The impact of monetary policy normalisation on secured money markets*

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Abstract

This article provides an empirical assessment of the main factors explaining the widening of repo-DFR spreads in the Euro Area. We focus on the analysis of monetary policy normalisation, using quantitative measures of policy rate hike expectations, uncertainty and demand for high quality assets. Our data is large enough both in terms of time, as covering the Covid crisis and the policy rate hiking cycle, and in terms of individual transactional data, as we identify individual characteristics. We show that the spreading of repo-DFR during 2022 was mostly explained by higher policy rate expectations. Additionally higher effects can be found for non-bank financial institutions (NBFIs) and bonds being on-the-run. Later in 2023, balance sheet reduction and the reassuring of tensions caused by financial markets adjustment to positive rates environment have kept the spread back to previous levels.

Keywords: repo rates; interest rate expectations; monetary policy normalisation; money markets granular data; panel data models.

JEL Codes: E40; E52; C81; C23.

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1 Introduction

Money markets constitute an essential element of financial markets and the main channel through which central banks decisions are transmitted to the financial system as a whole and to the real economy. Deposit-taking institutions and other financial entities make use of them to either obtain short-term funds or place its investments. Additionally, policy rate changes, driven by monetary policy decisions, affect money market rates, which also are conveyed into financial conditions for corporates, financials and households. Therefore, the well-functioning of money markets is crucial for the transmission of monetary policy.

Last years, and more precisely, after the global financial and euro area sovereign debt crises, money markets performance has been transformed. In terms of volume, differences between secured and unsecured markets became larger after the Global Financial Crisis (GFC), when financial participants revealed a preference for collateralized transactions. Currently, repo markets in the euro area have turned into the largest money market segment (Figure 1).

Another relevant factor in the evolution of market participants of money markets is the increasing importance of Non-Banking Financial Intermediaries (NBFIs). Traditionally and especially for Europe, banks were the primary source of funding for other economic agents. Since the GFC, Non-Financial Institutions have increase their participation in credit intermediation and for debt securities holdings.

In terms of rates, a downward trend was observed in money markets, especially for the secured segment. On the one hand, monetary policy rate decisions have been transmitted to the unsecured segment rates immediately (Figure 2), but on the other hand, transmission on secured segment rates has been weaker on the four initial rate hikes (from July 2022), being more complete on the last three movements (from February 2023 onwards). Repo markets have a dual role, where lenders and borrowers of cash transact with lenders of securities. In that sense, repo rates dynamics will be determined by the supply and demand for both cash and collateral. After unconventional monetary policy measures, two main changes emerged in money markets: unprecedented levels of excess liquidity and lower collateral supply, driven by a larger central bank balance sheet. In that context, the demand for collateral exceeded demand for cash, putting downward pressure on repo rates. All in all, this situation led to a shift away from unsecured money markets towards secured money markets but also from cash to security driven (Brand et al., 2019).

The vast majority of literature assessing collateral scarcity rely on the interrelations between unconventional monetary policy and money markets (Carrera de Souza and Hudepohl, 2022), (Arrata et al., 2020) and (Brand et al., 2019), but there is no empirical work on the interactions between monetary policy normalisation and the effects on repo markets. The fact that we are currently experiencing the first historic experience of return to positive rates after a long period of negative rates, poses some challenges for the reaction of financial markets. For that reason, assessing the transmission of monetary policy through money markets is crucial for central bankers. In that sense, it is very important to disentangle the different factors driving the recent widening for repo-DFR spreads in 2022.

The relevance of repo markets can be attributed to collateralized borrowing, but also for financing long bond positions or initiate short selling, as in Dufour and Skinner (2020).

In that vein, we get close to the strands of literature assessing the mechanisms of repo specialness and its determinants. For instance, Dufour and Skinner (2020) study some of the determinants of Italian repo rates over time, which are based on time-varying characteristics of bonds, such as the fact of being recently issued, the volume of trades for a specific bond or the presence of fire sales and volatility, among others. Additionally, Arrata et al. (2020) refer to the relevance of short-selling positions in increasing the demand of particular bonds. In this type of transactions, agents will only be willing to lend a security for a lower rate, compared to transactions on General collateral. Nagel (2016) also stated that when interest rates rise, demand for money-like assets [1] increase. Also, when there is a change in monetary policy expectations, one could expect a higher demand for hedging against additional rate hikes. One way of hedging can be done by buying bond futures and short-selling long-dated bonds. Both of them imply an increasing demand for reverse repos (i.e., borrowing a bond in the repo market) and selling it on the bond market in order to purchase again in after bond prices are down (and interest rates up). Additionally Jappelli et al. (2024) proposed a theoretical model that integrates the term structure of interest rates with the repurchase agreements (repo) market to shed light on the combined

[1] money-like assets include Treasury-bills, certificates of deposit, commercial paper and repo transactions.

effects of quantitative easing (QE) on the bond and money markets. More precisely, they assess repo rates based on the short selling behaviour. Hence, if securities are subject to excess demand, the competition to borrow or buy the bond, lowers repo rates that collateral borrowers can accept. This excess demand is normally related to "special" collateral and required to meet short selling commitments.

We rely on such mechanisms to analyse some of the determinants driving higher demand of collateral in two ways: i) time-varying drivers which can be common to all bonds (i.e. higher monetary policy uncertainty, flight-to-quality episodes, and higher expectations of rate hikes) and ii) bond identifiers, which let us to control for time-invariant specific characteristics. The motivation to take into account both common and time-varying factors driving higher collateral demand is based on the predominance of "specialness" [2] transactions in 2022, which was close to 80% of German repo trades (see ECB (2023)).

Our paper contributes to existing literature about the effects of collateral scarcity in security-driven repo markets, proposing quantitative indicators to measure the shift of monetary policy while controlling for other structural factors, such as the Eurosystem footprint, funding conditions, calendar effects, counterparties differences and collateral characteristics.

Therefore, our addition to the literature is fourfold: we offer a novel approach to quantify the different factors driving collateral scarcity. As stated in (ECB, 2023), one can think of both structural and conjunctural factors altering the demand and supply of collateral and therefore, repo rates (see figure 4 and section 2 for further details). As for conjunctural factors, we distinguish between higher monetary policy uncertainty, flight-to-quality episodes, and higher expectations of rate hikes, all of them putting upward pressure on the demand of sovereign collateral. Being able to disentangle each of the effects is an essential requisite to define, if necessary, most effective measures. Secondly, we construct a novel database to account for differences in repo rates depending on the counterparties involved in the transaction. This contribution is especially relevant given the growing importance of NBFI. Thirdly, we are able to assess the demand of collateral at the ISIN level, not only restricted to special collateral rates, as in Dufour and Skinner

[2] In that case, specialness is gathered from the observed rate of each transaction as compared to the General Collateral rate. We can think of "specialness" being a more general issue when most part of the transactions are reported at a high spread.

(2020) or Brand et al. (2019), but on a broader perspective for all bonds. Last but not least, we revisit some of the previous works studying the links between quantitative easing, asset scarcity and repo rates Arrata et al. (2020), Corradin (2020) or d'Amico and Kitsul (2018), exploring a more recent period of data that compares the Covid-19 event and the tightening cycle.

The remainder of the paper is organized as follows. Section 2 describes the interaction between demand and supply in repo markets, section 3 describes the evolution of repo rates in two episodes: post-pandemic monetary policy easing and normalisation period. Later, sections 4 and 5 respectively describe the methodology and the main results. Section 6 provides some robustness exercises and finally, section 7 concludes.

2 The supply and demand of repo markets in a nutshell

Repo transactions are considered a source of secured funding as they provide liquidity while accepting collateral as guarantee. Hence, they represent a singular part of money markets, where some characteristics could be advertised. Firstly, the specific characteristics of the bond used as collateral contribute to repo rates heterogeneity. These sources of heterogeneity could arise from several attributes of the asset employed as collateral. For instance, (Brand et al., 2019) or (Dufour and Skinner, 2020) have noted the importance of bond-market specific features in repo rates. Secondly, the fact of those transactions being collateralised implies lower rates than the observed in the unsecured money market segment[3].

Moreover, as repo transactions imply the property transmission of the collateral [4] it is possible to identify two primary usages driving repo operations:

Cash-driven transactions: where funding needs are the main objective. In these transactions, as a requisite to offer the cash, the lender accepts any collateral included in a basket of securities (generally known as "*General Collateral*". As funding is the main purpose behind, the

[3]The reference rate for unsecured transactions is the euro short-term rate (€STR), which is the average rate of overnight borrowing transactions.

[4]The definition of repurchase agreement in the MMSR Regulation (EU No.1333/2014 art.1(22)), includes not only repo operations through sale with a repurchase agreement but also pledged operations which imply the right to use the asset.

price of the transaction (repo rate) will be mainly determined by the supply and demand of cash or liquidity in the market.

Security-driven transactions: in that case, the preference for a specific colateral is the motivation to enter into a repo agreement and therefore, the price will be based on the demand and supply of each security. According to the International Capital Market Association (ICMA)[5]: some especific bonds would be considered as "*Special Collateral*", whose category is normally attributed to bonds with high demand, induced by benchmark bonds, recent issues or the possibility to make them deliverable into futures.

Figure 4 summarises the impact of changes in the supply and demand of cash and collateral on repo rates, distinguishing scenarios of high collateral supply (a1) collateral scarcity (a2), ample market liquidity (b1) or low market liquidity (b2). Currently, money markets can be characterized as having excess liquidity (which dampened demand for cash) and collateral scarcity (as there was a huge decline in assets supply amd increasing demand). This situation is illustrated by the combination of scenarios a2 and b1, and leads to a widening of repo-DFR spread, according to what we can observe in Figure 3. This is caused by the willingness of collateral borrowers to accept a lower repo rate (or pay a higher price) for obtaining the asset and relates to the shift from cash to security-driven repo explained in the previous section.

2.1 How each factor could affect demand and supply of collateral

In this section, we briefly explain the main drivers of the supply and demand of collateral and cash. As we explained before, the equilibrium in the repo markets (as in any other markets) would be determined by supply and demand. However, as the objectives to participate in repo markets can be twofold, one need to assess both the supply and demand for cash and collateral.

Regarding the drivers of supply and demand for cash-driven repos, one may think mostly on the funding conditions in money markets: i.e. demand and supply of cash. This will be represented by the right-hand part of figure

[5] see: https://www.icmagroup.org/market-practice-and-regulatory-policy/repo-and-collateral-markets/icma-ercc-publications/frequently-asked-questions-on-repo/3-what-is-the-role-of-repo-in-the-financial-markets/

4. As stated by (Brand et al., 2019), funding pressures were significant during the GFC and sovereign debt crisis due to high level of funding stress in the banking system. Later, the implementation of long-term refinancing operations (LTRO) and targeted long-term refinancing operations (TLTRO) constituted a break point, which helped to reduce funding pressures (i.e. higher demand than supply), putting downward pressure on repo rates. Nonetheless, considering the period covered in our analysis (i.e. since 2019), we can only think in one event of funding stress, coinciding with the inception of the pandemic, which heightened indicators on interbank stress, such as the Euribor-OIS[6]. More precisely, the environment of excess liquidity observed since the implementation of unconventional monetary policy contributed to a complacent period in terms of funding needs. Even more, in 2022 the combination of high levels of excess liquidity and financial markets volatility induced higher demand for short-term investments leading to a negative liquidity premium (ECB, 2023). This caused a shift from longer-tenor in money market funding to shorter ones and put downward pressure on the Euribor-OIS spread.

The elements affecting supply and demand of collateral deserve a more deeper approach, as could be triggered by multiple factors. One of the most common drivers of collateral scarcity has been attributed to the implementation of asset purchases programmes (APP) by the Eurosystem, and more precisely the ones related to sovereign debt[7]. This measure of unconventional monetary policy aimed to diminish duration risk for government debt reducing the supply of assets held by the private sector. However, this came together with a side-effect: the lower the supply of assets to be used as collateral in repo rates, the higher the collateral scarcity. Additionally, the long-term refinancing operations (which increased the amount of pledged collateral) contributed indirectly to this unintended consequence. To counteract those side-effects, the ECB implemented a Securities Lending Programme (SLF), which allowed market participant to borrow securities, thus alleviating asset scarcity. The literature have found that the use of the SLF contributed to reduce such pressures (see, for instance Arrata et al. (2020)).

However, there are other factors having an impact on collateral demand, such as, prudential regulatory measures. The Basel Committee on Banking Supervision introduced measures like the minimum leverage ratio (LR), a

[6]As shown in section 4 we employ the spread Euribor-OIS as a proxy for funding needs.

[7]Such as Public Sector Purchase Programme - PSPP and Pandemic Emergency Purchase Programme - PEPP

net stable funding ratio (NSFR), or the liquidity Coverage ratio (LCR). In that sense, the regulatory ratios impose some restrictions on bank's balance sheet during reporting dates (mostly quarter and year end). Therefore, the incentives to engage in short-term repo[8] transactions could be affected, altering also the rates (see BIS (2017)). These can be considered as structural factors affecting the demand of collateral (ECB, 2023).

The previous determinants can be understood as structural factors driving repo rates, but we can also refer to conjunctural drivers, that were observed during 2022 and triggered by higher financial uncertainty and the shift in monetary policy (bullet points from 1 to 3). Finally, we could think in other factors alleviating repo-DFR spread widening pressures (bullets 4 to 6).

1. Demand for specific securities (short-term safe assets) and flight-to-quality episodes related to geopolitical risks and markets uncertainty
2. Increase in short positions in the sovereign cash market
3. Increase in monetary policy uncertainty
4. Eurosystem portfolio run-off
5. Increase in securities lending limits
6. TLTRO repayments, which increase the amount of pledged collateral, among others.

In section 4 we explain which indicators we use to estimate each of the factors.

3 Developments of repo rates during the pandemic and the normalisation of monetary policy

3.1 Monetary policy easing after the pandemic

Secured market rates have been downward pressured since the inception of the Covid crisis. After the pandemic, central banks around the world

[8]For instance, borrowing repo transactions worsen the LR, as the cash received increase bank's balance sheet. Moreover, as short-term repos are not recognised as stable funding, the volume of repo rates would be reduced during the end of year and quarter. The impact of LCR will depen on the type of collateral used or the counterparty. As holdings of sovereign bonds are considered as high-quality assets, their demand could potentiate collateral scarcity.

intervened rapidly aiming to reduce the negative effects of the pandemic on financial markets and the real economy. More precisely, the ECB expanded asset purchase programmes and introduced a new one: the pandemic emergency purchase programme (PEPP). Additionally, the ECB announced an improvement of the conditions for targeted long term refinancing operations (TLTRO-III), including additional operations and more favourable price conditions. Those measures exarcebated structural collateral scarcity and increased excess liquidity, reducing the need for cash borrowing in money markets. In that context, repo rates were downward pressured since mid-2020, widening the spread between the repo rate and the DFR (Figure 3). More precisely, German repo rate spread widened 12 bps[9] after Covid measures, and the French, Spanish and Italian spread widened by 12, 11.5 and 8.3 bps respectively.

3.2 The normalisation period

The highest amplitude in repo rates spread against the DFR was observed in 2022, most prominently until the end of September. During the first part of the year, repo spreads went down gradually, especially for German collateral, which decreased 13 bps between January and the 13th September, just before the return of the deposit facility rate (DFR) to the positive territory. In that context, the pass-through of policy rate hikes in the second part of 2022 was not as orderly and immediate as for unsecured rates, being heterogeneous across the main collateral issuers.

German and French repo spreads declined dramatically by around 37 bps on days around the shift to positive rates, while Spanish and Italian collateral repo rates decreased on a minor extent (28 bps approximately). The return to positive rates came with some changes in investment dynamics, looking for positive remuneration with a short-term and low risk profile. Consequently, rates went down and they experienced high volatility on the days following the September rate hike from 0 to 0.75 p.p. (Figure 3).

Until 2022, one may think that the main driver of collateral scarcity was the reduction of supply of bonds caused by APP holdings by the Eurosystem. The results shown in section 5 are aligned to literature assessing the effects of asset purchase programmes on repo rates (Brand et al. (2019), Carrera de Souza and Hudepohl (2022) or Arrata et al. (2020)), which found that Eurosystem holdings of sovereign debt contributed to the asset scarcity of collateral and

[9] Average repo-DFR spread for the period between july'20 and december'21, considering overnight transaction, using government bonds as collaterals

therefore, to a significant reduction of repo rates. However, even if the stock of APP affected repo rates, this has been nearly unchanged in 2022. In a similar vein, excess liquidity and TLTRO amount were mostly constant in 2022 and were only significant reduced in december 2022.

Therefore, the factors driving the deep widening of repo rates in 2022 should be others than the ECB footprint. The next section explores empirically the contribution of each factor to repo-DFR widening.

4 Data and methodology to assess the drivers of repo rates

We obtain transactional level data for the period between the 1st of January 2019 until February 2024. The constructed database includes information on the price, type of transaction (i.e. borrowing or lending[10]), reporting agent (euro area bank), counterparty and collateral used[11]. Among all reported data, we select transactions with one day-maturity considering different settlement dates: overnight transactions (O/N), which refers to operations where settlement and trade date coincides; tomorrow-next (T/N) where the settlement is done one day before the trade and spot-next (S/N) for settlements two days after the trade. Those operations constitute on average, a 88% of daily volume for secured transactions. Moreover, we include only transactions backed by government collateral, which account for 90% of secured money markets volume. According to data availability[12], we do not distinguish special and general collateral as other authors did (Brand et al., 2019). Nevertheless, as shown later, we include controls for each individual bonds used in repo transactions, which permits us identify among most demanded collaterals. This approach is similar to the one by Carrera de Souza and Hudepohl (2022), who compute a weighted average repo rate for each day and collateral. We go beyond and explore the granularity of each transaction, i.e. assessing different rates within the same ISIN, provided they are negotiated

[10]Type of transaction is understood from the reporting bank perspective. Therefore, if one of the euro area banks reports a borrowing transaction, it means the bank has obtained cash in exchange of collateral and the opposite if they inform a lending operation. According to MMSR data structure, in each operation at least one of the parties involved in the transaction is a euro area bank, while the counterparty could be any other economic sector.

[11]We separate samples and regression depending on the country of collateral issuer.

[12]MMSR includes a reporting question to identify special collateral transactions. However, this information is not provided for most of the transactions (around 80 %.)

by different counterparties and/or reporting agents. That way, we are able to provide more accurate estimates of each of the factors driving repo-DFR spread as identifying and controlling for differences across counterparties (in section 6 we show how the inclusion of such controls, contributed to a clear improvement in goodness of fit measures).

As noticed in section 2, one of the sources of heterogeneity in repo rates arises from the different collaterals used in each transaction. The issuer (i.e. country) of the collateral could be one of the main determinants of specific bond demand. Therefore, we include repo transactions based on government collaterals from the main four government bond issuers of the Euro Area: Germany, Spain, Italy and France. In that sense, we compute the repo-DFR spread based on the four countries with separated panel regressions. This country selection is similar to the sample obtained by (Brand et al., 2019) or (Carrera de Souza and Hudepohl, 2022).

Following this approach, we are able to assess the impact of individual characteristics (i.e. the use of specific collateral or possible differences across counterparties and banks) as well as each of the timing factors, such as the effect of monetary policy normalisation, uncertainty or flight-to-safety. We define the specification in equation 1.[13]

$$\begin{aligned} Repo - DFR_{i,t,j} = \beta_{Slope} \cdot Slope_t + \beta_{SMOVE} \cdot SMOVE_t + \beta_{Sovereign} \cdot Sovereign_t \\ +\beta_{Euribor} \cdot EuriborOIS_t + \beta_{Eurosystemholdings} \cdot Eurosystemholdings_{t,j} + \\ \alpha_{collateral} + \alpha_{counterparty} \\ +\alpha_{time} + Quarter\ and\ year\ end\ controls + Type\ transaction_{t,i,j} + \epsilon_{i,t,j} \end{aligned} \tag{1}$$

where the subindex i refers to each transaction, for which we can identify the rate, the type of transaction (i.e. borrowing or lending), repo rate, counterparties involved in the transaction and collateral used. The subindex t refers to the date of the observation and j denotes the country issuer of the collateral. The $Slope$ variable refers to expectations of policy rates, $SMOVE$ are swaptions on Euribor, which approximate the uncertainty around monetary policy. $Sovereign$ refers to the Spread between the 10-year bond in Germany and France and the OIS for the same maturity. $EuriborOIS$ is the spread between the interbank Euribor 3 months and the OIS for the same tenor.

[13] We regress variables in levels as we checked the stationary of the variables using an Augmented Dickey-Fuller test.

Eurosystem holdings refer to the ratio of asset purchases over free float in each country and time. Different regressions are run for each collateral issuer.

In that vein, the two first variables included in the regression (Slope and SMOVE) provide a measure of the shift in the monetary policy rate stance focusing on: changing interest rate expectations and monetary policy uncertainty.

We use Overnight Index Swaps (OIS) to obtain the yield curve parameters, considering level, slope and curvature in a similar way than (Afonso and Martins, 2010)[14]. Yield curve estimates provide useful information for financial markets: it determines financial conditions and serves as a source of information about expectations of the future path of monetary policy. Therefore, we use the evolution of yield curve slope as a proxy for policy rate hike expectations in order to monitor the effect of monetary policy normalisation on repo rates.

Additionally, we assess the impact of higher volatility on financial markets, that has been experienced since 2022. We employ interest rate swaptions of Euribor (SMOVE), as it represents implied volatility on money market rates, so that the higher the value is the more uncertainty we observe in short-term rates. Dufour and Skinner (2020) defend that volatility and fire sales of bonds could be a factor to be explored in the studies of government bond and repos, which could imply a extreme selling and demand pressure.

Moreover, we consider additional drivers representing conjunctural and structural factors. As stated in (ECB, 2023), during 2022 the market experienced a flight-to-quality episode, which led to an idiosyncratic demand for short-term and safe assets. This behaviour affected mainly German bonds, which are considered as the safest sovereign bonds, but could be extended to other issuers, such as the French collateral. For that purpose, we proxy the flight to quality effect using the spread between the 10-year bond and the OIS on the same maturity. As OIS rates are considered as risk-free rates, a positive (negative) spread conveys a positive (negative) risk premia. In a context of higher financial uncertainty, investors will prefer to place their liquidity on safer assets. Therefore, the higher the negative spread is, the higher demand of such assets, which will exert downward pressure on repo rates.

Additionally, similarly to (Brand et al., 2019) we measure possible funding pressures through the spread between the Euribor-3 months, which is the

[14]We apply a Kalman filter for the estimations based on Nelson-Siegel model.

benchmark reference for interbank rates and the OIS on the same maturity, as a risk-free rate. Therefore, the spread between the two rates offers a proxy for credit and/or liquidity risk in the interbank market. While its relevance as a factor driving repo rates has been more important during the period of "cash-driven" repo markets, it can be useful as an indicator of the existing supply and demand of cash. The Euribor-OIS spread conveys information about the liquidity premium: the higher (lower) is the spread, the bigger (lower) liquidity needs are. Additionally, it would be of interest monitoring its evolution in recent periods of financial stress (such as the inception of the pandemic), when credit risk and reluctance to fund could be emerging among financial agents.

The structural factors in our study refer to the Eurosystem footprint in money markets, caused by the impact of asset purchases programmes expansion during the COVID-19 crisis. We include a measure of Eurosystem holdings of debt securities over free float (see equation 2), in a similar way than authors such as Carrera de Souza and Hudepohl (2022). For each country, we obtain the ratio of Asset Purchases Programmes (APP)[15] stock over free float (equation 2), which is computed as the outstanding debt securities[16] net of Eurosystem holdings, minus pledged collateral plus the amount used in the Securities lending facility (SLF) programme (equation 3).

$$Eurosystem\ holdings\ over\ freefloat_{j,t} = \frac{APP\ stock_{j,t}}{Free\ float_{j,t}} \tag{2}$$

$$\begin{aligned} Free\ float_{j,t} = Outstanding\ amount_{j,t} - Eurosystem\ holdings_{j,t} \\ -Pledged\ collateral_{j,t} + SLFbalance\ collateral_{j,t} \end{aligned} \tag{3}$$

where, j and t refers to country and time, respectively.

Additionally, we have included a dummy for the type of transaction (i.e. whether if the reporting bank borrows or lends money).

[15] We use public data on PEPP and PSPP purchases available at the country level on a monthly basis. Therefore, we apply a linear interpolation to get daily observations.

[16] Outstanding debt securities are provided in the Statistical Datawarehouse (SDW) of the ECB on a monthly basis, so we also apply a linear interpolation to as a conversion to daily data.

4.1 Exploring heterogeneities across counterparties

The specification described before brings the opportunity of exploring potential difficulties for an smooth monetary policy transmission to repo markets in a context of collateral scarcity. The next question one can think about is whether if some of the interferences to monetary policy transmission have been homogeneous across different sectors.

For instance, (Nguyen et al., 2023) who study the transmission of recent rate hikes to the repo market, found that transmission works better when transactions are done primarily by banks, while the participation of non-banks impairs this mechanism. Additionally, we rely on the theoretical model developed by (Jappelli et al., 2024), who state that arbitrageurs investors such as hedge funds borrow the overpriced and more demanded bond and sell it short, while other preferred-habitat investors (like central banks or deposit-taking institutions) respond on a lesser extent. Therefore, we extend the model documented in equation 1 in order to disentangle the short positioning effect across different counterparties[17].

We follow a similar classification of counterparties than the one presented in the last Money Market Study (ECB, 2023), where three main categories were identified: central clearing (CCP), non-bank financial institutions (NBFIs) and deposit-taking entities (banks). The information presented in this report showed that most of the transactions in the secured money markets were done through central clearing (close to 70% of total transations), followed by NBFIs (close to 20%) and banks (10%).

In order to account for different effects of the short-positioning motivated by higher monetary policy expectations, we add interactions for the counterparty sector and monetary policy expectations variable as shown in equation 4.

$$\begin{aligned} Repo - DFR_{i,t,j} = \beta_{Slope} * NBFI_{sector} \cdot Slope_t + \beta_{SMOVE} \cdot SMOVE_t + \\ \beta_{Sovereign} \cdot Sovereign_t + \beta_{Euribor} \cdot EuriborOIS_t + \\ \beta_{Eurosystemholdings} \cdot Eurosystemholdings_{t,j} + \\ \alpha_{collateral} + \alpha_{Reportingagent} + \alpha_{time} + Quarter\ and\ year\ end\ controls + \epsilon_{i,t,j} \end{aligned} \tag{4}$$

[17]According to MMSR data, one of the participants of a repo transaction is a deposit-taking entity (known as "reporting agent"). The counterparty can be an entity from any other sector (e.g. including non-bank financial entities, central clearing, households, centrals, among others. We include here only financial counterparties.

Where $NBFI_{sector}$ identifies each of three categories: CCP, NBFIs and banks, so that the interaction term let us estimate the effect of higher policy rate expectations on short positioning and demand of collateral for each sector. Additionally, we include a categorical variable for the counterparty sector, which measures the estimated spread between repo rates of NBFIs and CCP as compared to banks. Finally, it is worth mentioning, we focus in this analysis in reverse repo transactions (from the perspective of the counterparties), in which banks lend collateral to other counterparties, as our main interest is gathering the price paid by each counterparty in order to receive the asset.

4.2 Accounting for time variant collateral characteristics: the *on-the-run* "specialness"

Authors such as Dufour and Skinner (2020) or Brand et al. (2019) defend that specialness varies not only across bonds but also over time. More precisely, the analysis of Dufour and Skinner (2020), which is based on italian collateral, takes into acccount different characteristics that vary along time, determining collateral specialness. Moreover, d'Amico and Pancost (2022) assess how the special collateral premium (defined as the difference between special and general collateral) is increased by yield premium in the cash bond market. Hence, bonds that are *on-the-run* have a higher price than others with the same expected cash-flows and this premium is mainly driven by higher demand. Therefore, bonds that are more demanded in the cash market also transmit this "specialness" to the repo market. In that vein, we exploit the granularity of data to identify bonds being on-the-run at each point in time, as being more demanded will put downward pressure on repo rates. We include a *dummy* variable which takes the value 1 if the bond is *on-the-run* and 0, otherwise.

Using this new variable as a proxy for specialness, we can assess how short positions pressure on repo rates varies across time (using monetary policy expectations as proxy) and bonds time-varying characteristics. We expand the specification in equation 4 with a new interaction, as shown in equation 5. In that case, we get rid of the grouping for collateral, which only capture time-invariant characteristics.

$$
\begin{aligned}
Repo - DFR_{i,t,j} = \beta_{Slope} * ontherun_{i,t,j} \cdot Slope_t + \beta_{Slope} * NBFI_{sector} \cdot Slope_t + \\
\beta_{SMOVE} \cdot SMOVE_t + \\
\beta_{Sovereign} \cdot Sovereign_t + \beta_{Euribor} \cdot EuriborOIS_t + \\
\beta_{Eurosystemholdings} \cdot Eurosystemholdings_{t,j} + \\
\alpha_{Reportingagent} + \alpha_{time} + Quarter\ and\ year\ end\ controls + \epsilon_{i,t,j}
\end{aligned} \quad (5)
$$

5 Results

The results of our estimates confirm that collateral scarcity driven by asset purchase programmes are the main driver of repo rate downward trend in late 2020 and 2021 (figure 13).

In contrast, most part of the euro area repo rates spread downward trend in 2022 was driven by monetary policy normalisation and higher monetary policy uncertainty in the four jurisdictions, while the effects of ECB footprint were nearly inappreciable (figure 14).

Table 1 provides estimation results for each country based on equation 1. All the factors included in the model are significant and have the expected sign. The coefficient for the *Slope* (used as proxy for interest rate expectations) is negative and the bigger effect has been found for German collateral. The reason to assess the impact of policy rate expectations on secured money markets is motivated by the crucial role of policy rate decisions on the financial markets and agents behaviour. In 2022, market based measures of interest rate expectations pointed to a clear shift in the monetary policy stance, moving from a period of negative rates and accomodative monetary policy to the preface of a tightening cycle.

Figure 5 shows the evolution of level and slope of the expected path of policy rates, where the first element denotes the expected level of rates in the long run while the slope informs about expected changes based on differences between the short and long-term. Therefore, a negative value for the slope suggests declining rates in the future while a positive value points to increasing expected rates. One can alert a significant increase in both the slope and level of the expected path of ECB rates, conveying a clear shift in the monetary policy stance and the start of the hiking cycle. Using this information, financial agents could expect rates going up in the near future, not only for policy rates but also for bond markets. This expected evolution could change investors decision as the increase in yields will also imply a drop in sovereign bonds price and motivating a temporary increase in short positions for government bonds. This behaviour has been defined and analysed empirically by other authors (such as Dufour and Skinner (2020), using Italian repos). More precisely, the authors assessed the impact of short-selling activities around bond auctions and they found that participants are willing to accept lower rates in reverse repos (i.e. transactions in which the lender obtains cash and recibes collateral), motivated by higher demand for some securities. Hence, this developments suppose a (temporary) increase in collateral demand motivated by an increase in short positions in the sovereign bond market (see point 2 in section 2.1). Other authors, such as d'Amico and Pancost (2022) also refer to the existance of a repo premia (i.e. lower rates) for "Special Collateral" bonds and found that higher repo premia is driven by factors reflecting investors´ preference for safe and liquid assets as well as uncertainty about the availability of those assets. Therefore, higher risk and market volatility contribute to the widening of repo spreads.

The estimates provided in Table 1 confirm that higher (lower) expectations of policy rates reduce repo rates, which means a widening of the spread (or a huge negative difference between the secured rates and DFR). The channel through which this result operates is the higher demand of collateral. The fact that this effect is bigger for German collateral could be related to the condition of the bund as safe asset, meaning that more investors prefer using this collateral for short-selling positions. Figure 9 shows the contribution of changes in interest rate expectations to the evolution of repo-DFR spreads in each country. For German collateral, the contribution was particularly relevant and can explain a drop of more than 15 bps in the repo-DFR spread during the first part of 2022. This effect was also notorious for the French repo spread (around 8 bps) and less prominent for Spanish and Italian collaterals.

The second conjunctural factor of interest is the higher uncertainty around monetary policy, measured by swaptions on Euribor (Figure 6). The evolution of this indicator also pointed to a prompt uncertainty increase since the start of 2022, in a context of monetary policy shift, market volatility around the war in Ukraine and higher inflation. The coefficient in Table 1 is negative and significant, implying that higher uncertainty dampens the repo-DFR spread. Following the mechanism described in section 2.1, higher monetary policy uncertainty was a driver moving up demand for government bonds. Figure 10 shows the contribution of higher monetary policy uncertainty driving repo rates down. This supposed a widening of around 4 bps in the repo-DFR spread.

A flight-to-quality episode was also observed during the first part of 2022, when the negative spread between German 10-year bond and the risk-free rate (OIS) peaked (Figure 7). We include this effect only for the German collateral, which is considered a safe asset, whose demand increases in periods of stress. We also estimate the effect for the French sovereigns, as the spread between the 10-year bond in this country and the OIS with the same maturity has also been on the negative territory during the first semester of 2022. The coefficients shown in Table 1 are significant but only have the expected sign for the German collateral[18]. The results confirm that a more positive (negative) spread brings repo rate up (down). In that sense, when the negative spread between the german bond and the risk-free rate widens (related to the use of the German bond as safe assets increases), higher demand of such assets brings repo rates down (and widens the spread). This flight-to-quality episode had also a relevant contribution for widening of repo-DFR spread of around 4 bps (figure 12).

Additionally, as we mentioned in previous section, liquidity needs have been contained during the normalisation period, with no signs of funding pressures, pointing to a negative Euribor-OIS spread during the second half of 2022. This measure of credit and liquidity risk had a positive and significant effect on repo-DFR spread (Table 1), meaning that higher (lower) funding pressure for banks could bring repo rates up (down). Figure 11 suggests that funding/liquidity risk put upward pressure on repo rates until the first half of 2022, with a peak during the Covid crisis event. However, during the first half of 2022 negative liquidity premia driven by higher levels of excess liquidity and the higher demand of short-term safe assets implied lower demand for cash (driving repo rates down) while increasing demand for collateral (also dampening repo rates). Consequently, the effect of lower funding needs contributed to decrease in the repo-DFR spread of around 6 bps. This trend clearly shifted in the second half of 2022, coinciding with the redemption of TLTRO, which lead to lower levels of excess liquidity. Since 2023, the contribution of lower excess liquidity pointed to an upward pressure on repo rates, which is related to one of the factors reducing collateral scarcity (identified as point 6 in section 2.1).

Regarding the effect of Eurosystem footprint on repo markets, the estimated coefficient is negative and significant, which is aligned with the findings by

[18]Therefore, we can only think about the German collateral as a safe asset.

the literature (Carrera de Souza and Hudepohl (2022) or Brand et al. (2019)). These results are also consistent with the economic intuition behind: a higher ratio of APP holdings, reduces the availability of collateral in the private sector, putting downward pressure on the supply. The expansion of APP purchases and the implementation of the PEPP programme contributed to a widening of the repo-DFR spread of around 10 bps for German collaterals and 5 bps for the French, Spanish and Italian ones. However, when looking at the contribution of collateral scarcity driven by APP programmes over time, one can notice that, as the ratio of APP holdings during 2022 was nearly unchanged, this could not explain the strong widening of repo-DFR rates during the tightening period (Figure 8). Looking ahead, the quantitative tightening would contribute to a reduction of repo-DFR spread as noticed in point 4 contained in section 2.1 and alerted in figure 8. Finally, other factors driving the narrowing of repo-DFR spread could be related to the announcement by the ECB of the increase in the aggregate limit for securities lending against cash to €250 billion in November 2022 (see point 5 in 2.1).

5.1 Additional results accounting for counterparty sector heterogeneity and *on-the-run* "specialness"

Tables 3 to 6 show the results of assessing differences across counterparties and time-variant bond characteristics. First, we account for differences in repo-DFR spread arising from counterparties other than banks. That way, one can gather if transactions with NBFIs or central clearing counterparties are negociated at different prices. The coefficients presented in rows 6 and 7 of those tables show the differences in repo spreads for NBFIs and CCP, respectively. Our estimates prove that repo rates of NBFIs are significantly below than repo rates of interbank transactions. On the contrary, centrally cleared transactions trade at significantly higher repo rates than interbank transactions[19].

Moreover, our estimates confirm that, in the case of more scarce collaterals (i.e. German and french assets), demand pressures coming from an increase in short positions are stronger for non-banks. This can be gathered from a more negative value of the coefficients in row 9 (with respect to the coefficient for banks) of tables 3 and 4. Therefore, in the case of german collateral, higher policy rate expectations that motivate short positions drive an additional

[19]It is difficult to provide clear conclusions in the case of tri-party transactions as one cannot purely know how is the final counterparty.

reduction of 1.25 bps for NBFIs (per each p.p. increase in rate expectations) as compared to interbank transactions. This result confirms the hypothesis of Jappelli et al. (2024) in which arbitrageurs intensify the search for collateral in repo markets when bonds are more demanded. The estimations for the French collateral bring even stronger differences in the role of NBFIs in intensifying the widening of repo-DFR spread. The estimates also show that demand pressures motivated by higher monetary policy expectations and short-positions are not significant for banks, while it is when looking at NBFIs. Conversely, demand of spanish and italian government bonds by NBFIs seems to be less significant.

Last column of tables 3 to 6 also account for differences across collaterals, and more precisely, the role of *on-the-run* bonds in collateral demand and repo-DFR widening. That way, we can respond not only through which counterparties higher demand for collateral is transmitted to repo markets, but also which how collateral specialness can intensify the effects of short-positions on repo rates. Our results confirm that, in the four countries, higher monetary policy expectations and short positions increase the demand of collateral, which is strong for recently issued (on-the-run) bonds.

These results have relevant implications for policymakers and potential decisions about the design of measures to improve the transmission of monetary policy to money markets.

6 Comparing different models

In this section, we compare different models to check the robustness of the results, specially regarding the contribution of the conjunctural factors. As mentioned in the introduction, one of the main contributions of our paper is providing a quantitative assessment of the effects of monetary policy normalisation on repo markets. This imply the inclusion of some factors, that have not been broadly used by the literature, to differentiate what we call as "conjunctural" collateral scarcity, from the "structural" scarcity motivated by the Eurosystem footprint. Therefore, we compare the estimates and goodness of fit of the models including only the "structural" factors (i.e. ECB footprint and calendar effects driven by regulatory ratios) with models employing also conjunctural factors.

The comparison of R^2 measures on different specification models confirms that conjunctural sources of collateral scarcity clearly improve model estimations (Table 7). The baseline scenario is the specification in equation 6, which only includes the "structural" factors and this model offers the poorer results. In the second specification shown in equation 7, we include the factors related to the conjunctural increase in collateral demand. These imply an increase in the goodness of fit of 13 p.p. for the German collateral, and 7, 5, and 9 p.p., respectively, for the French, Spanish and Italian repos. The inclusion of time effects also provides a modest improvement. Finally, our choosen specification (equation 1) included in the last column provides a significant better approach than the baseline specification. The R^2 of the model to explain repo-DFR spread for German collateral is clearly enhanced from 40% to 63% when including our main contributions: i.e. the conjunctural factors related to the shift in the monetary policy stance and counterparty and bond identifiers. The incorporation of counterparty and ISIN identifiers makes a great difference in the case of French bonds, meaning an improvement of the from 23% to 51%) comparing columns 1 and 5 suppose an improvement of the R^2 of the model. Last but not least, the improvements are also relevant for Spanish (from 48% to 66%) and Italian collaterals (from 30% to 53%).

Figures 15,16 and 17 compare the observed repo-DFR spread over time for each collateral issuer as well as the predicted spreads for different specifications: i) the one only assessing structural factors, ii) adding conjunctural effects and iii) accounting for differences among collaterals and counterparties[20]. The charts also confirm a clear improvement of the estimation models accounting for the effects of the normalisation of monetary policy as well as counterparty and collateral heterogeneities.

$$\begin{aligned} Repo - DFR_{i,t,j} = \beta_{Eurosystem\ holdings} \cdot Eurosystem\ holdings_{t,j} + \\ Quarter\ and\ year\ end\ controls + \epsilon_{i,t} \end{aligned} \tag{6}$$

$$\begin{aligned} Repo - DFR_{i,t,j} = \beta_{Slope} \cdot Slope_t + \beta_{SMOVE} \cdot SMOVE_t + \beta_{Sovereign} \cdot Sovereign_t \\ + \beta_{Euribor} \cdot EuriborOIS_t + \beta_{Eurosystem\ holdings} \cdot Eurosystem\ holdings_{t,j} + \\ Quarter\ and\ year\ end\ controls + \epsilon_{i,t} \end{aligned} \tag{7}$$

7 Conclusions

We propose an assessment of the main factors explaining the widening of the repo-DFR spread during the monetary policy normalisation period that

[20]Timely estimated effects are computed as the volume weigthed average of estimates at the transaction level.

started in July 2022. Excess liquidity and collateral scarcity observed in secured markets since the inception of unconventional monetary policy have played an important role in the evolution of volumes and rates of money markets since 2019. These factors have changed some of the dynamics in money markets between 2019 and 2021.

Furthermore, we have tested another relevant milestone: the first time the ECB policy rate shift from negative to positive rates. The normalization of monetary policy has not been without effects for investors and money markets, therefore making sluggish the pass-through into the secured segment. We propose an empirical way to assess the impact of this change in monetary policy stance in repo rates.

Our work contributes to the literature investigating the development of repo markets in several ways. First, our work offers a detailed analysis using transactional-level data for the euro area repo markets and accounts for individual characteristics such as the counterparty sector and the specific bond used in the transaction. The assessment of this micro data improves our estimates, and it is used to explore the transmission of monetary policy through non-bank financial intermediaries. Second, we complement earlier studies analysing the effects of large central bank footprint in repo markets with special focus on the normalisation period. As far as we know, this is the first empirical work that studies, econometrically, the effects of higher policy rates. Third, we revisit studies such as Arrata et al. (2020) or d'Amico and Kitsul (2018) which explore the interaction between unconventional monetary policy, repo markets and collateral scarcity, but covering a more recent period of data.

We provide an assessment of the drivers of temporary strains observed in 2022 in a repo market already affected by collateral scarcity. These frictions have proven to be more related to conjunctural factors, i.e. interest rate hiking, higher demand for liquid assets, rather than to the structural ones (ECB footprint and regulatory effects). Latest data for 2023 suggests that unprecedented downward of repo rates in 2022 fade as further increases of policy rates are less likely and we get closer to the terminal rates expected by markets. Additionally, we show that higher demand for collateral in repo markets to enter into short positions was stronger for NBFIs, specially in the case of German and French collateral and for on-the-run bonds, suggesting than specialness is a key factor. The monitoring of those drivers is needed, especially as uncertainty around the future evolution of rates is still high.

Further work could be done based on our analysis. First, we could enrich time variant characteristics of bonds, incorporating market data and combining it with the prices in the cash market. Second, we could refer to data on effective short positions done by different counterparties.

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Table 1: Estimated coefficients: the factors driving supply and demand of cash and collateral

Repo - DFR spread				
Factors	Germany	Spain	France	Italy
Slope	-6.36*** (0.00)	-2.69*** (0.00)	-3.90*** (0.00)	-2.38*** (0.00)
SMOVE	-0.09*** (0.00)	-0.03*** (0.00)	-0.08*** (0.00)	-0.03*** (0.00)
Sov.spread	0.08*** (0.00)	- -	-0.08*** (0.00)	- -
EURIBOROIS	0.10** (0.01)	0.14*** (0.00)	0.18*** (0.00)	0.16*** (0.00)
APP	-0.60*** (0.00)	-0.24*** (0.00)	-0.67*** (0.00)	-0.62*** (0.00)
$Adjusted R^2$	63%	66%	51%	53%
Observations	875.450	766.299	756.299	1.453.352

P-values in parenthesis: Significant levels: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

This table shows estimations based on specification in equation 1 for the main factors driving repo-DFR spread. The variable *Slope* is the slope of the expected interest rate path, which offers an insight of policy rate expectations at each point in time. $SMOVE$ is the implied volatility of short-term rates based on 3 month options for Euribor swaps. The spread $10Y - OIS$ is the difference between the 10-year sovereign yield for each country and the OIS at the same maturity. $EURIBOROIS$ refers to the spread between Euribor rate and OIS for a three months maturity. APP is the ratio between ECB holdings of sovereign debt in each country and the free-float net of pledged collateral and SLF. Quarter and year-end effects are included in the next page and are dummies taking value 1 if the observed date is ending of year/quarter and 0, otherwise. We also include time effects and identify each collateral and counterparty. Transactions are grouped at the combination of counterparty and reporting agent location and collateral.

Table 2: (Cont.): Year and quarter end effects of estimations in Table 1

Repo - DFR spread				
Factors	Germany	Spain	France	Italy
$Yearend_{2019}$	-28.09*** (0.00)	-2.52 (0.58)	-14.52*** (0.01)	12.12*** (0.01)
$Yearend_{2020}$	-144.03*** (0.00)	-86.25*** (0.00)	-125.60*** (0.00)	-52.06*** (0.00)
$Yearend_{2021}$	-333.69*** (0.00)	-326.46*** (0.00)	-341.67*** (0.00)	-311.05*** (0.00)
$Yearend_{2022}$	-242.65*** (0.00)	-230.84*** (0.00)	-196.15*** (0.00)	-158.06*** (0.00)
$Quarterend_{2019}$	-2.68 (0.43)	-1.68 (0.52)	-4.63 (0.15)	0.05 (0.99)
$Quarterend_{2020}$	-4.83 (0.16)	-3.51 (0.18)	-2.56 (0.43)	-1.91 (0.46)
$Quarterend_{2021}$	-18.34*** (0.00)	-21.14*** (0.00)	-18.07*** (0.00)	-13.92*** (0.00)
$Quarterend_{2022}$	-67.98*** (0.00)	-37.02*** (0.00)	-48.38*** (0.00)	-30.21*** (0.00)
$Quarterend_{2023}$	-27.82*** (0.00)	-12.60*** (0.00)	-36.71*** (0.00)	-5.46* (0.06)
Lending	2.38*** (0.00)	2.15*** (0.00)	1.71*** (0.00)	2.76*** (0.00)

P-values in parenthesis: Significant levels: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

The variable *Lending* is a dummy identifying transactions in which Euro Area banks reporting to MMSR place liquidity in exchange of collateral

Table 3: Estimated coefficients: German collateral adding counterparty sector interactions

dependent variable: repo-DFR spread	**(I)**	**(II)**	**(III)**	**(IV)**	**(V)**	**(VI)**
Slope	-	-4.07*** (0.00)	-4.25*** (0.00)	-4.49*** (0.00)	-	-
SMOVE	-	-0.17*** (0.00)	-0.17*** (0.00)	-0.16*** (0.00)	-0.16*** (0.00)	-0.18*** (0.00)
Sov.spread	-	0.31*** (0.00)	0.22*** (0.00)	0.23*** (0.00)	0.23*** (0.00)	0.23*** (0.00)
EuriborOIS	-	0.55*** (0.00)	0.20*** (0.00)	0.25*** (0.00)	0.26*** (0.00)	0.27*** (0.00)
APP	-0.53*** (0.00)	-0.52*** (0.00)	-0.56*** (0.00)	-0.49*** (0.00)	-0.48*** (0.00)	-0.51*** (0.00)
NBFI vs bank	-	-	-	-	-4.39*** (0.00)	-5.80*** (0.00)
CCP vs bank	-	-	-	-	1.66*** (0.00)	0.92*** (0.00)
Slope bank	-	-	-	-	-3.16*** (0.00)	-3.74*** (0.00)
Slope NBFI	-	-	-	-	-4.41*** (0.00)	-3.98*** (0.00)
Slope CCP	-	-	-	-	-4.55*** (0.00)	-3.75*** (0.00)
Slope on-the-run	-	-	-	-	-	-1.56*** (0.00)
Adjusted Rsquared	42%	56%	62%	68%	68%	64%
Observations	1,411,529	1,411,529	1,411,529	1,411,529	1,411,529	1,411,529
Quarter and year end controls	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Time effects	*no*	*no*	*no*	*yes*	*yes*	*yes*
Collateral FE	*no*	*no*	*yes*	*yes*	*yes*	*no*
Reporting agent location FE	*no*	*no*	*yes*	*yes*	*yes*	*yes*

P-values in parenthesis: Significant levels: $*p < 0.1$; $**p < 0.05$; $***p < 0.01$.

This table shows estimations based on specification in equation 4. Transactions are segregated at the transaction level. In column 1 to IV the coefficient for *Slope* refers to the effect of higher MP expectations for all type of counterparties. Dates included in the analysis: from january 2019 to february 2024. In column VI we include the different effect of short positions demand pressure on repo rates (compared to off-the-run bonds).

Table 4: Estimated coefficients: French collateral adding counterparty sector interactions

dependent variable: repo-DFR spread	**(I)**	**(II)**	**(III)**	**(IV)**	**(V)**	**(VI)**
Slope	-	-2.93*** (0.00)	-3.07*** (0.00)	-3.39*** (0.00)	-	-
SMOVE	-	-0.11*** (0.00)	-0.12*** (0.00)	-0.11*** (0.00)	-0.11*** (0.00)	-0.12*** (0.00)
Sov.spread	-	-0.03*** (0.00)	-0.13*** (0.00)	-0.11*** (0.00)	-0.11*** (0.00)	-0.12*** (0.00)
EuriborOIS	-	0.29*** (0.00)	0.15*** (0.00)	0.24*** (0.00)	0.24*** (0.00)	0.24*** (0.00)
APP	-0.69*** (0.00)	-0.24*** (0.00)	-0.58*** (0.00)	-0.46*** (0.00)	-0.46*** (0.00)	-0.56*** (0.00)
NBFI vs bank	-	-	-	-	-4.80*** (0.00)	-2.22*** (0.00)
CCP vs bank	-	-	-	-	0.43*** (0.00)	2.38*** (0.00)
Slope bank	-	-	-	-	-0.03 (0.93)	-0.16 (0.64)
Slope NBFI	-	-	-	-	-3.43** (0.00)	-3.39** (0.00)
Slope CCP	-	-	-	-	-3.56*** (0.00)	-3.36*** (0.00)
Slope on-the-run	-	-	-	-	-	-1.06*** (0.00)
Adjusted Rsquared	35%	41%	50%	55%	55%	48%
Observations	1,189,501	1,189,501	1,189,501	1,189,501	1,189,501	1,189,501
Quarter and year end controls	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Time effects	*no*	*no*	*no*	*yes*	*yes*	*yes*
Collateral FE	*no*	*no*	*yes*	*yes*	*yes*	*no*
Reporting agent location FE	*no*	*no*	*yes*	*yes*	*yes*	*yes*

P-values in parenthesis: Significant levels: $*p < 0.1$; $**p < 0.05$; $***p < 0.01$.
This table shows estimations based on specification in equation 4. Transactions are segregated at the transaction level. In column 1 to IV the coefficient for *Slope* refers to the effect of higher MP expectations for all type of counterparties. Dates included in the analysis: from january 2019 to february 2024. In column VI we include the different effect of short positions demand pressure on repo rates (compared to off-the-run bonds).

Table 5: Estimated coefficients: Spanish collateral adding counterparty sector interactions

dependent variable: repo-DFR spread	(I)	(II)	(III)	(IV)	(V)	(VI)
Slope	-	-2.51*** (0.00)	-2.05*** (0.00)	-2.08*** (0.00)	-	-
SMOVE	-	-0.03*** (0.00)	-0.03*** (0.00)	-0.04*** (0.00)	-0.04*** (0.00)	-0.04*** (0.00)
EuriborOIS	-	0.24*** (0.00)	0.13*** (0.00)	0.16*** (0.00)	0.16*** (0.00)	0.15*** (0.00)
APP	-0.53*** (0.00)	-0.11*** (0.00)	-0.73*** (0.00)	-0.68*** (0.00)	-0.68*** (0.00)	-0.89*** (0.00)
NBFI vs bank	-	-	-	-	-3.09*** (0.00)	-2.61*** (0.00)
CCP vs bank	-	-	-	-	1.64*** (0.00)	0.51*** (0.00)
Slope bank	-	-	-	-	-1.29*** (0.00)	-1.73*** (0.00)
Slope NBFI	-	-	-	-	-0.47** (0.03)	-2.48** (0.03)
Slope CCP	-	-	-	-	-3.18*** (0.00)	-2.48*** (0.00)
Slope on-the-run	-	-	-	-	-	-0.35*** (0.00)
Adjusted Rsquared	43%	49%	53%	57%	58%	54%
Observations	1,164,961	1,164,961	1,164,961	1,164,961	1,164,961	1,164,961
Quarter and year end controls	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Time effects	*no*	*no*	*no*	*yes*	*yes*	*yes*
Collateral FE	*no*	*no*	*yes*	*yes*	*yes*	*no*
Reporting agent location FE	*no*	*no*	*yes*	*yes*	*yes*	*yes*

P-values in parenthesis: Significant levels: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

This table shows estimations based on specification in equation 4. Transactions are segregated at the transaction level. In column 1 to IV the coefficient for *Slope* refers to the effect of higher MP expectations for all type of counterparties. Dates included in the analysis: from january 2019 to february 2024.In column VI we include the different effect of short positions demand pressure on repo rates (compared to off-the-run bonds).

Table 6: Estimated coefficients: Italian collateral adding counterparty sector interactions

dependent variable: repo-DFR spread	(I)	(II)	(III)	(IV)	(V)	(VI)
Slope	-	-1.49*** (0.00)	-1.53*** (0.00)	-1.52*** (0.00)	-	-
SMOVE	-	-0.04*** (0.00)	-0.04*** (0.00)	-0.04*** (0.00)	-0.04*** (0.00)	-0.05*** (0.00)
EuriborOIS	-	0.25*** (0.00)	0.16*** (0.00)	0.19*** (0.00)	0.20*** (0.00)	0.17*** (0.00)
APP	-0.68*** (0.00)	-0.39*** (0.00)	-0.61*** (0.00)	-0.55*** (0.00)	-0.55*** (0.00)	-0.61*** (0.00)
NBFI vs bank	-	-	-	-	-11.13*** (0.00)	-10.85*** (0.00)
CCP vs bank	-	-	-	-	-1.47*** (0.00)	-1.08*** (0.00)
Slope bank	-	-	-	-	-3.33*** (0.00)	-2.93*** (0.00)
Slope NBFI	-	-	-	-	-1.22*** (0.00)	-1.00*** (0.00)
Slope CCP	-	-	-	-	-3.47** (0.03)	-3.00** (0.03)
Slope on-the-run	-	-	-	-	-	-0.54** (0.03)
Adjusted Rsquared	22%	29%	40%	44%	45%	36%
Observations	2,221,427	2,221,427	2,221,427	2,221,427	2,221,427	2,221,427
Quarter and year end controls	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Time effects	*no*	*no*	*no*	*yes*	*yes*	*yes*
Collateral FE	*no*	*no*	*yes*	*yes*	*yes*	*no*
Reporting agent location FE	*no*	*no*	*yes*	*yes*	*yes*	*yes*

P-values in parenthesis: Significant levels: $*p < 0.1$; $**p < 0.05$; $***p < 0.01$.

This table shows estimations based on specification in equation 4. Transactions are segregated at the transaction level. In column 1 to IV the coefficient for *Slope* refers to the effect of higher MP expectations for all type of counterparties.Dates included in the analysis: from january 2019 to february 2024.In column VI we include the different effect of short positions demand pressure on repo rates (compared to off-the-run bonds).

Table 7: Goodness-of-fit (R^2) indicators for different specification models

German collateral				
(1)	(2)	(3)	(4)	(5)
40%	53%	58%	58%	63%
French collateral				
(1)	(2)	(3)	(4)	(5)
23%	30%	35%	48%	51%
Spanish collateral				
(1)	(2)	(3)	(4)	(5)
48%	53%	57%	62%	66%
Italian collateral				
(1)	(2)	(3)	(4)	(5)
30%	39%	44%	49%	53%

The following specifications have been included:

(1): Only APP (see equation6); (2): APP + MP measures (equation 7); (3) : regression especified in equation 7 plus time effects; (4) : the previous one including counterparties and collateral identifiers; (5) : the final specification presented in equation 1.

Table 8: Alternative estimates

Repo - DFR spread				
Factors	Germany	Spain	France	Italy
Slope	-6.36*** (0.00)	-2.69*** (0.00)	-3.90*** (0.00)	-2.38*** (0.00)
SMOVE	-0.09*** (0.00)	-0.03*** (0.00)	-0.08*** (0.00)	-0.03*** (0.00)
Sov.spread	0.08*** (0.00)	- -	-0.08*** (0.00)	- -
EURIBOROIS	0.10** (0.01)	0.14*** (0.00)	0.18*** (0.00)	0.16*** (0.00)
APP	-0.60*** (0.00)	-0.24*** (0.00)	-0.67*** (0.00)	-0.62*** (0.00)
R^2	63%	66%	51%	53%
Observations	875.450	766.299	756.299	1.453.352

The following specifications have been included:
(1): Only APP (see equation6); (2): APP + MP measures (equation 7); (3) : regression especified in equation 7 plus time effects; (4) : the previous one including counterparties and collateral identifiers; (5) : the final specification presented in equation 1.

Figure 1: Transaction volumes for secured and unsecured money markets

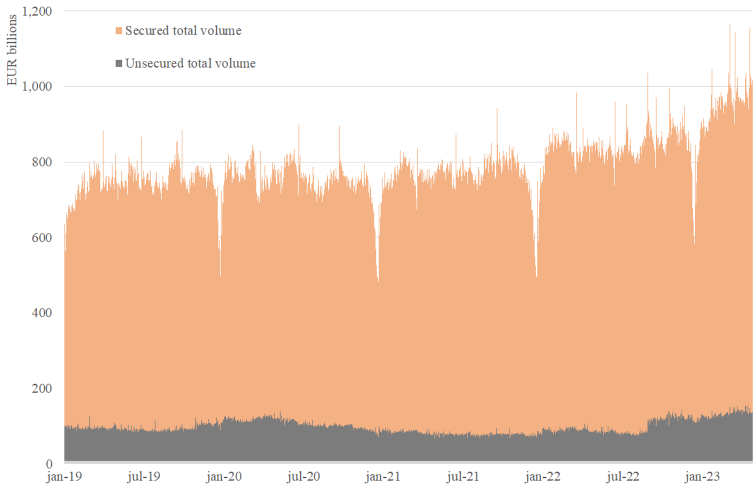


Figure 2: Government repo rate and €STR versus DFR.
Source: ECB, MMSR and own computations. Government repo rate has been computed as a weighted average rate of one-day maturity transactions (O/N, T/N, S/N) referenced to the settlement date, that are traded with a collateral issued by general government by Germany, Spain, France or Italy.

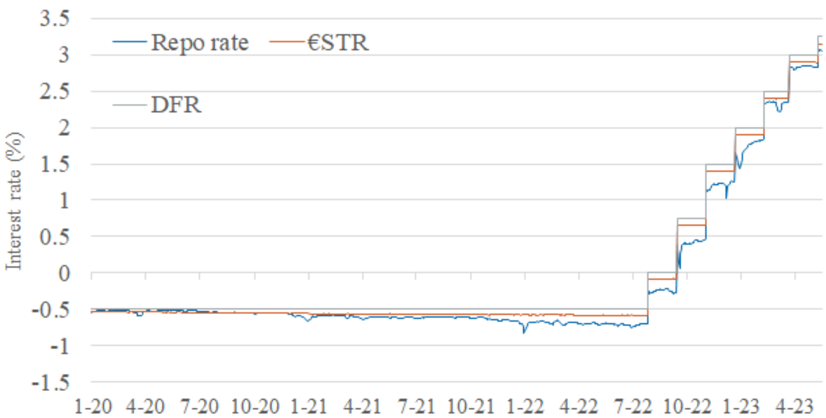
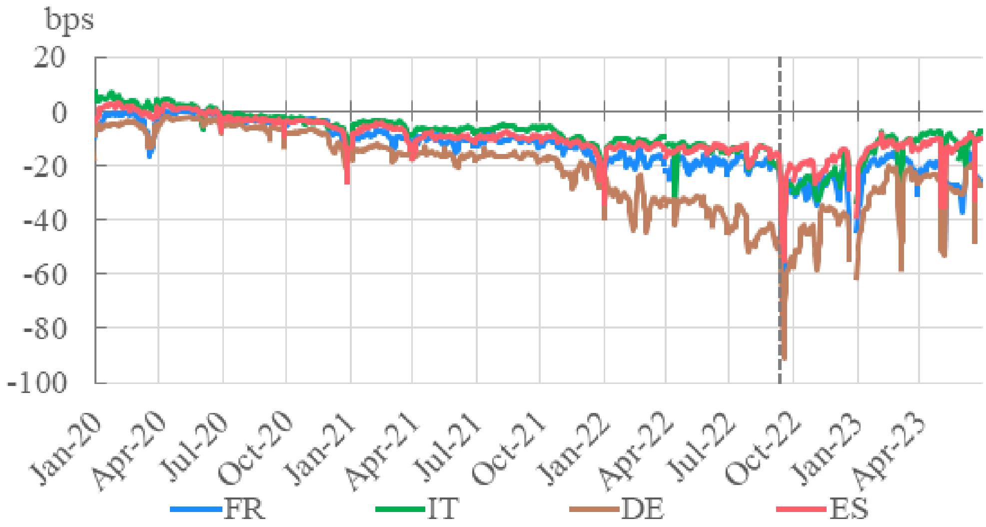
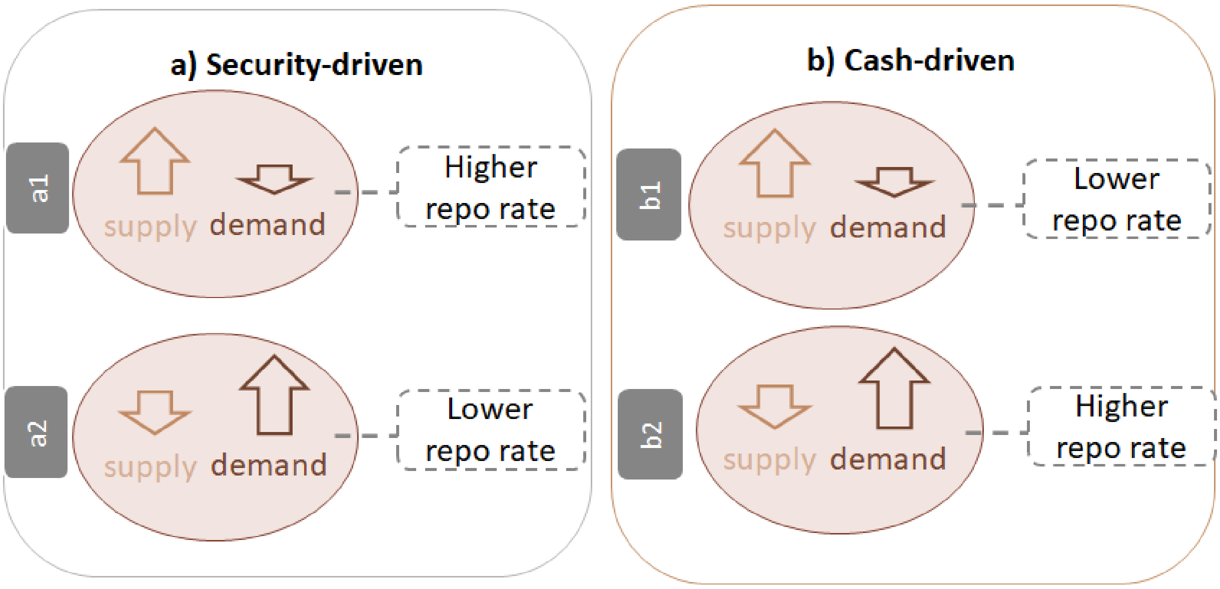


Figure 3: Repo-DFR spread by issuer location



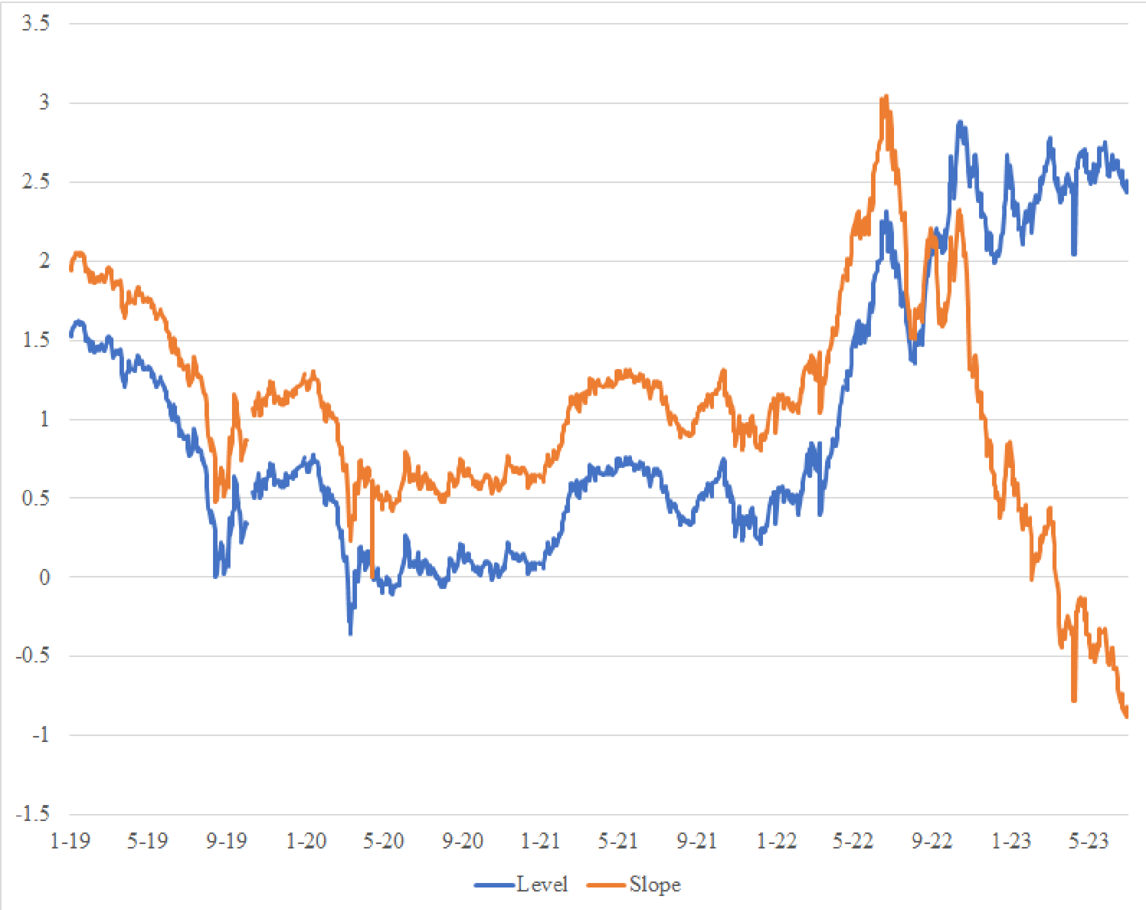
Source: MMSR and own computations. Repo rate breakdown by collateral issuer computed as the volume-weighted average.

Figure 4: The impact of changes in supply and demand of cash and collateral on repo rates



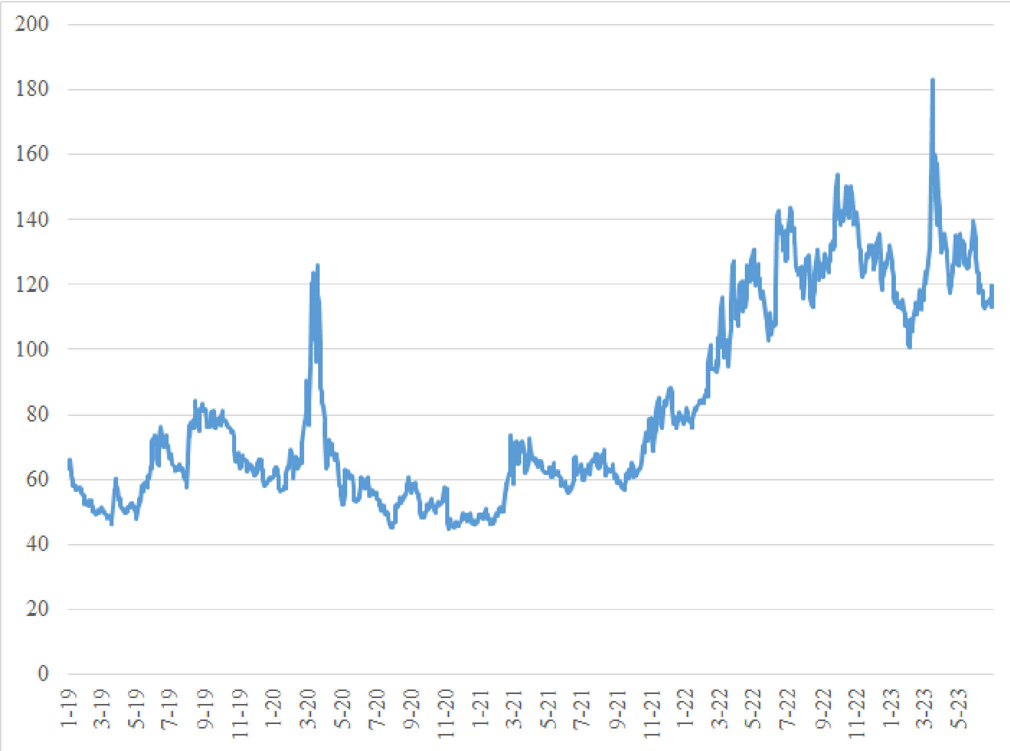
Source: authors.

Figure 5: Level and slope of the expected path of policy rates



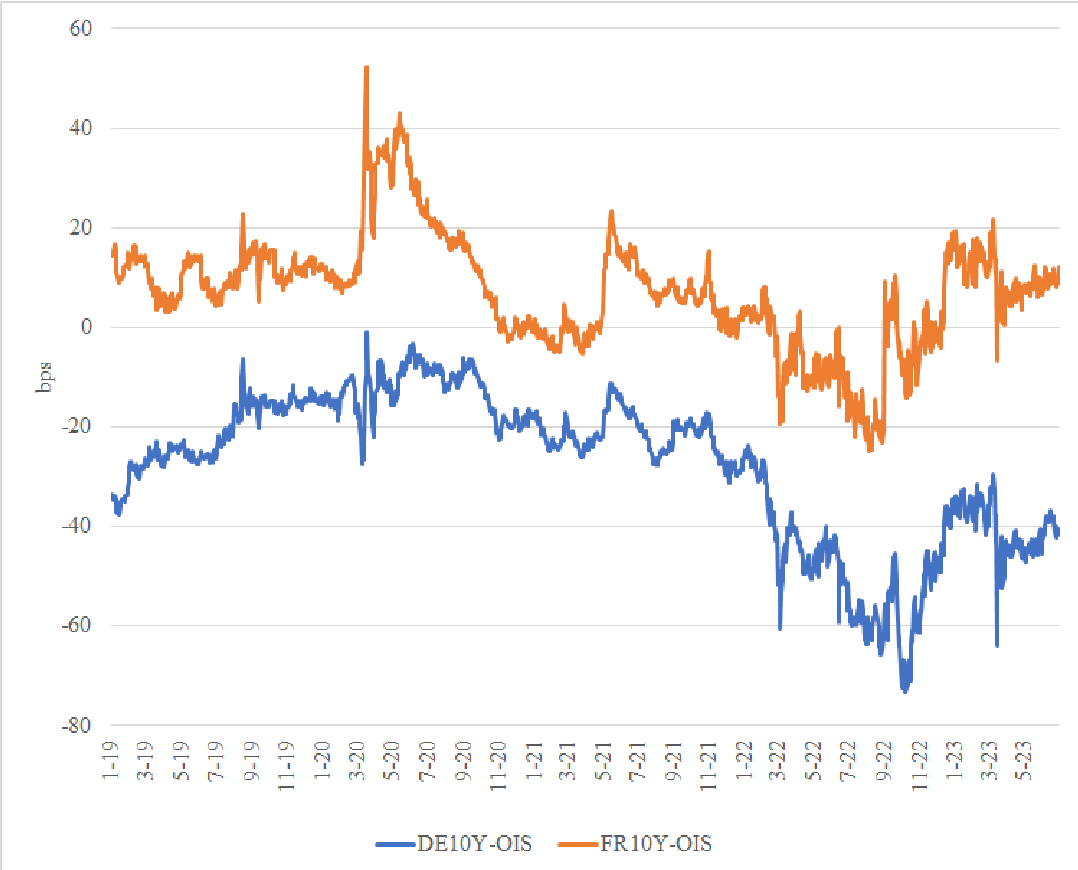
Source: Bloomberg and own computations. Level and slope constructed using OIS forward curves based on the Nelson-Siegel model

Figure 6: Monetary policy uncertainty (SMOVE)



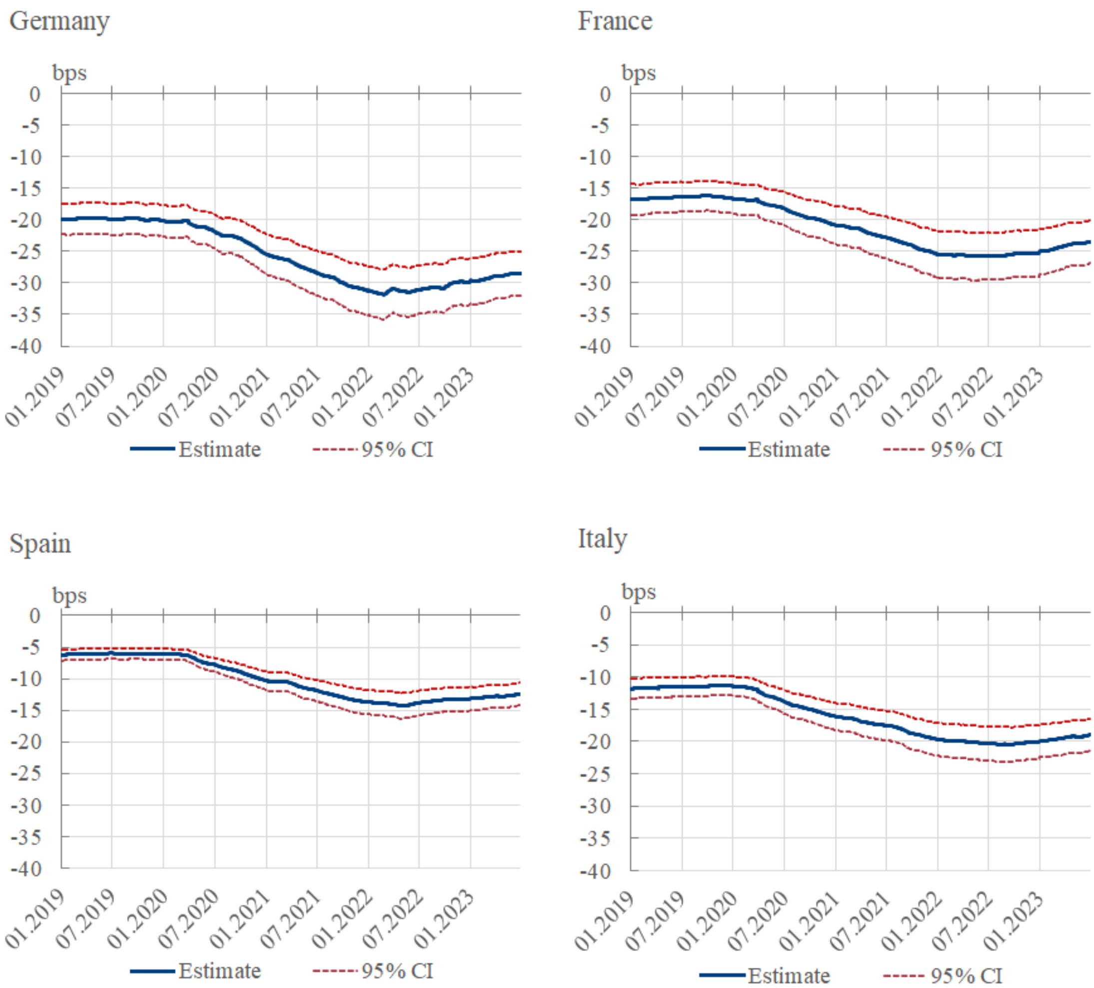
Source: Bloomberg. SMOVE index constructed by Merril-Lynch based on swaptions on Euribor 3 months.

Figure 7: Proxies for measuring flight-to-quality



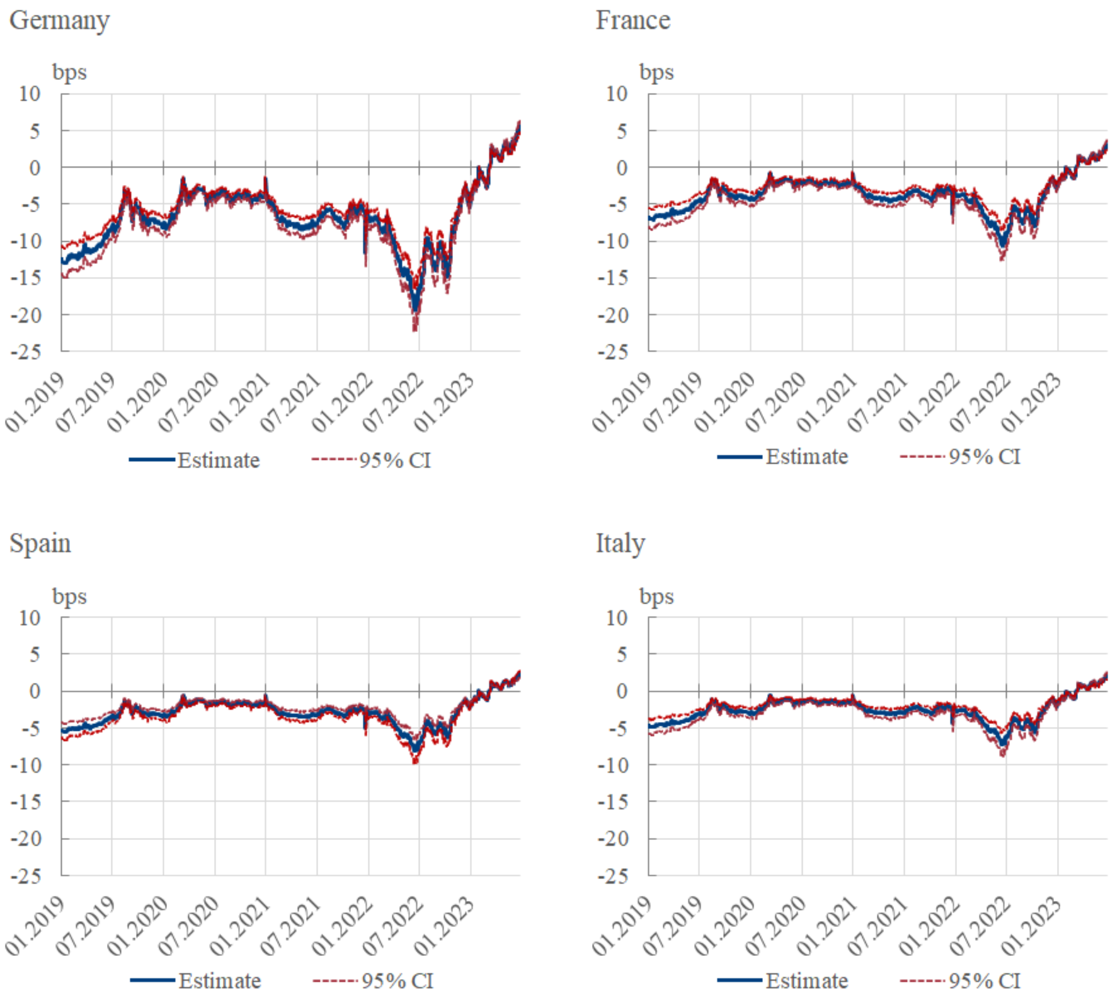
Source: Bloomberg. The chart shows the spread between the 10-year bond for Germany and France and the OIS with the same maturity.

Figure 8: Contribution of ECB footprint to the widening of repo-DFR spreads



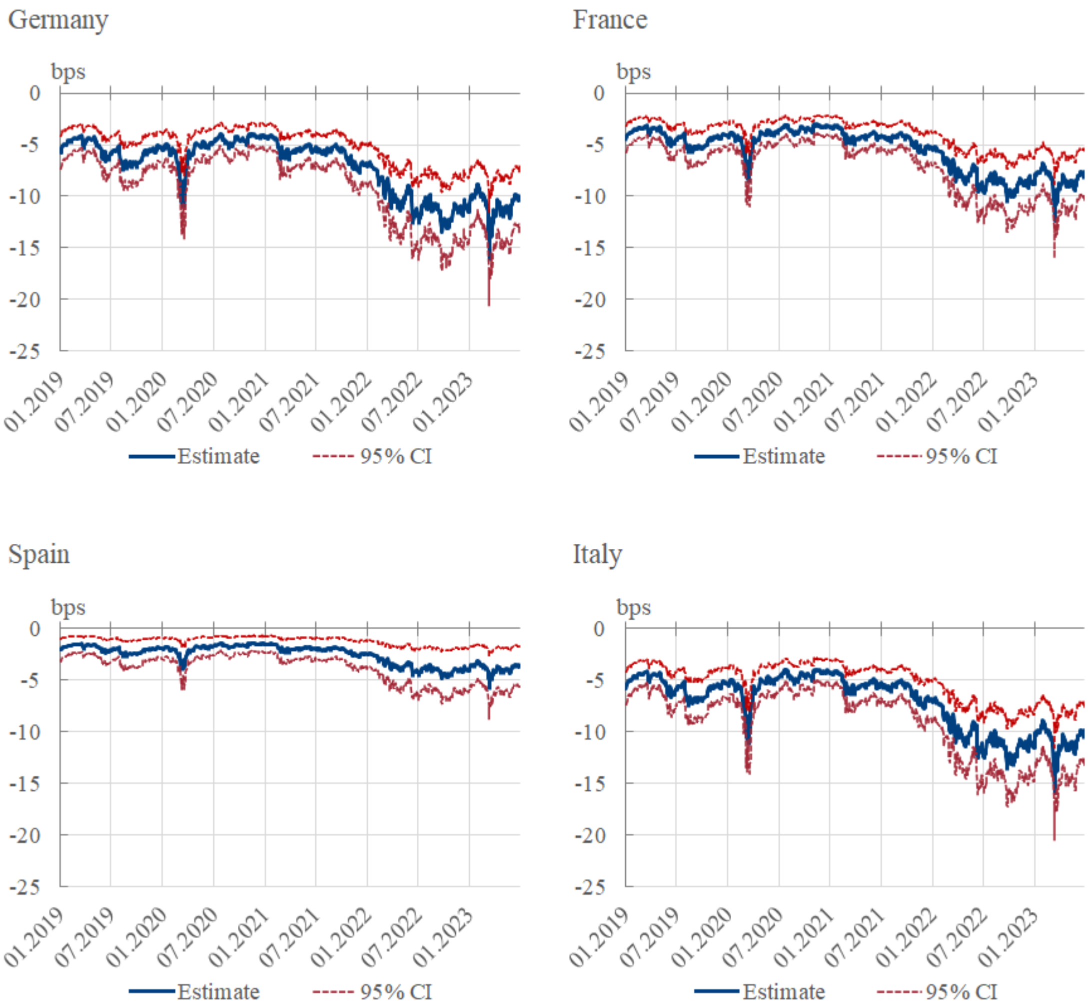
Source: MMSR, SDW datawarehouse and own computations. The estimated effect is computed as the estimated coefficient β_{APP} in equation 1 multiplied by the stock of Eurosystem holdings over free-float (in each country) in each transaction and at each moment in time. The timely estimated effects are shown as the volume-weighted average of estimation at the granular level. Confidence intervals at 95% are also shown.

Figure 9: Contribution of higher interest rate expectations to the widening of repo-DFR spreads



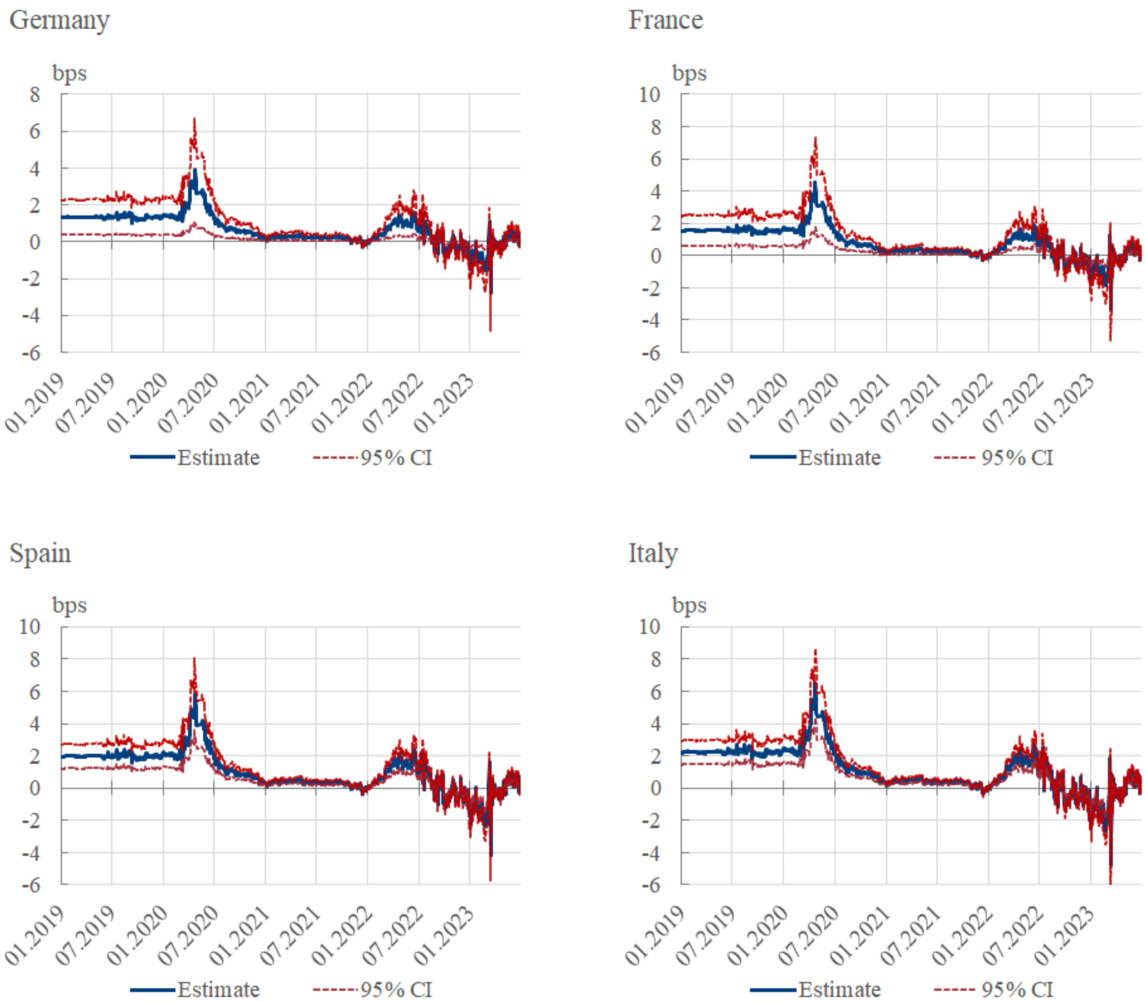
Source: MMSR, Bloomberg and own computations. The estimated effect is computed as the estimated coefficient β_{slope} in equation 1 multiplied by Slope. Confidence intervals at 95% are also shown.

Figure 10: Contribution of monetary policy uncertainty (SMOVE) to the widening of repo-DFR spreads



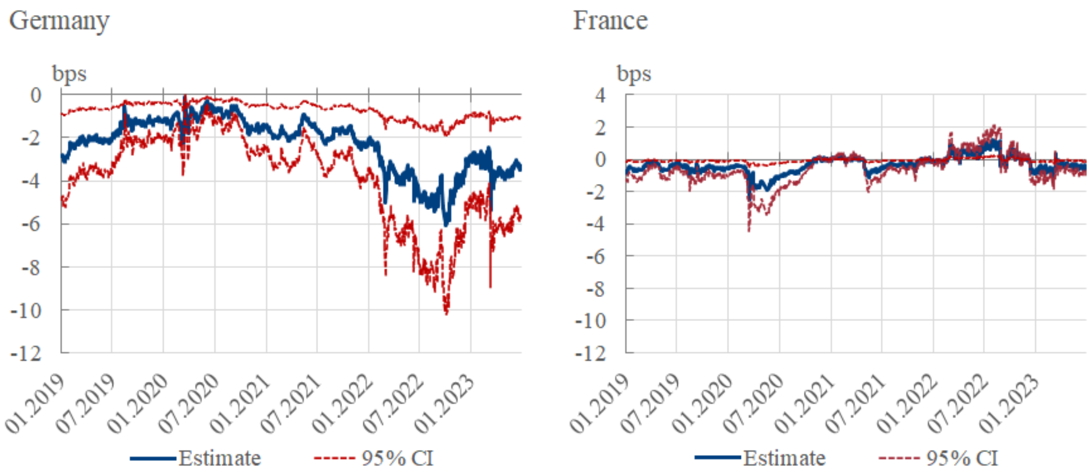
Source: MMSR, Bloomberg and own computations. The estimated effect is computed as the estimated coefficient β_{SMOVE} in equation 1 multiplied by the SMOVE index. Confidence intervals at 95% are also shown.

Figure 11: Contribution of Euribor-OIS to the widening of repo-DFR spreads



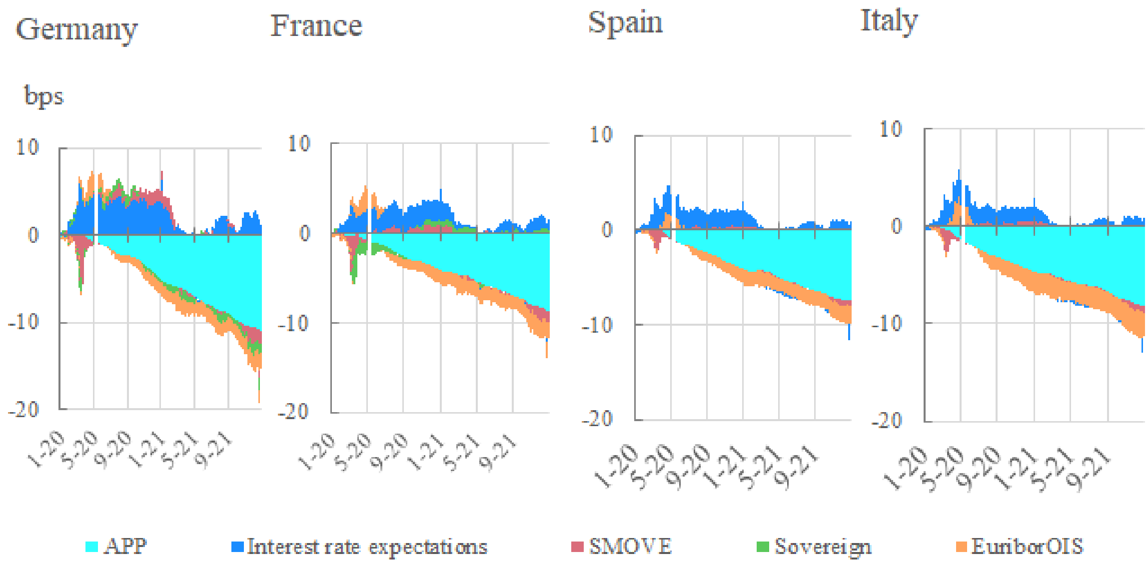
Source: MMSR, Bloomberg and own computations. The estimated effect is computed as the estimated coefficient $\beta_{Euribor}$ in equation 1 multiplied by the Euribor-OIS 3M. Confidence intervals at 95% are also shown.

Figure 12: Contribution of flight to quality to the widening of repo-DFR spreads



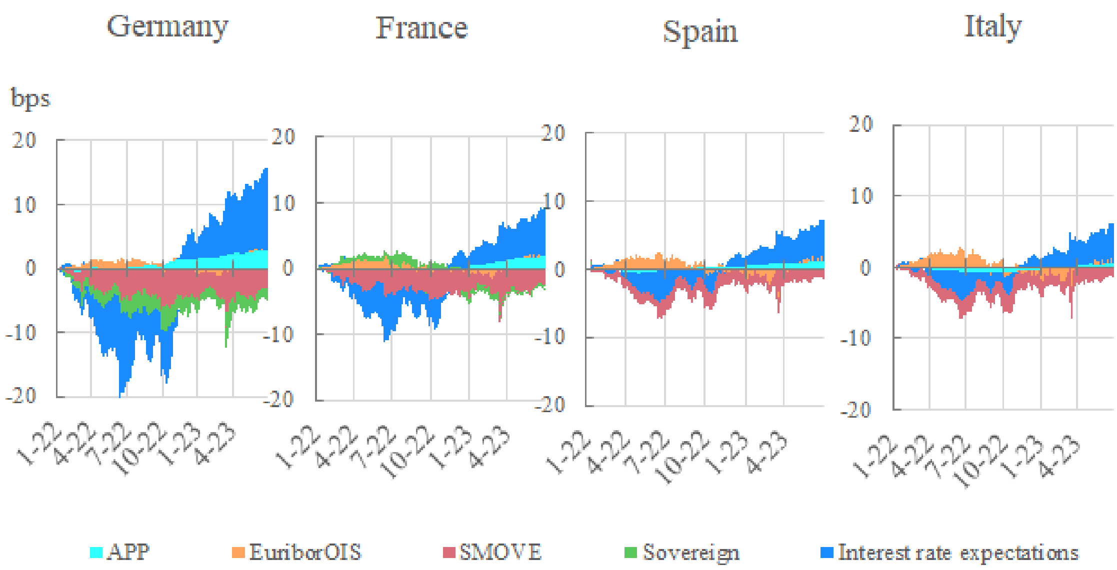
Source: MMSR, Bloomberg and own computations. The estimated effect is computed as the estimated coefficient $\beta_{Sovereign}$ in equation 1 multiplied by the 10-year sovereign minus the 10-year OIS. Confidence intervals at 95% are also shown.

Figure 13: Contribution of each factor to the widening of repo-DFR spread after COVID-19 pandemic



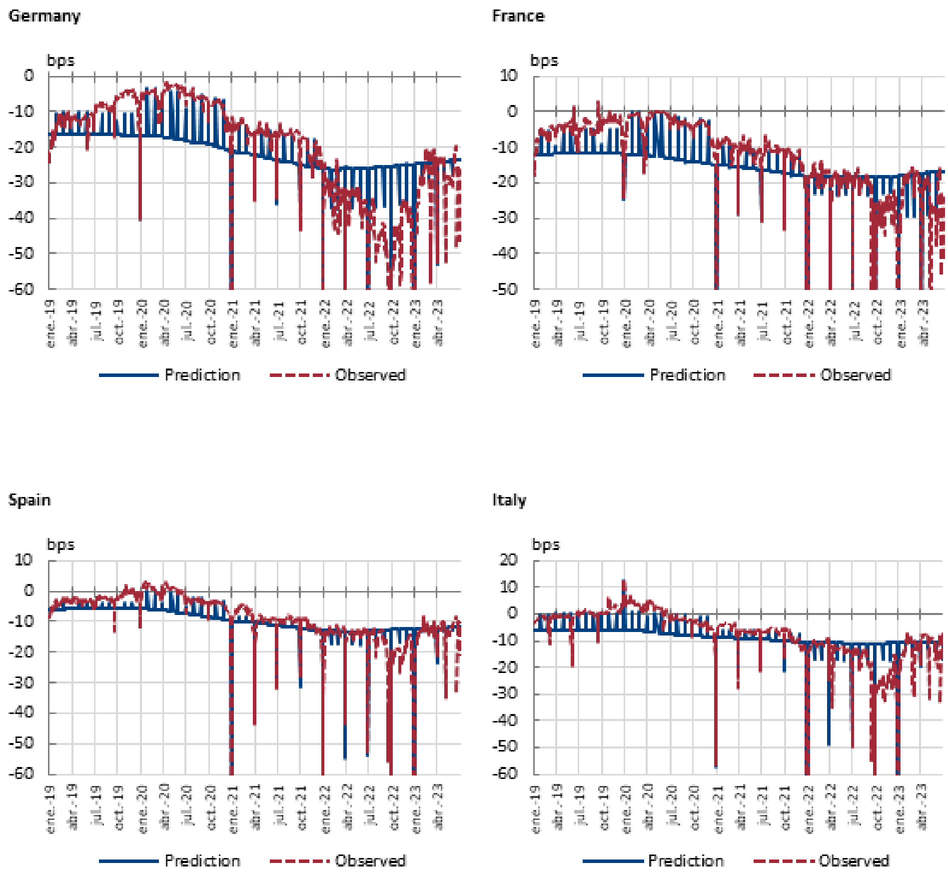
Source: MMSR, Bloomberg and own computations. The figure shows the accumulated change in the contribution of each factor since January 2020.

Figure 14: Contribution of each factor to the widening of repo-DFR during the normalisation of the monetary policy



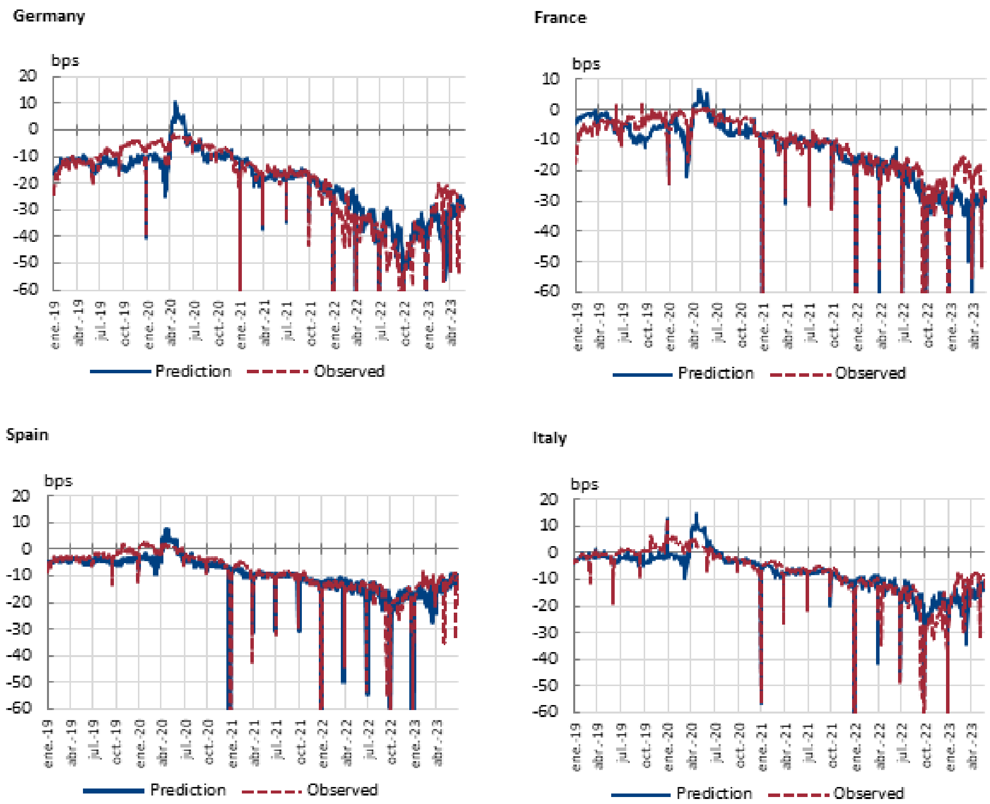
Source: MMSR, Bloomberg and own computations. The figure shows the accumulated change in the contribution of each factor since January 2022.

Figure 15: Estimated repo-DFR spread assessing only ECB footprint



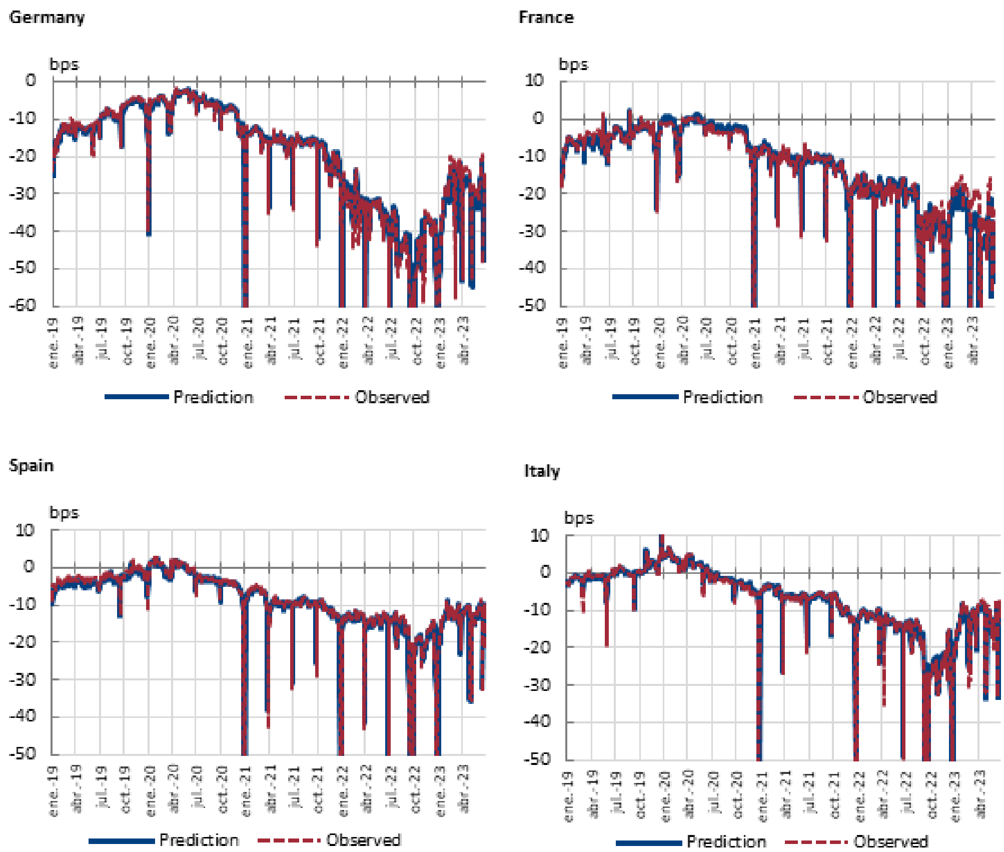
Source: MMSR, Bloomberg and own computations. The timely estimated effects are shown as the volume-weighted average of estimation at the granular level using specification in equation 6.

Figure 16: Estimated repo-DFR spread including MP normalisation



Source: MMSR, Bloomberg and own computations. The timely estimated effects are shown as the volume-weighted average of estimation at the granular level using specification in equation 7.

Figure 17: Estimated repo-DFR spread including MP normalisation, collateral and counterparty effects



Source: MMSR, Bloomberg and own computations.The timely estimated effects are shown as the volume-weighted average of estimation at the granular level using specification in equation 1.