debt relaxes the domestic constraint on savings, stabilise macroeconomic fluctuations and smooths consumption, and finances large expenditures. Investors see it as a 'safe haven' (Gorton, 2017; Azzimonti and Yared 2019), as a way to enhance portfolio returns (Meyer *et al.*, 2022; Czech et al., 2021) and as a means of portfolio diversification (Dufour *et al.*, 2016; Naik and Yadav, 2003). Beside these important functions, government bonds influence the liquidity creation process of banks, which is an essential ingredient for the effectiveness of monetary policy and more broadly for the smooth functioning of financial markets and the overall economy (Chatterjee, 2015; Manganelli and Wolswijk, 2009; Aiyagari and Gertler, 1985). Sovereign bonds are also used by certain intermediaries to fulfil capital and/or liquidity regulatory requirements (e.g., Bonner, 2016; Curfman, Kandrac, 2022). Furthermore, many investors seek refuge into these securities, especially in times of uncertainty (Costantini and Sousa, 2022).

Government bond markets, especially those in advanced economies, are typically characterised by high levels of liquidity. This is particularly true for on-the-run bonds (or, more broadly, recently issued bonds) and for benchmark tenors underlying futures contracts. Market liquidity is a key factor underpinning well-functioning and resilient financial markets. It can be defined as the *'ability to rapidly execute large financial transactions at low cost with limited price impact'* (CGFS, 1999). Central banks have a strong focus on this dimension, provided that dysfunctions in financial markets, especially when occurring in core segments, may affect also monetary policy implementation, monetary policy transmission and financial stability more broadly (BIS, 2022). However, sound liquidity conditions in government bond markets cannot be taken for granted under any circumstances (Duffie, 2020). A number of recent crisis episodes have shown that even government securities can be subject to liquidity strains, with profound implications for the broader financial system. In March 2020, for example, many government bond markets experienced severe dislocations. When investors rushed to convert highly liquid

assets into cash, even the safest and most liquid government securities suffered large price declines. Another striking episode occurred in September 2022, when the UK government bond market experienced severe turbulences owing to distressed forced sales of gilts by liability-driven IFs. The gilt market became unbalanced and characterised by disproportionate one-way selling pressure. As a result, intermediation began to break down and market functioning deteriorated rapidly (Alexander *et al.*, 2023).

The lack of liquidity in financial markets can increase market volatility and the cost of capital (Elliott, 2015); in adverse scenarios it can trigger or exacerbate a financial crisis by generating losses for investors. Liquidity conditions in government bond markets may transmit shocks into stock markets, given the existence of a two-way relationship between stock and bond market liquidity (Goyenko and Ukhov, 2009). Clancy *et al*. (2019) document the role that the interdependencies between liquidity and tail risks play in amplifying sovereign bond market tensions. Pelizzon *et al.* (2016) analyse the interactions between credit and liquidity risk in sovereign bond markets, concluding that during the euro area sovereign debt crisis the former has been a predominant leading factor. Having relaxed liquidity conditions is also important from the perspective of financial intermediaries, as they may have an impact on the pricing of securities, on the ability (and cost) of both trading and hedging. Brunnermeier and Pedersen (2009) provide a framework that connects market liquidity (e.g. the ease with which assets are traded) and funding liquidity (i.e. the ease with which traders can obtain funding), showing that under certain adverse conditions market and funding liquidity are mutually reinforcing, leading to sudden liquidity spirals.

Resilient, liquid and well-functioning government bond markets are critically dependent on the maintenance of an adequate intermediation capacity of dealers. Dealers are key players in government bond markets as they are active across cash, repo and futures segments. Duffie (2023) provides evidence that the resilience of the US government bond market may be limited by dealers' balance sheet, which is not large and flexible enough to effectively counterbalance unilateral selling pressures that may arise during extreme distress periods (such as in March 2020). While market volatility is likely to explain most of the variation in illiquidity in normal times, this is not the case when dealer capacity is constrained. During March 2020, bank dealers did not contribute to the sale of bonds, but rather increased their trading activity, although this was insufficient to fully absorb the huge sell requests from the market; importantly, other non-bank liquidity providers did not increase substantially their funding provision to compensate for the high liquidity demand (FSB, 2022).

These findings emphasise the importance of investors' behaviour in mitigating or amplifying financial stress episodes. The academic literature exploring this topic is long-standing. A number of seminal papers on trading behaviours and market efficiency discuss, for instance, the co-existence across financial markets of diverse trading strategies and types of investors (Friedman, 1953; Kyle, 1985; Campbell and Kyle, 1988; De Long *et al.*, 1990). More recently, He et al. (2010) and He and Krishnamurthy (2013) highlight that during crisis times heterogeneity in

capital constraints within the intermediation sector – including for example commercial banks, investment banks and hedge funds – can emerge and that such constraints can exacerbate market fluctuations. NBFIs contribute to procyclical price spirals as they rely more on liquid assets, while traditional banks tend to exhibit greater resilience owing to their more stable funding sources (Hanson *et al.*, 2015). Similar evidence on investors' behaviour is gathered for the Italian sovereign bond market (Panzarino, 2023). Abbassi *et al.* (2016) document that, during the global financial crisis, German banks with higher trading expertise increased their investments in those securities that experienced the biggest price drops; interestingly, this effect is more pronounced for banks with a higher level of capital. Timmer (2018) provides evidence that banks and IFs respond procyclically to past returns, while insurance companies (ICs) and pension funds (PFs) typically behave in a countercyclical manner. This behaviour is related to differences in the balance sheet structure of these sectors.[3] Further research by Hanson *et al.* (2018) investigates the impact of the Federal Reserve's quantitative easing policies and their impact on market dynamics, revealing how adjustments in risk premia by bond specialists and the reallocation of capital by generalist investors can also induce procyclical movements in market prices. Arrata *et al.* (2020) provide empirical evidence that the holdings of bonds by so-called 'inelastic investors' – which are more insensitive to repo market conditions and therefore unlikely to lend their bond holdings in the market – may have an impact on repo rates.[4]

Beside the investors' behaviour, how these securities are traded and settled also play a significant role in shaping market outcomes. Notably, there is no agreement that specific market structures consistently deliver better outcomes under stress, thus indicating that resilience benefits from (micro)structural adjustments are often highly context-specific and vary by jurisdiction (FSB, 2022). Trading mechanisms, e.g. bilateral over-the-counter (OTC) trading *vs*. regulated electronic platforms and an involvement of a CCP, have their own advantages and disadvantages. They are related to efficiency, transparency, trading costs and availability of information. OTC trading involves search costs, and prices are determined through bargaining (Duffie *et al.*, 2005). Greater bargaining power in OTC markets can result in trade discounts, potentially making these transactions cheaper than similar trades on an exchange. De Roure et al. (2019) document that dealers in the German government bond market are more likely to use the MTS platform when immediacy is crucial, particularly for less liquid bonds; in such cases, MTS serves as an outside option and as a potential last provider of liquidity. Furthermore, while OTC transactions are less visible and therefore may have a negligible impact on the pricing of government bonds, regulated electronic platforms provide greater transparency as order books

[3] For example, banks that are relatively less capitalised have a more pronounced procyclical investment behavior; IFs that face more outflows act more procyclically.

[4] Arrata *et al.* (2020) also find that the Eurosystem public sector purchase program (PSPP) contributed to depressing repo rates, both by increasing the scarcity of the bonds purchased and by increasing the amount of excess liquidity in the system. This finding is consistent with a wide academic literature showing the impact of central bank purchases of securities on short-term interest rates (ECB, 2021; Jank and Mönch, 2018; D'Amico *et al.*, 2018). There is also evidence that the Eurosystem's Securities Lending Facility alleviated somewhat this pressure (ECB, 2021; Greppmair and Jank, 2023), although not necessarily compensating for the downward shift in rates induced by asset purchases (Carrera de Souza and Hudepohl, 2024).

reveal price impacts. When considering settlement mechanisms, a CCP takes on counterparty risk during the settlement of transactions. In contrast, OTC transactions carry this risk, which may severely affect liquidity in case of failure. Historical events have shown that CCP clearing increases market confidence during periods of stress, allowing these markets to continue functioning while non-cleared segments become illiquid (Deutsche Bundesbank, 2022; Hüser *et al.*, 2024). Moreover, central clearing lowers the overall net exposures, freeing up space on dealers' balance sheet (Aquilina *et al.*, 2024). Therefore, central clearing could relax the dealer capacity constraint explained by Duffie (2023) and help mitigating risks to market functioning.

Our work aims to enhance the comprehension of the role of different market participants in different segments of the government bond markets. For this purpose, we look at the holding and market structure of German and Italian government bonds. We disaggregate holdings at the sectoral level using granular information on the sectoral affiliation of various market participants and their trading activity. Furthermore, we look at different market participants in the repo market for transactions backed by German and Italian government bonds. Our study helps to better understand past developments in government bond scarcity, as well as the investor base and its impact on scarcity. Lastly, we look at the futures market, where government bonds are particularly heavily traded and thus a crucial factor in price discovery. We look at the role of principal trading firms (PTFs) and dealer banks as liquidity providers during the COVID-19 pandemic. In doing so, we help to better understand the behaviour of these market participants during crises.

3 Data description

In this section we provide an overview of the main datasets used in the description of the institutional framework and in the empirical analyses.

The investor base – holdings. Bond-level information on sectoral holdings of euro-denominated central government bonds (CGBs) in the Italian and German markets is obtained from the Securities Holding Statistics by Sector (SHSS) dataset, collected by the European Central Bank (ECB). SHSS provides quarterly information on securities held by selected categories of euro area investors, broken down by instrument type, holder country and further classifications. Available information includes the market and face value of holdings at ISIN-by-ISIN level. The institutional sectors covered are the following: banks, insurance companies (ICs), pension funds (PFs), investment funds (IFs), other financial institutions (OFIs), non-financial corporations (NFCs), households and non-profit institutions (HHs) and public administration (Sov).[5] For non-euro area investors, sectoral information is not available and the mapping is limited to securities deposited with euro area custodians. The analysis focuses on direct investments of

[5] SHSS does not cover central bank holdings. Debt securities, listed shares and IFs units held by euro area residents are covered.

holder sectors, without considering indirect exposures through shares of funds (i.e. no 'look-through' approach).

The investor base – trading. To analyse the trading activity on Italian sovereign bonds, we employ granular data from the Euro Market Activity Report (EMAR). The reporting scheme is consolidated at the European level and covers all trades on Italian sovereign bonds where at least one of the two counterparties is a primary dealer.

Trading activity in repo markets. Granular data on trading in repo markets are obtained under the 'Securities Financing Transactions Regulation' (SFTR, n. 2365/2015), which requires all entities domiciled in the EU (and their foreign branches) to report their SFTs to Trade Repositories (TRs). Data collected at transaction level are very comprehensive. They include information on the counterparties of the trade, the currency, the maturity, the rate and collateral used, and the margins exchanged for cleared transactions. In addition, the analysis on the Italian repo market (see Section 5) relies on proprietary data from the MTS Italy Repo platform, to which the Banca d'Italia has access provided its oversight responsibilities on this market.

Trading activity in futures markets. Granular data on activity in futures markets are collected under the 'European Market Infrastructure Regulation' (EMIR, n. 648/2012). Based on that, derivative transactions are reported since February 2014 on a daily basis by entities resident in the EU and collected through TRs, which, in turn, make these data available to authorities. The information collected on each individual transaction is very rich and includes details such as the identity of the counterparties involved, the type of derivative, the contract value, its maturity and notional amount outstanding, the underlying security, the execution and clearing venues, and, if any, the collateral (margin) paid and received. As EMIR data are subject to a number of data quality issues (Bianchi *et al.*, 2025), EMIR reporting on futures collected by Banca d'Italia was cross-checked with data collected by the Bundesbank.[6] The final dataset comprises all futures transactions accessible to Banca d'Italia and Bundesbank for entities and markets falling within the jurisdiction and financial stability mandate of the authorities in the European System of Central Banks (ESCB). Furthermore, the analysis on futures market in Section 4 is based on data collected due to the 'EU Regulation on markets in financial instruments' (MiFIR, n. 600/2014). The dataset available at the Bundesbank covers all transactions in German and Italian government bond futures conducted by German counterparties and/or on German trading venues; the dataset also includes futures trades conducted by EU counterparties or on EU trading venues.

[6] Under EMIR, both authorities are expected to have access to the same data on futures related to the underlying assets analysed in this study. However, the implementation of the regulation varied across different trade repositories (TRs), leading to inconsistencies such as underreporting of EMIR data to Banca d'Italia and Bundesbank. As a result, it became necessary to cross-check the data collected by both Banca d'Italia and Bundesbank to ensure accuracy and completeness.

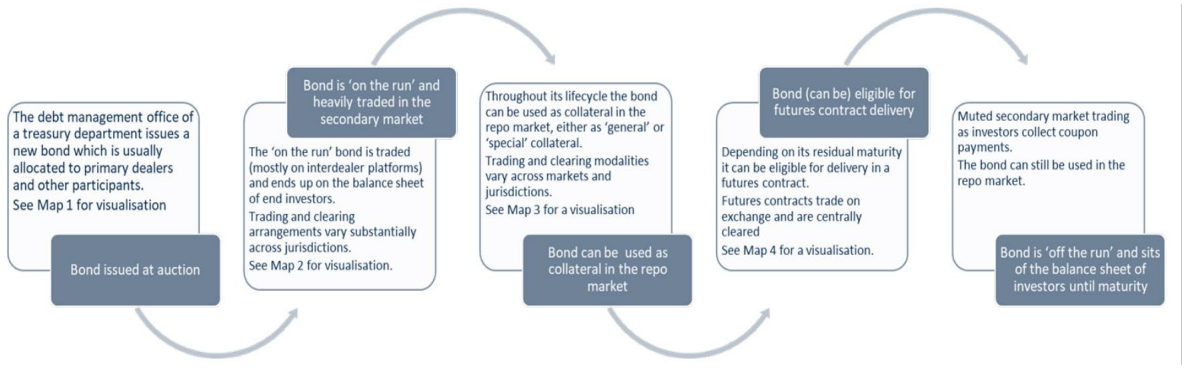
4 The institutional and (micro)structural features of the German and Italian government bond market

A wide range of market participants, each with distinct objectives and operating across different market segments, utilise government bonds. These participants include both domestic and international entities, such as banks, ICs and PFs, IFs, NFCs, governments and HHs.

A comprehensive view on government bond markets requires to investigate the cash, the repo and the futures segments. They are all tightly linked and disruptions in one of these segments can rapidly transmit to the other ones (Figure 1). Once issued, government bonds can be traded in secondary markets (FSB, 2022). These securities can be used in repo markets to obtain liquidity throughout their life cycle.[7] The functioning of the repo market can have feedback effects on the underlying cash market. The existence of a repo market in fact reduces the cost for market makers as they can operate with smaller or less costly inventories, thus allowing them to run their functions more efficiently with overall positive effects on market liquidity in secondary government bond markets. Furthermore, repo markets are connected to future markets as well. Investors may source specific securities on repo markets to fulfill delivery obligations in future markets; they may also conduct arbitrage strategies, sourcing liquidity or specific security into repo markets. Finally, trading activity in futures markets can have an impact on liquidity in the underlying cash markets in both normal times (Panzarino *et al.*, 2016) and distress periods (Kerssenfischer and Helmus, 2024).

Figure 1

The stylised lifecycle of a government bond and associated markets



Source: *Liquidity in Core Government Bond Markets*, FSB (2022)

In this section, we provide some stylised facts on the main investors in German and Italian government bond markets, as well as developments and features of the repo and futures segments.

[7] In 2023, government securities accounted for about 87 per cent of the overall collateral pledged in EU repo transactions (ESMA, 2024). At global level, the CGFS reports that in 2017 around $12 trillion of repo and reverse repo transactions were outstanding globally; about $9 trillion were collateralised with government bonds (CGFS, 2017).

4.1 The cash market

The issuance of new (central) government bonds is a strategic decision for each country and the operational management of sovereign debt typically varies across jurisdictions. In Italy, the Ministry of Economy and Finance (Ministero dell'Economia e delle Finanze, MEF) is responsible for both the issuance of bonds and the debt management. Conversely, in Germany, a specialised agency, the Federal Republic of Germany – Finance Agency takes on these tasks for the German Ministry of Finance (Bundesfinanzministerium, BMF).

In both jurisdictions, bonds are issued in the primary market through auctions. The issued bonds differ in types and maturities. In Germany, the Finance Agency issues zero-coupon bonds up to 12 months, bonds that pay a fixed annually coupon with different maturities up to 30 years, and green bonds with different maturities.[8] The MEF provides zero-coupon bonds up to 12 months, bonds that pay a fixed semi-annually coupon with different maturities up to 50 years, bonds with a variable coupon, inflation-linked bonds with different maturities, bonds for retail investors and green bonds. At the end of 2023, the outstanding volume of German and Italian central government bonds amounted to EUR 1.8 trillion and EUR 2.4 trillion, respectively. At the same date, a significant fraction of German and Italian government bonds were held by the Eurosystem. Importantly, these holdings are excluded from the scope of this section.[9]

When focusing on bonds outside the Eurosystem balance sheet, significant differences are observed in the investor base. Based on SHSS data, by the end of 2023 foreign investors held about 77 percent of the German government bonds with China being the largest foreign debt holder, followed by the US and the UK. Notably, NBFIs located in the euro area (excluding Germany) held approximately 20 percent of the bonds, with half of these held by IFs. In Italy, in contrast, around 60 percent of sovereign bonds were held domestically as of the end of 2023; banks accounted for the largest share, followed by HHs and ICs. Domestic financial institutions combined accounted for about 40 per cent of total holdings. While insurers typically hold bonds with longer maturities to align with the duration of their liabilities, banks maintain a more diversified portfolio across various maturities. As regards foreign holders, the footprint of investors from other euro area countries (mostly IFs) is about 20 per cent, comparable to what is observed for the German market, but the share of non-euro area investors is much smaller (around 16 per cent).

Trading activity of German and Italian bonds on secondary markets relies on different market infrastructures. Dealers' trading activity takes place in the so-called 'dealer-to-customer' segment, where dealers provide liquidity to end investors, e.g. IFs, ICs and PFs, and in the 'interdealer' segment, where dealers trade among themselves to manage their inventories. By buying and selling securities from/to customers, dealers play a key intermediation role in government bond markets. While German government bonds are typically traded bilateral and over-

[8] In the past, the BMF also issued inflation-linked Federal securities. However, from 2024 onwards, this type of Federal securities will no longer be issued or reopened. The currently outstanding securities will continue to be tradable on the market.

[9] The largest holder of issued bonds in both countries is the Eurosystem. Since the Eurosystem acts market-neutrally in purchases and sales, central bank holdings are not included in this analysis. The holding shares commented in this section are referred to the total amount of securities not held by the Eurosystem.

the-counter (both voice and electronic), Italian government bonds are mostly traded on MTS Cash Italy, a regulated interdealer platform with market-making obligations. Notably, the majority of German government bonds transactions are not centrally cleared. In contrast, trades on Italian government bonds conducted on MTS are all cleared via Euronext Clearing, the CCP offering clearing services on government bond transactions conducted on MTS Italy.

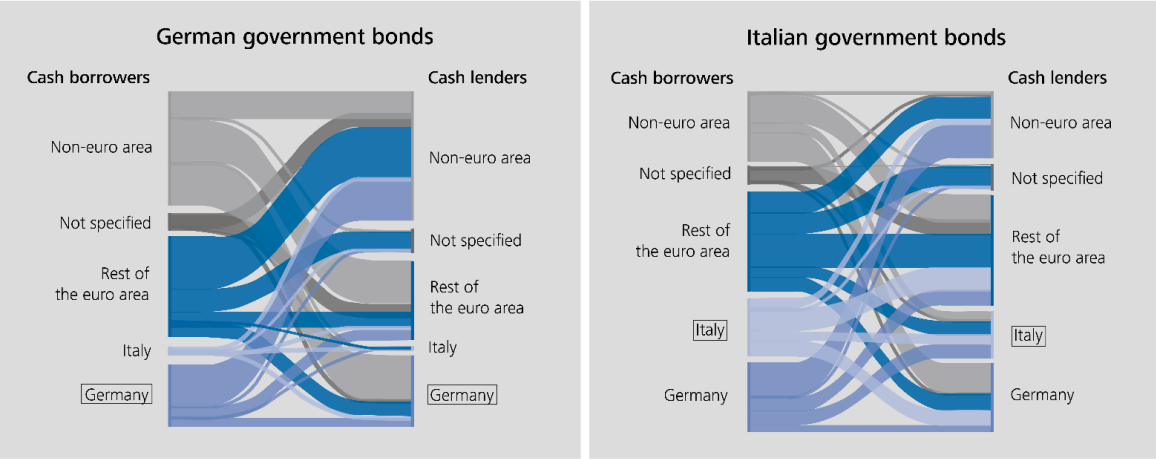
4.2 The repo market

The trade amounts of repos backed by German and Italian government bonds are roughly the same size; however, especially the repo transactions backed with Italian government bonds have grown remarkably in recent years. Based on SFTR data the daily transaction-volume of repos backed with German government bonds increased from about €140 billion in August 2021 to about €180 billion in August 2024, while the daily transaction volume of repos backed with Italian government bonds increased from €160 billion to €280 billion over the same period. In both cases, special repo (i.e. collateral driven as opposed to liquidity driven repos) trades represent the largest share of overall transactions. Repo trading on Italian government securities primarily takes place on MTS Italy Repo, a fully electronic regulated wholesale market. Almost all transactions on this platform are centrally cleared. For repos backed with German government bonds, most interdealer trades are centrally cleared via LCH SA.

By trade amounts, approximately 65 percent of repos backed with German and 70 percent of repos backed with Italian government bonds are centrally cleared. Both markets are dealer-based, meaning that most transactions involve dealer-banks that either borrow or lend money against government bonds as collateral. Hedge funds are other active players in the repo market, highlighting the increasing role of the non-bank sector in the government bond market. While most repos using Italian government bonds as collateral are conducted among counterparties of the eurozone, with a significant fraction belonging to German counterparties, repos backed by German government bonds often involve a counterparty belonging to a non euro area country (Figure 2).

Figure 2

Countries of repo market counterparties with German and Italian government bonds



Source: Calculations on the basis of data from the Securities Financing Transactions Regulation (SFTR).
Deutsche Bundesbank

4.3 The futures market

Futures based on both, Italian and German government bonds are mostly traded at Eurex, the leading European derivatives exchange that also incorporates Eurex Clearing, a central counterparty. It is considered a central platform for European exchange-traded interest rate derivatives. The Bund Futures and the Btp Futures are standardised, exchange-traded government bond futures that are exclusively available on Eurex. These futures offer various opportunities for hedging, speculation, and arbitrage. On Eurex, buy and sell orders are matched based on price and time priority (central limit order book).

The German government bond futures market is extremely liquid and offers four types of future contracts with underlying bond maturities of two, five, ten, and thirty years. In contrast, the Italian futures market is characterised by two actively traded futures, with underlying bond maturities of three and ten years. Each type of future contract is offered for different expiration dates which occur on a quarterly frequency.

In both markets, trading activity is predominantly concentrated on the contract with the nearest expiration date. Importantly, the trading volume of German futures is around ten times larger than for the cash market. In Italy in contrast, the trading volumes in the cash and futures markets are of comparable size. At the end of Q1-2024, about 6,000 and 2,000 counterparties were active on the German and Italian markets respectively.

In regulated future markets, liquidity provisioning is predominantly facilitated by traditional dealer banks and PTFs, also known as high-frequency traders (HFTs). For Bund and Btp futures, each of these firms play a very dominant role, both in terms of number of trades and trading volume. These entities are essential for ensuring market stability and efficiency by providing liquidity and thereby facilitating price discovery in the underlying cash markets.

While PTFs liquidity provisioning occurs mainly intraday, dealer banks are more inclined to take overnight risks, highlighting the different risk appetites and trading strategies between these two types of liquidity providers. On the demand side, liquidity is primarily sought by asset managers, hedge funds, ICs and PFs, and other non-bank investors, collectively referred to as buy-side investors.

5 Some selected deep dives on the two markets

5.1 The role of 'inelastic investors' in the Italian MTS repo market

Rates in euro area repo markets have been affected by the implementation of non-standard monetary policy measures by the Eurosystem (see Section 2). In normal conditions, absent market frictions, repo rates should track the ECB's policy rates. However, the expansion of central banks' reserves, including through the use of asset purchase programmes (e.g. the Asset Purchase Programme and the Pandemic Emergency Purchase Programme), contributed to reduce banks' need for short-term funding. This effectively decreased the use of repo markets for liquidity management purposes (general collateral, GC segment) and increased their use for security management needs (special repo, SR segment).[10] The unprecedented levels of excess liquidity exerted downward pressure on money market rates, including in secured markets where rates declined also as a reflection of the overall lower collateral supply (scarcity). Especially for the safest forms of collateral, borrowing specific securities was associated with a premium (specialness).[11] The existence of a premium has a number of important implications, which go beyond the smooth transmission of monetary policy. Specialness in fact has been linked to more frequent fail-to-deliver episodes in repo markets (Corradin and Maddaloni, 2019), to frictions in bond market intermediation via a higher bid-ask spread (Huh and Infante, 2021), to higher volatility in secured money market rates (Heider *et al.*, 2015).

Based on SFTR data, we see that since the beginning of 2021 it has been relatively more expensive to source German compared to Italian collateral on repo markets, with particular pressures on rates at year-ends (Figure 3). The premium in this case is measured by looking at the difference between repo rates and the deposit facility rate (DFR).[12] Scarcity reached a first peak in September 2022, surging again by the end of the year and at beginning of 2023, when about 80 per cent of repos collateralised with German government bonds were traded with a premium

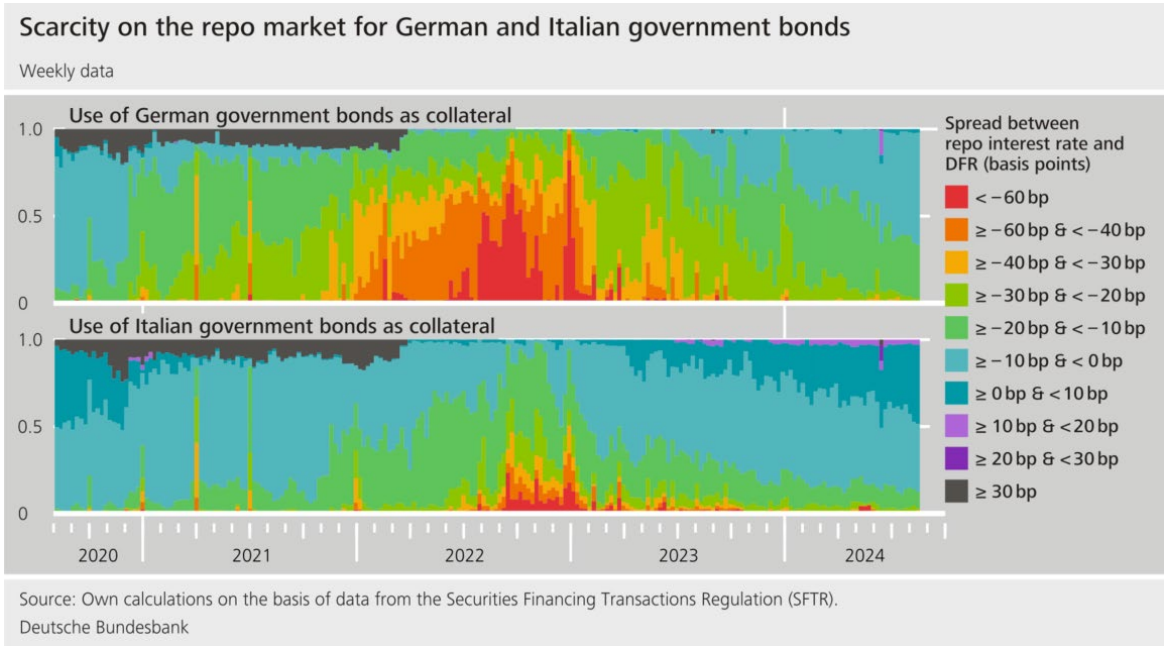
[10] In GC transactions, funds can be exchanged against any security included in a basket of government bonds. By contrast, in SRs, precisely determined government bonds are requested to collateralize the exchange of funds.

[11] Other possible factors may have affected the large demand of investors' safe assets. The phasing-in of Basel 3 liquidity requirements, which started in 2015, may have exacerbated these frictions (ECB 2023). Some studies have also suggested the existence of 'country-specific channels' – acting on top of bond-specific issues – which affected in particular some jurisdictions, including Germany but not Italy (Brand *et al.*, 2019). Ferdinandusse *et al.* (2020) report that core countries in the euro area tend to have a higher share of preferred habitat investors, and consequently tend to suffer more for the scarcity problem from central bank asset purchases.

[12] We use the DFR instead of the GC rate as over the period considered the vast majority of German government securities were scarce and therefore even the German GC baskets were traded with a scarcity premium. Thus, using the German GC rate as benchmark would most likely underestimate scarcity.

amounting to at least 60 basis points. In the same period, for repos backed by Italian sovereign collateral the share of trades with such a premium was significantly lower (around 17 per cent). Interestingly, following the QT implied progressive scaling back of the Eurosystem's presence on financial markets, the size of the premium for German government bonds has fallen significantly.[13] As of August 2024, only a minor fraction of the trades having German collateral is executed with an absolute spread of more than 20 basis points (less than 5 per cent) but almost all transactions still occur at negative spreads. Also, the premium paid to get Italian collateral is now less pronounced.

Figure 2



As documented in Arrata *et al.* (2020), the premium may also be affected by the investor base. Holdings of bonds by so-called 'inelastic investors' may have an impact on repo rates. This hypothesis has been tested on the repo market for Italian government bonds, considering one-day maturity transactions executed on the MTS Italy Repo platform over the period January 2016 - December 2023.[14] Over this interval, these transactions account, on average, for more than 90 per cent of total turnover. Following Arrata *et al.* (2020), we consider ICs and PFs, HHs

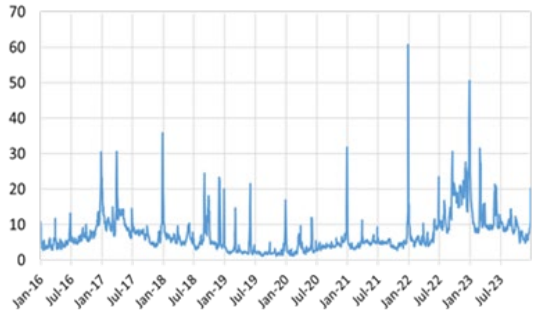
[13] Next to QT there have been other factors that mitigated the scarcity of government securities. The German Finance Agency has increased own holdings of German government securities and uses them to increase supply of these securities on the repo market. (see Bericht über die Kreditaufnahme des Bundes 2023 (bundesfinanzministerium.de). In Italy, the Ministry of Economy and Finance has started its activity on repo markets in May 2021 (see: Launch of the repurchase agreements (Repo) activity: a new instrument for managing Treasury cash liquidity - MEF Department of Treasury). Furthermore, the Eurosystem decided to relaxed the limits of its security lending facility for its holdings (Securities lending of holdings under the asset purchase programme (APP) and pandemic emergency purchase programme (PEPP) (europa.eu)).

[14] In particular, we consider overnight, spot-next and tom-next transactions conducted on the MTS Repo Italy platform.

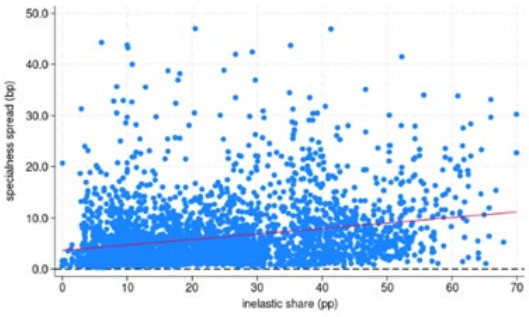
and NFCs to be 'inelastic investors'.[15] We then compute the share of Italian outstanding government debt held by this group, by making use of sector-by-sector holdings data in the ECB Securities Holdings Statistics database. The footprint of 'inelastic investors' on the Italian government bond market is material, as over the sample period they held on average almost a quarter of the total outstanding amount of Italian government securities. Following Duffie (1996), we use the spread between the GC and the SR rate (*specialness*).[16] The average volume weighted degree of specialness on the MTS Italy repo market over the reference period is shown in Figure 4, panel a. A simple correlation analysis indicates that the share of debt held by 'inelastic investors' may have a role in explaining the degree of specialness on the Italian MTS repo market (Figure 4, panel b).

Figure 4

(a) Specialness on Italian MTS Repo market



(b) Specialness and inelastic investors share



Source: Banca d'Italia calculations based on data from MTS Repo Italy, ECB SHSS. In line with Duffie (1996), we measure specialness at security-level by taking the difference between the general collateral and the special repo rates at daily frequency.

To better investigate the role of 'inelastic investors' on the repo market for Italian government bonds, we run a panel analysis where specialness is regressed against the share of 'inelastic investors' together with a large set of control variables. The baseline specification is the following:

$$specialness\ spread_{it} = \beta InelasticShare_{it-1} + \gamma_2 X_{it} + \theta_i + \varepsilon_{it} \qquad (1)$$

The *specialness spread* is the daily difference between the GC and the SR rate for each bond *i* in day *t*. The key variable of interest is *InelasticShare*, which is the share of security *i* held by

[15] The category of 'elastic investors' include banks, IFs, OFIs, non-euro area investors and the Italian Government. As the Italian Ministry of Economy and Finance is active in the Italian sovereign repo market, we categorize the domestic government sector into this group.

[16] During the reference period, the Italian GC rate hovered around the DFR, so using the GC rate rather than the DFR does not significantly affect the results. In contrast, the use of the GC rate allows to absorb daily time-varying factors common to all Italian government securities.

inelastic investors; this variable relies on quarterly data from SHSS and is computed considering holdings at the previous quarter-end *(t-1)* to mitigate possible endogeneity issues.[17] *X* includes a set of potential determinants of the spread, bond characteristics and market wide factors, traditionally used in the literature.[18] The baseline includes security fixed effects, while time fixed effects are added in subsequent specifications. Our estimates show that the investors' base in the Italian government bond market matters for the repo segment. An increase of 10 percentage points in the bond holdings of 'inelastic investors' can be associated with a higher premium of about 3.7 basis points in the repo market (Table 1, column 1), which represents about 40 per cent of the standard deviation in the analysed period. The magnitude of the effect remains broadly similar when we include time fixed effects (column 2) – which absorb time-invariant factors – and by distinguishing between the inelastic share of domestic and foreign investors (column 3). Consistent with our expectations, we find that *specialness* is higher for CTD bonds, as well as for those that are eligible under the PSPP and PEPP. In line with the literature, we also find that specialness is on average higher in the last day of a quarter, when banks engage in window dressing to fulfil regulatory requirements (Munyan, 2015; Duffie and Krishnamurthy, 2016; Klee *et al.*, 2016).

[17] Quarterly SHSS data are merged with the daily MTS data by keeping sectors' holdings constant for all the days in a given quarter.

[18] To control for bond level features, we consider the following variables: *cheapest-to-deliver* (CTD), which is a dummy equal to 1 if bond *i* is the cheapest-to-deliver (CTD) in the Btp futures market in day *t*; *PSPP-Eligible* and *PEPP-Eligible*, which are dummy variables equal to 1 if bond *i* is eligible in *t* for the respective asset purchases programme; *Time-to-Maturity* for each bond *i* to account for the existence of a liquidity premium for the most recently issued bonds. To control for market-wide factors, we include the following regressors: *EndQuarter*, which is a dummy equal to 1 at the last day of a quarter, to control for window dressing effects; *ExcLiquidity*, which is the logarithm of the Eurosystem excess liquidity to account for monetary policy effect; *OIS1Y-DFR*, which is the spread between the 1-year overnight indexed swap (OIS1Y) and the DFR to account for investors' monetary policy expectations; *SecurityLendingMTS*, which is a dummy equal to 1 after July 2019 when the Banca d'Italia allowed securities lending activity on the MTS Repo platform.

Table 1: main determinants of specialness in the Italian government bond market

	(1)	(2)	(3)
	Specialness spread	Specialness spread	Specialness spread
InelasticShare	0.3667***	0.3293***	
	(0.0000)	(0.0000)	
CTD	0.0381***	0.0407***	0.0406***
	(0.0010)	(0.0001)	(0.0001)
Time-to-Maturity	-0.0012	-0.0394	-0.0395
	(0.4164)	(0.1720)	(0.1709)
EndQuarter	0.0832***		
	(0.0000)		
OIS1Y-DFR	0.0444***		
	(0.0000)		
ExcLiquidity	0.0180***		
	(0.0003)		
PSPPEligible	0.0129***	0.0078**	0.0079**
	(0.0006)	(0.0355)	(0.0352)
PEPPEligible	0.0151***	0.0065	0.0065
	(0.0000)	(0.2973)	(0.2948)
SecurityLendingMTS	-0.0196***		
	(0.0000)		
InelasticShareItalian			0.3224***
			(0.0000)
InelasticShareEA			0.3794***
			(0.0017)
Security FE	Yes	Yes	Yes
Time FE	No	Yes	Yes
Adj. R-squared	0.3858	0.5060	0.5060
Observations	206097	206097	206097

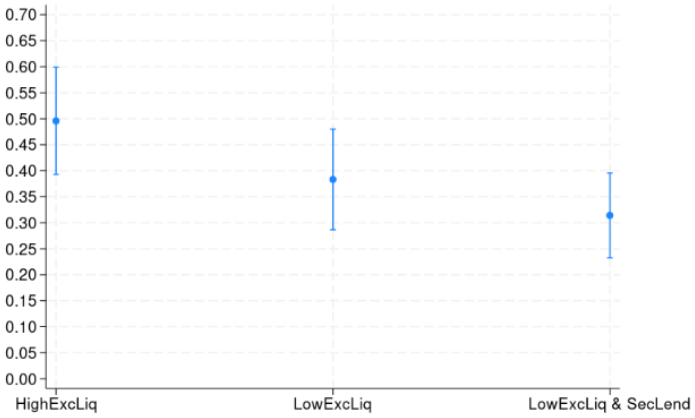
Notes: Banca d'Italia calculations. Column (1) shows the results of Eq. (1). In column (2) we add time fixed effects. In column (3) we split *InelasticShare* into the share held by domestic inelastic investors (*InelasticShareItalian*) and that held by inelastic investors resident in other euro area countries (*InelasticShareEA*). The dependent variable in each column is *Specialness spread*, which is the daily difference between the general collateral rate and the special repo rate (expressed in basis points). Standard errors are clustered at the security level. *p*-values in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Also when investors expect a monetary policy tightening (i.e. the *OIS1Y-DFR* spread is positive) specialness increases, as investors take short positions on government bonds using the repo market to procure the shorted securities. This result is consistent with previous analyses, finding that short-positioning in bond market aggravates stress in repo rates (ECB, 2023). In line with our expectations, excess liquidity contributes to more specialness, owing to the fact that a large amount of liquidity, either via MRO/LTRO or asset purchases, leads to a lower

collateral availability. Finally, the shift towards a more flexible securities lending facility, directly activated on the MTS Italy Repo platform, contributed to reduce pressure on repo rates.[19]

In subsequent specifications, we focus on how the impact of inelastic investors on specialness varies depending on monetary policy expectations and market conditions.[20] Under the hypothesis that market expectations are tilted towards a tightening of monetary policy (i.e. a 1 percentage point increase of the OIS1Y-DFR spread), we estimate the impact of a 1 percentage point change in the share of inelastic investors on repo specialness (β) under three scenarios (Figure 5): i) high excess liquidity, ii) low excess liquidity and iii) activation of a direct securities lending in a context of low excess liquidity. When investors expect a tightening of monetary policy during a period of high excess liquidity, a 1 percentage point rise in the *InelasticShare* would lead to an increase of about 0.5 bps in specialness. Holding all else equal, the impact on specialness would decline to about 0.4 bps when the excess liquidity is low and to 0.3 bps when the excess liquidity is low and a direct securities lending facility is activated.

Figure 5: the impact of a 1 p.p. change in the share of inelastic investors on repo specialness when the OIS1Y-DFR spread is equal to 1 p.p. across different scenarios



Notes: Banca d'Italia calculations. for each scenario, the marginal impact of a 1 p.p. change in the share of inelastic investors on repo specialness when *OIS1Y-DFR* is equal to 1 percentage point is computed by relying on the corresponding coefficients of Eq. (1) estimated by interacting *InelasticShare* with, respectively, OIS1Y-DFR, *HighExcLiquidity*, which is a dummy equal to 1 when the level of excess liquidity is above the median, and *SecurityLendingMTS*.

5.2 Bond Future Liquidity: The role of PTFs vs. Dealer Banks

The recent crisis episodes, including the COVID-19 pandemic, the Ukraine conflict, and the Gilt crisis in the UK, have led to spikes in market volatility, significantly impacting the trading behaviour of investors. The eurozone future market, which is particularly reliant on PTFs for

[19] The Banca d'Italia Securities Lending (SL) facility was launched in 2015. Securities were initially offered exclusively via the main international central securities depositories. Since July 2019, the Banca d'Italia has been lending government securities (purchased under the PEPP, PSPP and SMP) directly to market counterparties. Lending can take place on the MTS Repo platform, following registration with the Italian central counterparty Euronext Clearing, or bilaterally.

[20] Specifically, we estimate equation (1) by interacting the InelasticShare variable with the OIS1Y-DFR, the HighExcLiquidity, which is a dummy equal to 1 when the level of excess liquidity is above the median, and *SecurityLendingMTS*.

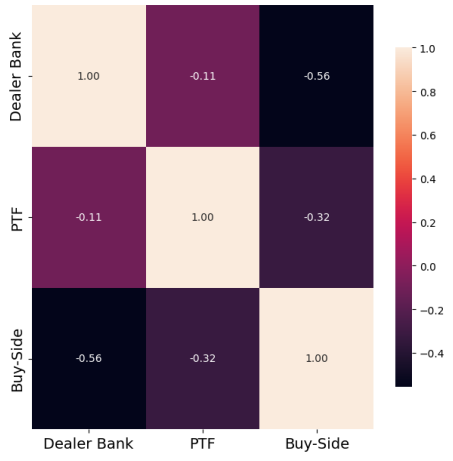
market functioning, provides a compelling context to analyse the role of different liquidity providers during these turbulent periods. During the initial outbreak of the COVID-19 pandemic, there was a significant increase in trading volumes of Bund and Btp futures. The rise can be attributed to the heightened uncertainty and volatility caused by the pandemic, prompting investors to readjust risk exposures to navigate the turbulent market conditions. Hence, the COVID-19 shock provides an interesting laboratory to study liquidity provisioning during a crisis. To this purpose, we correlate daily net trading flows on Btp and Bund futures at the aggregate level before and during the COVID-19 outbreak. We cluster entities by considering the following sectors: dealer banks, PTFs, and buy side investors, typically represented by asset managers and other financial institutions. The period from February 20, 2020, to March 20, 2020, characterised by a marked increase in uncertainty as measured by the VIX, is designated as the COVID-19 period. The pre-COVID-19 period is represented by trading activities during 2019.

Figure 6 illustrates the daily net correlations (net buying) among dealers, PTFs, and buy side investors. In the Bund future market, dealer banks exhibit in both periods (pre- and during COVID-19) a negative correlation with the buy-side. This means that when end-investors are buying, dealer banks are typically selling, thereby facilitating market clearing and acting as liquidity providers for end-investors. PTFs also show a negative correlation with the buy-side and weak negative correlation with dealer banks. This behaviour can be attributed to their dual trading strategy, as PTFs typically both demand and supply liquidity; our finding suggests that in normal times the latter function presumably dominates. The negative correlation with buy-side investors shows that liquidity provisioning across days is substantial. In the Italian futures segment dealer banks also consistently absorb net trading flows on a daily basis, underscoring their role as reliable liquidity providers. Similarly to the German Bund futures, the daily net correlation between PTFs and dealer banks is weakly negative; in contrast, the correlation between PTFs and the buy-side is weakly positive. This again highlights that PTFs may adopt multiple trading strategies, conditional on the market where they are operating, rather than taking a fixed role in the market.

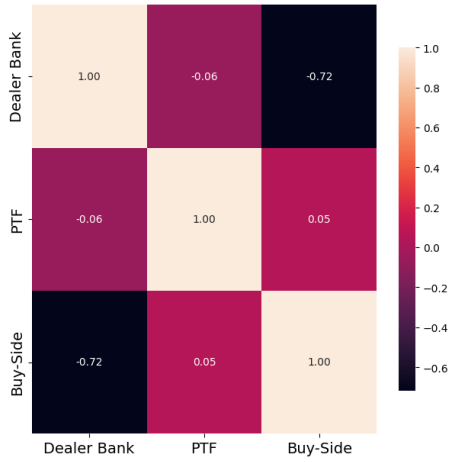
Figure 6

Trading before COVID-19

(a) Bund Future



(b) Btp Future



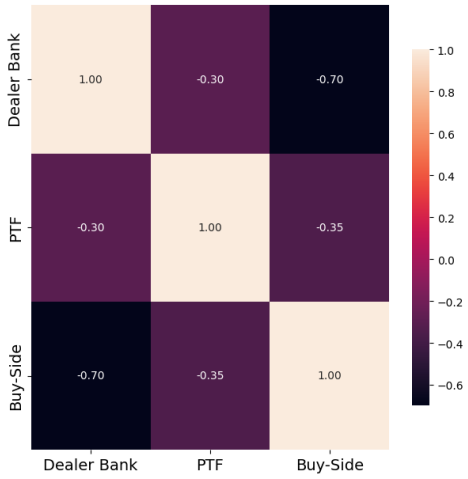
Source: Deutsche Bundesbank calculations based on MiFIR data. We show daily aggregate net trading flows between sectors, between February 20, 2020 and March 20, 2020.

Figure 7 shows the correlation during the COVID-19 period. For Bund futures, the correlations remained largely unchanged, with especially dealers absorbing the liquidity demand of the buy-side. Similarly, in the Italian segment, there is no significant evidence that the COVID-19 market turmoil altered trading behaviour. As observed in normal times, the role of PTFs in the Btp market for cross-daily liquidity provisioning appears negligible also in this case.

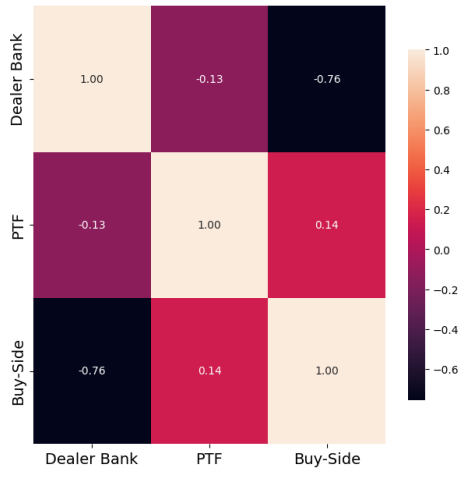
Figure 7

Trading during COVID-19

(a) Bund Future



(b) Btp Future



Source: Deutsche Bundesbank calculations based on MiFIR data. We show daily aggregate net trading flows between sectors for 2019.

However, it is important to note that most liquidity provisioning occurs intraday, and this analysis only illuminates across-day liquidity provisioning. The latter could be particularly crucial

during a crisis when market participants systematically engage in one-sided trades. That is, if liquidity providers can ensure that there is enough liquidity over several days, it helps stabilise the market even when there is a surge in one-sided trades. When the initial shock of the COVID-19 pandemic subsided, level of trading turnover returned to normal, highlighting the resilience of the futures market in adapting to unprecedented global events.

Recent trends since the beginning of 2022 indicate a shift in the market dynamics for both German and Italian futures. In Germany, there has been a marked increase in the popularity of short-term contracts compared to long-term ones. This trend indicates a growing investor preference for shorter maturities, likely driven by changing market expectations about monetary policy and the higher rates environment. In Italy, both short and long-term futures have seen an increase in open interest (outstanding amounts), reflecting heightened market activity and investor interest in Italian government bonds.

6 Conclusions

The joint project of the Bundesbank and the Banca d'Italia examines the German and Italian government bond markets, with a special focus on liquidity and on the role played by banks *vs.* non-banks. The results thus far provide a deeper insight into the main features of both markets, enhancing the understanding of government bond market dynamics, investor behaviour, and liquidity and providing insights for policymakers and market participants.

First, the holder structure of German government bonds shows a large share of foreign investors and IFs. How and to what extent foreign investors and NBFIs are involved is a significant feature for the price discovery and liquidity of government bond markets. The high share of foreign investors across countries leads to diversified holdings of German government bonds and therefore creates additional demand, also in the event of changing market conditions. However, it may temporarily increase market price volatility due to potential international contagion. By contrast, a large portion of Italian government bonds is held by domestic investors. In Italy the relatively high share of domestic investors, mostly characterised by buy-and-hold strategies, tends to favour stability. On the other hand, a particularly high presence of domestic holders leads to a higher level of interconnectedness within an economy.

Second, the market structure of the two government bond cash markets is very different. While investors typically use OTC trading for German government bonds, Italian ones are mostly exchanged on a regulated electronic platform, where trades are centrally cleared. These trading mechanisms can each come with a range of trade-offs, most likely to be related to efficiency, transparency, trading costs, and availability of information, especially in economically uncertain times. Despite the two markets have very diverse trading and settlement arrangements in place, they are both well-functioning and have proved always resilient also during turbulent periods. It is therefore not straightforward to derive conclusions in terms of resilience enhancing policies, which tend to be context-specific and jurisdiction-dependent (FSB, 2022).

Third, NBFIs have an important footprint in government bond markets. The implications for financial markets may be wide-ranging, depending on the categories of non-banks holding government bonds. For the Italian repo market, we have seen that the presence of inelastic investors, which include ICs and PFs (among others), may have an effect on collateral scarcity in the repo markets. The reason for this is that such investors are less likely to lend their bonds in the repo market, making these bonds less readily available. At the same time, these investors typically adopt buy-and-hold strategies and are less prone in times of volatility to engage in trading. Understanding whether and how these 'inelastic investors' could be encouraged to participate more actively in the repo market, since lending scarce government bonds would be profitable for them, could be useful.
Fourth, we examine the futures market, where government bonds are heavily traded and thus represent a crucial node in price discovery. We look at the role of PTFs and dealer banks as liquidity providers during the COVID-19 pandemic. We provide insights that dealer banks in both the German and Italian futures markets did not stop acting as reliable liquidity providers during the COVID-19 outbreak; in contrast PTFs may adopt multiple trading strategies, conditional on the market where they are operating, rather than taking a fixed role.

To conclude, liquidity conditions on government bond cash, repo and futures markets depend on many factors, including the structure of the markets and investors' behaviour. On top of that, the macro-financial environment is also crucial. To ensure resilience of government bond markets, it is key to have a comprehensive understanding of how these factors behave and interact, especially in times of financial stress. This may not be straightforward, though. Investment funds, for example, are heavily involved in the transaction of government bonds; non euro area entities have a large footprint, especially in German markets. An in-depth study of their investment strategies and reaction behaviour, especially in economically uncertain times, would be necessary to fully understand market dynamics and potential risks. This requires the use of more granular data at the security-investor level, which however are not always available, especially in the case of foreign (non euro area) investors. To enhance risk monitoring and resilience, it is crucial to close data gaps that may limit the full comprehension of the relevant factors affecting liquidity in government bond markets.

References

Abbassi, P., Iyer, R., Peydró, J. and Tous F. R., 2016. Securities trading by banks and credit supply: Micro-evidence from the crisis, Journal of Financial Economics, vol. 121, issue 3, pp. 569 – 594.

Aiyagari, S. R. and Gertler, M., 1985. The backing of government bonds and monetarism, Journal of Monetary Economics, vol. 16, issue 1, pp. 19 – 44.

Alexander, P. Fakhoury, R. Horn, T., Panjwani, W. and Roberts-Sklar, M., 2023. Financial stability buy/sell tools: a gilt market case study, Bank of England Quarterly Bulletin 2023.

Arrata, W., Nguyen, B., Rahmouni-Rousseau, I. and Vari, M., 2020. The scarcity effect of QE on repo rates: Evidence from the euro area. Journal of Financial Economics, vol. 137, pp. 837-856.

Aquilina, M., Scheicher M. and Schrimpf, A., 2024. Central clearing in government bond markets: keeping the "safe asset" safe?, Bis Bulletin No. 92.

Azzimonti, M. and Yared, P., 2019. The optimal public and private provision of safe assets, Journal of Monetary Economics, vol. 2019, issue C, pp. 126 – 144.

Bank of International Settlements (BIS), 2022. Market dysfunction and central bank tools, Market Committee.

Bianchi, M.L. and Ruzzi, D., 2023. Shifting the yield curve for fixed-income and derivatives portfolios, preprint.

Bianchi, M. L., Sorvillo, B., Ruzzi, D., Apicella, F., Abate, L. and Del Vecchio, L., 2025. EMIR data for financial stability analysis and research, IFC Bulletin.

Bonner, C., 2016. Preferential Regulatory Treatment and Banks' Demand for Government, Journal of Money, Credit and Banking, vol. 48, issue 6, pp. 1195 – 1221.

Brand, C., Ferrante, L. and De Fraisse, A. H., 2019. From Cash- to Securities-Driven Euro Area Repo Markets: The Role of Financial Stress and Safe Asset Scarcity. ECB Working Paper No. 2232 (2019) ISBN 978-92-899-3494-7.

Brunnermeier, M. K. and Pedersen, L. H., 2009. Market Liquidity and Funding Liquidity. The Review of Financial Studies, vol. 22, pp. 2201–2238.

Campbell, J. Y. and Kyle, A., 1993. Smart Money, Noise Trading and Stock Price Behavior, The Review of Economic Studies, vol. 60, No. 1, pp. 1-34.

Carrera de Souza, T. and Hudepohl, T., 2024. Frictions in scaling up central bank balance sheet policies: How Eurosystem asset purchases impact the repo market. Journal of Banking & Finance, vol. 158, 107037.

Chatterjee, U. K., 2015. Bank liquidity creation and asset market liquidity. Journal of Financial Stability, vol. 18, pp. 139-153.

Clancy, D., Dunne, P. G., and Filiani P., 2019. Liquidity and Tail-Risk Interdependencies in the Euro Area Sovereign Bond Market, European Stability Mechanism, Working Paper Series No. 41, vol. 2019.

Committee on the Global Financial System (CGFS), 1999. Market liquidity: research findings and selected policy implications, CGFS Papers No. 11.

Committee on the Global Financial System (CGFS), 2017. Repo market functioning, CGFS Papers No. 59.

Costantini, M. and Sousa, R. M., 2022. What uncertainty does to euro area sovereign bond markets: Flight to safety and flight to quality, Journal of International Money and Finance, vol. 122.

Corradin, S. and Maddaloni, A., 2019. The Importance of Being Special: Repo Markets During the Crisis, Journal of Financial Economics.

Curfman, C. J. and Kandrac, J., 2022. The Costs and Benefits of Liquidity Regulations: Lessons from an Idle Monetary Policy Tool, Review of Finance, vol. 26, issue 2, pp. 319–353.

Czech, R., Gual-Ricart, B., Lillis, J. and Worlidge J., 2021. The role of non-bank financial intermediaries in the ‘dash for cash’ in sterling markets, Bank of England, Financial Stability Paper No.47.

D'Amico, S., Fan, R. and Kitsul, Y., 2018. The Scarcity Value of Treasury Collateral: Repo-Market Effects of Security-Specific Supply and Demand Factors. Journal of Financial and Quantitative Analysis, vol. 53, pp. 2103 – 2129.

De Roure, C., Mönch, E., Pelizzon, L. and Schneider, M., 2024. OTC Discount. Leibniz Institute for Financial Research SAFE Working Paper Series, No 298.

Deutsche Bundesbank, 2022. Financial Stability Review.

De Long, J. B., Shleifer, A., Summers, L. H., Waldmann R. J., 1990. Noise Trader Risk in Financial Markets, The Journal of Political Economy, vol. 98, No. 4, pp. 703-738.

Duffie, D., 1996. Special Repo Rates. The Journal of Finance, vol. 51, pp. 493-526.

Duffie, D., Garleanu, N. and Pedersen, L. H., 2005. Over-the-Counter Markets. Econometrica, vol. 73, pp. 1723-2038.

Duffie, D. and Krishnamurthy, A., 2016. Pass-Through Efficiency in the Fed's New Monetary Policy Setting

Duffie, D., 2020. Still the world's safe haven? Redesigning the U.S. Treasury market after the COVID-19 crisis. Hutchins Center Working Paper No. 62.

Duffie, D., 2023. Resilience Redux in the U.S. Treasury Market. Stanford University Graduate School of Business Research Paper No. 4552735.

Dufour, A., Stancu, A. and Varotto, S., 2017. The equity-like behaviour of sovereign bonds. Journal of International Financial Markets, Institutions and Money, Vol. 48, pp. 25-46.

European Securities and Markets Authority (ESMA), 2024. EU Securities Financing Transactions markets 2024, ESMA Market report.

European Central Bank (ECB), 2021. Assessing the efficacy, efficiency and potential side effects of the ECB's monetary policy instruments since 2014, ECB Strategy Review, Occasional Paper Series.

European Central Bank (ECB), 2023. Money market trends as observed through MMSR data; Euro money market study 2022.

Elliott, D. J., 2015. Market Liquidity: A Primer. Economic Studies at Brookings

Eren, E. and Wooldridge, P., 2021. Non-bank financial institutions and the functioning of government bond markets, BIS Paper No. 119.

Federal Ministry of Finance, 2023. Kreditaufnahmebericht des Bundes 2023, available online at https://www.bundesfinanzministerium.de/Content/DE/Downloads/Broschueren_Bestellservice/kreditaufnahmebericht-2023.pdf?__blob=publicationFile&v=2.

Ferdinandusse, M., Freier, M. and Ristiniemi, A., 2020. Quantitative Easing and the Price-Liquidity Trade-Off. ECB Working Paper No. 20202399.

Financial Stability Board (FSB), 2022. Liquidity in Core Government Bond Markets. FSB Report.

Friedman, M., 1953. The methodology of positive economics.

Gorton, G., 2017. The History and Economics of safe assets, Annual Review of Economics, 9: 547-86.

Goyenko, R. Y. and Ukhov, A. D., 2009. Stock and Bond Market Liquidity: A Long-Run Empirical Analysis. Journal of Financial and Quantitative Analysis, vol. 44, pp. 189 – 212.

Greppmair, S. and Jank, S., 2023. Collateral Scarcity and Market Functioning: Insights from the Eurosystem Securities Lending Facilities. Deutsche Bundesbank Discussion Paper No. 31/2023.

Hanson, S. G., Lucca, D. O. and Wright, J. H., 2018. Rate-Amplifying Demand and the Excess Sensitivity of Long-Term Rates. FRB of NY Staff Report No. 810.

Hanson, S. G., Shleifer, A., Stein, J. C. and Vishny, R. V., 2015. Banks as patient fixed-income investors. Journal of Financial Economics, vol. 117, pp. 449-469

He, Z., Khang, I. G. and Krishnamurthy, A., 2010. Balance Sheet Adjustments in the 2008 Crisis. NBER Working Paper No. 15919.

He, Z. and Krishnamurthy, A., 2013. Intermediary Asset Pricing. American Economic Review, vol. 103, no. 2, pp. 732–70.

Huh, Y. and Infante, S., 2021. Bond market intermediation and the Role of Repo. Journal of Banking & Finance, vol. 122, 105999.

Hüser, A., Lepore, C. and Veraart, L. A. M., 2024. How does the repo market behave under stress? Evidence from the COVID-19 crisis.

Heider, F., Hoerova, M. and Holthausen, C., 2015. Liquidity Hoarding and Interbank Market Spreads: The Role of Counterparty Risk, Journal of Financial Economics (JFE), vol. 118, pp. 336-354.

Jank, S. and Mönch, E., 2018. The impact of Eurosystem bond purchases on the repo market. Deutsche Bundesbank, Research Brief.

Kerssenfischer, M. and Helmus, C. (2024). Outages in sovereign bond markets. ECB Working Paper Series, No 2944.

Klee, E., Senyuz, Z. and Yoldas, E., 2016. Effects of Changing Monetary and Regulatory Policy on Overnight Money Markets, Finance and Economics Discussion Series 2016-084. Washington: Board of Governors of the Federal Reserve System.

Kyle, A. S., 1985. Continuous Auctions and Insider Trading, Econometrica, vol. 53, issue 6, pp. 1315 – 1336.

Manganelli, S. and Wolswijk, G., 2009. What drives spreads in the euro area government bond market?, Economic Policy, vol. 24, issue 58, pp. 191–240,

Meyer, J., Reinhart, C., and Trebesch, C., 2019. Sovereign Bonds Since Waterloo, CEPR Discussion Paper No. DP13514.

Munyan, B. K., 2015. Regulatory Arbitrage in Repo Markets. Office of Financial Research Working Paper No. 15-22.

Naik, N. Y. and Yadav, P. K., 2003. Trading Costs of Public Investors with Obligatory and Voluntary Market-Making: Evidence from Market Reforms.

Organisation for Economic Co-operation and Development (OECD), 2024. Global Debt Report 2024: Bond Markets in a High-Debt Environment.

Panzarino, O., 2023. Investor Behavior Under Market Stress: Evidence from the Italian Sovereign Bond Market, Banca d' Italia Working Paper No. 33.

Panzarino, O., Potente F. and Puorro, A., 2016. I BTP futures and cash relationships: a high frequency data analysis, Banca d' Italia Working Paper No. 1083.

Pelizzon, L., Subrahmanyam, M.G., Tomio, D. and Uno, J., 2016. Sovereign credit risk, liquidity, and ECB intervention: Deus ex machina? Journal of Financial Economics, vol. 122, pp. 86 – 115.

Timmer, Y., 2018. Cyclical Investment Behavior Across Financial Institutions, ESRB: Working Paper Series No. 2018/77.

Appendix

A A preliminary analysis from Banca d'Italia on "The impact of a yield curve shift on investors in the German and Italian government bond markets" [21]

In this section, we analyse the potential impact of an increase in the entire yield curve on the exposure of different categories of investors in the Italian and German government bond markets.[22] More specifically, we take a comprehensive view of the interlinked cash, repo and futures segments by considering together the risk stemming from: i) direct investments (or holdings), ii) exposures in repos where these bonds are used as collateral, and iii) exposures in government bond futures. Following a rise in interest rates, investors face lower values on their bond holdings and potential variation and collateral margin calls on their derivatives and repo transactions. In such circumstances, intermediaries may face liquidity pressures and decide to sell their holdings and/or unwind their repo and derivatives positions, thus further depressing prices in financial markets. This was seen for instance in UK in September 2022, when liability-driven IFs facing large collateral and margin calls tried to sell considerable amounts of gilts to raise cash, and as a results intermediation began to break down and market functioning deteriorated. In this section, building on the sectoral mapping of the main players in the three segments, we estimate aggregate potential losses when they are confronted with a sizeable interest rate change. In addition, we examine the degree of interconnectedness across sectors based on the simulated margin calls that would hit repo and future exposures in the adverse scenario. Our exercise provides insights to assess the distributional effects of interest rate risk materialisation and cross-sectoral linkages.

Drawing on Bianchi and Ruzzi (2023), we consider a 100 basis points parallel upward shift of the yield curve ('adverse scenario') and estimate profits and losses that originate on investor positions (i.e. cash market, repo market, future market).[23] The mechanism generating economic losses is plain: an upward shift of the yield curve leads to a decrease in the market value of the underlying bonds, therefore resulting in a loss (or a margin call) for those having a long position in cash bond holdings, a positive net borrowing of cash in the repo market and a positive net exposure in futures.[24] Conversely, investors who benefit from the shock are those holding a negative net exposure in futures, a negative net borrowing position of cash and a short position

[21] This section rests on an additional analysis conducted and drafted by co-authors from Banca d'Italia under the umbrella of the joint work.

[22] The focus of the analysis is on all bonds issued by the central government of Italy and Germany. In some cases, we simply refer to Btp and Bund.

[23] For the type of investments considered, upward and downward parallel shifts in the yield curve are roughly symmetric, meaning that the impact of a 100 basis points parallel downward movement is roughly the opposite of an upward shift with the same magnitude. We assume that the shock is instantaneous and does not affect the issuers' credit risk. To put the 100 basis point shock into perspective, this value is more than three times larger than any single-day moves of 12-month Euribor rates in history. Although extremely unlikely within a day, a 100 basis point move in rates may be observed over longer time horizons like the two-month periods in the second half of 2022 in our sample.

[24] This statement holds when exposures are measured in terms of interest rate risk (sensitivity).

in cash bond holdings. [25] Exposure to Italian and German government bonds is computed at sector level for the whole euro area; we also map the exposures of outside euro area investors, although sectorial level data for this category is not available. While we consider financial and non-financial sectors, we focus our attention on the former group (i.e. banks, ICs & PFs, and IFs) and on entities outside the euro area (OUT-EA). The effects of the interest change are estimated over the period Q1-2021 to Q1-2024, by computing the difference between the observed value of the positions and their estimated values under the 'adverse scenario'. Importantly, we calculate fair value changes[26] for the whole portfolio of exposures, irrespective of any accounting or prudential rules related to these products.[27] To perform the analysis we consider: i) net long notional exposure on German and Italian government bond futures, available at counterparty level (EMIR data); ii) net borrowing of cash in repo transactions having German and Italian government bond as collateral, available at counterparty level (SFTR data); iii) market value of German and Italian government bond holdings, available at sectorial level (SHSS data). In the case of derivatives and repos, we integrate the above metrics by also considering the overall amount of margins that would be requested without taking into account potential netting effects. This measure simulates the overall liquidity needs under a very conservative hypothesis in which netting is not foreseen, and thus denotes the maximum potential loss originating from the shock.[28]

Our empirical analysis shows that the risks associated with the cash market are greater than those of the futures and repo markets. At the aggregate level we find that the average potential losses on holdings of Italian and German government bonds would be about 2-times larger than the combined losses in futures and repo markets.[29] From a financial stability perspective, losses on all exposures would be manageable – even under the most severe hypothesis, i.e. no netting – as they would represent about 0.3 per cent of all sectors' total assets.

Importantly, these aggregate findings mask some degree of heterogeneity and we cannot exclude that pockets of vulnerability may exist. In the case of German government bonds, entities OUT-EA area would suffer the most, reflecting the large footprint of foreign investors into this segment (see also Section 4); in the case of Italian bonds, ICs & PFs and banks would be the sectors most exposed to the interest rate change. Heterogeneity is especially observed in the activity of euro area banks in the Italian and German government bond markets. While they are

[25] In the future market, a positive (negative) net notional exposure indicates a long (short) future position. In the repo market, when a counterparty is posting collateral to receive cash (i.e. borrowing cash) the net borrowing is positive, otherwise it is negative (i.e. lending cash).

[26] To estimate fair value changes, we perform a full repricing of government bond futures and a partial revaluation, that is a second order approximation based on duration and convexity, of bonds in investors' portfolio and used as collateral in repo transactions.

[27] In the case of cash holdings, for example, the estimated interest rate shock impacts also cover so-called *'unrealized losses'*, namely those losses that would materialize only in the unlikely event that financial intermediaries have to sell these securities. This amount may be relevant for some entities in our sample, for example banks with bonds held in the amortized cost portfolio, although in fact only latent.

[28] In this case, we allow netting only at the counterparty pair level and then we sum, for each counterparty, all the outflows, but not inflows, of margins.

[29] As already noticed, this figure represents an 'upper bound' as accounting rules are not considered. To compute losses on repo and derivatives exposures, we adopt the no-netting hypothesis. Aggregate losses in fact would be almost nihil when netting is allowed, as exposures/losses would net across entities/sectors of the whole system.

mostly long in the former, with Italian banks accounting for the largest share of holdings, exposure to the latter is more diversified and characterised by both long and short positions that balance each other out. Conversely, on both futures and repo markets banks hold in aggregate (and on average) positive net positions but the impact of the yield shift would be heterogeneous. Euro area ICs & PFs have considerable holdings of Italian and German bonds and would suffer significant losses in case of an adverse event; they have in contrast a very limited activity on both future and repo markets. For IFs, exposure in futures changed over time: they held profitable net short positions on government bond futures when rates were increasing fast and since Q3-2023, when the rise of rates stopped, they gradually reversed their net positions on both Italian and German futures markets. Their activity on repo markets is not material and risk exposure is negligible by all measures. In contrast, losses on cash holdings would be similar to those of banks.

As of end of March 2024, IFs represented the main counterparty of banks in the trading of Btp and Bund futures. This can be seen in Figure A, where we show, at sector level, the simulated margin calls that would hit each sector under the adverse scenario and the counterparty sectors that the margins would be paid to.[30]

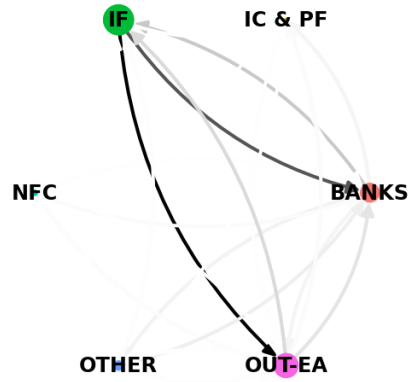
This allows us to visualise the interconnection between sectors and compare the impact of the shock on each sector's positioning in different underlyings (Btp and Bund) and different products (future and repo). In the futures markets, IFs and OUT-EA entities are the most exposed players; visual inspection of the networks reveals that the interconnection is stronger in the Bund futures market than the Btp one. The flow of risk reported in Figure A shows that IFs represent the main counterparty of banks in the trading of Btp and Bund futures, and they would pay margins in case of a shock; at the same time, they have relatively high exposures to OUT-EA entities, with whom margins are exchanged in both ways. In repo markets, in contrast, OUT-EA entities and euro area banks would face the largest margin calls, with margins flowing in both directions. The other sectors considered would be only marginally affected by the shock.

[30] The size of each node and the thickness of each edge are proportional to the margins posted.

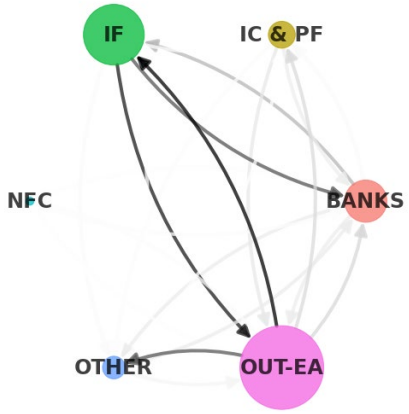
Figure A

Simulated margin calls and directional flows among sectors

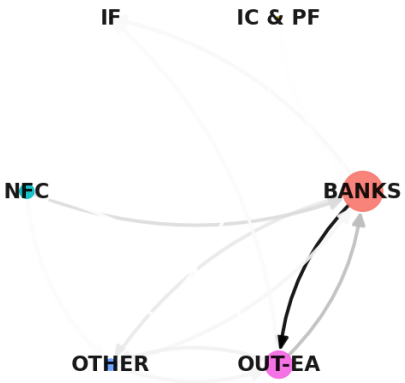
Future on Italian government bonds



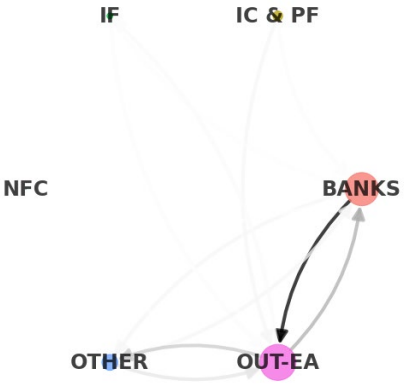
Future on German government bonds



Repo on Italian government bonds



Repo on German government bonds



Source: Banca d'Italia elaboration on EMIR and SFTR data as of end of March 2024. Data are reported at sector level. The size of each node and the thickness of each edge are proportional to the margins exchanged. The arrows point to the sectors that margins are paid to. The colours depict the entity sector: banks (light red), insurance companies & pension funds (goldenrod), investment funds (green), non-financial companies (turquoise), other (sky blue) and outside euro area (magenta).

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