Inelastic Demand and Elastic Supply: Pricing in the Repo Market *

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This draft: March 25, 2026

Abstract

We develop and quantify a model of supply and demand in the repo market. Using regulatory data for transactions collateralized by German Bunds, we classify market participants and identify the natural security suppliers—governments and central banks—and demanders—foreign hedge funds. We estimate sector-specific price elasticities using an optimal granular instrumental variables approach. We find that supply is highly elastic, whereas demand is strongly inelastic. Hedge funds are the marginal investors and play a central role in determining repo specialness. To rationalize these findings, we develop a parsimonious theoretical model in which hedge funds exhibit inelastic borrowing demand when sourcing securities enables large arbitrage profits. Consistent with the model, hedge fund demand significantly increases specialness, particularly when exploiting mispricings such as the cash–futures basis. Both theoretically and empirically, repo specialness arises from imbalances in the cash bond market. Our results highlight the tight linkage between bond and repo markets and underscore the role of foreign and non-bank financial institutions in monetary policy transmission.

JEL Classification Codes: E51, E52, E58, G21.

Keywords: Keywords: Monetary Policy, Repo Market, Bond Market, Safe Assets.

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*The views expressed here are our own and do not necessarily reflect those of the Deutsche Bundesbank, the European Central Bank (ECB), or the eurosystem. We thank Nina Boyarchenko, Stefania D'Amico, Ruggero Japelli, Gabriele La Spada, Matteo Leombroni, Angelo Ranaldo and the participants in the 8th Short-Term Funding Markets Conference, ChaMP 3rd Workshop in Banca d'Italia, ECB RCC1 Workshop, 12th University of York-BoE-BdF Asset Pricing Workshop. We are particularly grateful to ECB's Directorate General Market Operations's staff for their support with the data.

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1 Introduction

When and why does the repo market become special? Whose trades price specialness in the repo market? While textbook models relate specialness to demand for specific bonds to cover short trades (Duffie, 1996), the past decade has been characterized by large and persistent specialness episodes driven by collateral availability, owing especially to central banks' asset purchases.

Figure 1 illustrates, for the european repo market, that collateral availability—measured as the free-float of bonds outstanding—is linked almost one-to-one to repo specialness. Prime examples of reduction in free-float are the 2015–2017 and 2020–2022 periods, when the ECB's balance sheet expanded aggressively to accomodate QE purchases. Larger bond availability, which *improves* collateral availability and reduces specialness, on the other hand, followed the unprecedented increase in government debt supply and the gradual reduction of the ECB balance sheet, beginning in 2020 and 2023, respectively.

The relation between free-float and specialness, however, is hardly monotonic: For instance, while the free-float remained broadly stable between 2021 and 2022, repo specialness *rose* in 2022 to historically unprecedented levels. These developments suggest that collateral supply alone is far from the only driving factor of specialness, bringing the forefront the question of how demand for collateral in the repo market affects its pricing.

In this paper, we model and estimate supply and demand curves for collateral and link specialness to investors' elasticities, using a novel regulatory data, which provides the first source "who-to-whom" transactions in the repo market. We focus on the market for repo transactions backed by German government bonds, the second largest safe asset repo market in the world—with 200 billion EUR transactions daily—after the U.S. Treasury market.

We establish a topology of investors' participation in the repo market, looking through intermediaries and central counterparties, to identify the final lenders and borrowers in the German Bund repo market. We document three new facts. First, euro area banks, far from financing themselves in the repo market, tend to run matched repo books and, thus, have limited net exposure in the repo market. Repo is largely organized around euro-area and non-euro-area securities firms acting as dealers. Second, participation in the repo market is all but detached from bond holdings: large bond holders, like insurance companies and pension funds, barely participate to the repo market, while dealers and banks are extremely active in repos, while holding little net bond positions on their own. Third, the public sector—the Debt Management Offices (DMO) and the central banks—emerges as a key, natural, and nearly monopolistic lender of securities in the repo market,

via their securities lending facilities. On the other side, hedge funds constitute the main final securities borrowers, particularly those domiciled offshore.

To connect these quantities to their impact on repo rates and on the determination of the specialness premium, we adapt the optimal granular instrumental variables (OGIV) framework of Chaudhary, Fu, and Zhou (2024) to the repo market, to estimate both the price elasticity of supply (i.e. of net securities lenders) and the price elasticity of demand (i.e. of net securities borrowers). Estimating demand (supply) elasticities requires dealing with the endogeneity between sectoral repo borrowing and repo market rates. To address this issue, Chaudhary et al. (2024) develops an optimal generalized method of moments (GMM) estimator.

Our identification strategy follows the standard approach in the literature, by exploiting idiosyncratic, sector-specific shocks. These shocks are used as instruments for repo rates in other sectors, ensuring exogenous variation. The model allows us to estimate a repo market–wide elasticity, estimate an elasticity at the sector level, and decompose the specialness changes into their sector- and factor-specific contributions. We estimate an aggregate elasticity of 1.2, implying that a 10% demand shock increases repo specialness by approximately 8%, the inverse of the aggregate elasticity. In our sample, this corresponds to a 2 basis point increase in specialness for a EUR 1 billion increase in net repo borrowing.

We show that non–euro area hedge funds are the most price-inelastic investors in the market: hedge funds borrow bonds trading on special, aggravating specialness. This behavior is consistent with funds engaging in profitable relative-value trades: In our sample, cash prices diverged markedly from futures prices, and other measures of cash-market mispricing spiked, such as asset swap spreads and deviations from fitted yield curves. Hedge funds capitalized on these arbitrage opportunities by shorting bonds in the cash market, while taking offsetting long positions in futures. Through these short bond sales, hedge funds indirectly satisfied demand for bonds in the cash market.

To rationalize these findings, we develop a parsimonious model that links the cash bond market, the futures market, and the repo market through the behavior of asset managers, hedge funds, and securities lenders. Asset managers have a structural preference for holding the physical bond, which makes cash bonds rich relative to synthetically equivalent futures positions. Hedge funds exploit this wedge by shorting the bond and taking offsetting long positions in futures. On the supply side, dealers and the central bank provide securities through lending, with supply that is increasing in specialness but subject to intermediation and institutional costs.

This framework delivers two central findings that provide a framework to interpet our empirical analysis. First implication of the model is that, because shorting the bond requires borrowing it in the repo market, cash-market imbalances translate directly into repo borrowing demand. Conditional on a profitable basis trade, hedge funds' repo borrowing is thus not determined by a conventional downward-sloping demand curve, but is instead pinned down by the equilibrium imbalance in the cash market.

Equilibrium specialness is therefore determined by the interaction between a demand for securities borrowing that originates in the cash-market and an upward-sloping supply of collateral. A second implication is that, while hedge funds are highly elastic in the cash market—expanding their positions to accommodate asset-manager demand—they are effectively inelastic in the repo market, as borrowing is a necessary input into the arbitrage trade. Together, these results provide a unified interpretation of repo specialness as an equilibrium outcome of cross-market positioning rather than a purely mechanical reflection of collateral scarcity.

We find that while hedge funds remained similarly inelastic during quantitative easing and quantitative tightening, their positioning in the repo market changed. Starting in 2023, hedge funds reduced their net securities borrowing positions, driving down specialness alongside a broader reduction in mispricing measures.

Our methodology allows us to estimate the elasticities of both repo market demand and supply. We find that collateral supply, quite surprisingly, is predominantly provided by the public sector, acting as the main natural securities lender in the repo market via the DMO and central bank securities lending facilities. The differences in pricing of these facilities in the euro area gave more prominence to the DMO in providing collateral to the repo market. Overall, our results highlight the strong integration between cash and repo markets and indicate that monetary policy transmission in euro-area collateral markets—through repo pricing—increasingly depends on the participation of non–euro area entities, such as hedge funds, to the market.

The remainder of this paper is structured as follows. Section 3 explores the novel data we use to get a full picture of borrowers, lenders and intermediaries in the repo market, and draw a topology of the German Bund repo. Section 4 adapts the Optimal GIV (OGIV) framework to our setup, and section 5 presents the aggregate and sector-specific elasticites estimated with the OGIV. Given the prominence of hedge funds in the pricing of specialness, we discuss their trading strategies and their role in connecting cash and repo market in section 6. Section 7 concludes.

Literature Review

This paper relates to several strands of the literature. First, it contributes to the demand-system literature pioneered in asset pricing by Koijen and Yogo (2019a) and Gabaix and Koijen (2024), who developed the granular instrumental variables (GIV) framework. This approach has been applied to a variety of asset classes, including equities (Gabaix and Koijen, 2021), the U.S. Treasury market (Kaminska and Zinna, 2020; Jansen, Li, and Schmid, 2024; Chaudhary et al., 2024), and foreign exchange markets (Kubitza, Sigaux, and Vandeweyer, 2024). To the best of our knowledge, our paper is the first to estimate demand and supply price elasticities for the repo market.

Methodologically, we adopt the Optimal GIV approach developed by Chaudhary et al. (2024), which is particularly well suited to our setting as it allows elasticities to be estimated at the sector level, rather than only at the aggregate market level. In addition, this paper is the first to use transaction-level data from the Securities Financing Transactions Data Set (SFTDS) to map the entire repo market for the European safe asset collateral and link investors' positions to prices. Our work complements the work by Hermes, Schmeling, and Schrimpf (2025), who use SFTDS to highlight U.S. dollar–repo positions by European banks.

Our work also relates to the literature highlighting the importance of repo market specialness for monetary policy transmission (Nguyen, Tomio, and Vari, 2023), bond–futures pricing (Pelizzon, Subrahmanyam, and Tomio, 2025), and the term structure of interest rates (D'Amico and Pancost, 2022; Jappelli, Subrahmanyam, and Pelizzon, 2023). Conceptually, Duffie (1996) models demand for repos as a by-product of bond short selling, a mechanism that is central to our interpretation of hedge fund activity.

Our paper contributes to the literature on public sector interventions in repo markets. The impact of eurosystem's security lending facilities in alleviating repo specialness has been studied by Jank and Moench (2018); Baltzer, Schlepper, and Speck (2022); Greppmair and Jank (2023); Carrera de Souza and Hudepohl (2024). Using transaction-level data from the Deutsche Finanzagentur, Ampudia, Formoso da Silva, Hesse, Putz, Schobert, von Landesberger, and Wohlert (2025) study the interactions between the eurosystem and German Treasury activities in the cash and repo markets for their respective Security lending facilities for German collateral.

Finally, our paper underscores the role of hedge funds in the repo market, so far studied primarily in the U.S. context. Barth and Kahn (2025) show that basis trades account for the

large majority of hedge fund positions in the U.S. Treasury repo market. In related work, Chaudhary et al. (2024) find that hedge funds are the most elastic investors in the U.S. Treasury market, while similar results for the euro-area cash bond market are documented by Koijen, Koulischer, Nguyen, and Yogo (2021). d'Avernas, Petersen, and Vandeweyer (2025) develop a theoretical model of the interaction between banking regulation and central bank balance sheet, and show how they impact hedge funds' compensation for liquidity, i.e., the cash-futures basis.

2 Theoretical Framework

This section develops a simple one-period model designed to capture the mechanism underlying the elasticities estimated in our empirical analysis. The model features three markets, the cash bond-, futures-, and repo-market. The central agents in the model are hedge funds, which act as a link between the cash bond and repo markets: They allow the former to clear, by borrowing bonds in the latter, increasing supply. Hedge funds' motive is profititing from the wedge in price between the physical bond and a synthetically equivalent futures position. The wedge originates from asset managers' preference for holding the cash bonds, which makes them "rich" relative to the futures.[1] Because shorting the bond requires borrowing it in the repo market, cash-market imbalances translate into hedge funds' repo borrowing demand. This demand, combined with the securities-lending supply from dealers and the central bank, determines the level of specialness at which the repo market clears.

The model is characterized by three traded assets: a cash bond, a futures contract on the same underlying bond, and a risk-free asset available in perfectly elastic supply at rate r_s, which can be interpreted as the policy rate. The model derives demand and supply functions for the three markets from the agents' objective functions. The net supply of futures is zero, while the physical supply of the bond is exogenous. There are four types of agents: asset managers (A), hedge funds (H), dealers (D), and the central bank (CB). Asset managers and hedge funds interact in the cash bond market. Hedge funds, dealers, and the central bank interact in the repo market. We first present the objective functions of the four investors, then solve for cash- and the repo-market equilibria.

[1] While we refer to this synthetical asset as a futures contract, they may be thought to be asset or interest-rate swaps, as well.

2.1 The Hedge Fund

Hedge funds have mean-variance preferences and implement a range of strategies, including relative-value arbitrage. They trade in both the cash bond and futures markets and obtain bonds in the repo market to support short positions. The relative-value strategy exploits the cash-futures wedge, or basis, defined as $x = r_F - r_T > 0$, i.e., the per-unit return advantage of a long futures position relative to a long cash-bond position.

Hedge funds implement this trade by shorting the bond and taking an offsetting long futures position, earning gross arbitrage profits equal to x before repo and margin costs. A positive basis therefore reflects a situation in which the cash bond is rich relative to futures: obtaining exposure through the physical bond is more expensive than replicating it synthetically, consistent with a premium paid by asset managers for holding the underlying security.

To short the bond, the hedge fund must borrow it in the repo market. Let $\chi > 0$ denote the specialness spread, i.e., the spread between the policy rate and the repo rate received from lending cash against the borrowed bond. Specialness is therefore the per-unit cost of obtaining the scarce bond.

The representative hedge fund chooses a short position in the cash bond, $D_H < 0$, and a futures position with two components. The first is a hedging leg, denoted $D_F^H > 0$, which supports the basis trade and satisfies

$$D_F^H = -D_H. \tag{1}$$

The second is an additional directional futures position, N_F^H, which can be long or short.

The cash bond and the futures contract reference the same underlying bond, so their returns are perfectly correlated: $\text{corr}(r_T, r_F) = 1$. Since hedge funds perform relative-value strategies with $D_F^H = -D_H$, the variance of the basis-trade component is zero. The directional trade exposes the fund to the common variance in bond and futures returns, σ^2, that for simplicity we assume equal to 1.

Both the basis-trade futures leg and the directional futures position require margin. Let $m > 0$ denote the margin requirement per unit of futures exposure, and let $k > 0$ denote the opportunity cost of one unit of posted margin. Total margin usage must be lower than the fund's equity capital $E_H > 0$:

$$m\left(|D_F^H| + |N_F^H|\right) \leq E_H. \tag{2}$$

A hedge fund that shorts the bond and finances in repo pays χ per unit. Once specialness and funding costs are accounted for, the basis trade earns a per-unit profits equal to $x - \chi - mk$ and the directional future position earns $N_F^H(r_F - r_s) - m|N_F^H|$. The basis trade is profitable if $x > \chi + mk$. The hedge fund objective function is therefore:

$$\max_{D_F^H,\, N_F^H} \quad D_F^H(x - \chi - mk) + N_F^H(r_F - r_s) - km|N_F^H| - \frac{1}{2B}(N_F^H)^2 \tag{3}$$

subject to (1) and (2), where $B > 0$ is hedge fund risk tolerance. The directional futures position is standard and is characterized by a no-trade region induced by the margin friction.

Lemma 1 (Optimal basis trade)**.** *Two cases arise:*

(i) Basis trade profitable *($x > \chi + mk$): the hedge fund optimally sets $D_F^H = -D_H$, earning a riskless profit of $D_F^H(x - \chi - mk)$. Since this profit is linear and increasing in D_F^H, the hedge fund is willing to take as large a short bond position as possible.*

(ii) Basis trade unprofitable *($x \leq \chi + mk$): the hedge fund does not engage in the basis trade. $D_F^H = 0$ and $D_H = 0$.*

Lemma 2 (hedge fund future directional positions)**.** *The optimal directional futures position is*

$$N_F^{H*} = \begin{cases} 0, & \text{if } |r_F - r_s| \leq km, \\ B(r_F - r_s - km), & \text{if } r_F - r_s > km, \\ B(r_F - r_s + km), & \text{if } r_F - r_s < -km. \end{cases}$$

2.2 The Asset Manager

Asset managers—such as pension funds, insurance companies, and bond mutual funds—have a structural preference for holding the physical bond rather than obtaining equivalent exposure synthetically. We capture this reduced-form demand pressure by assuming that asset managers are the only investors willing to bear unhedged duration risk. Let $D_A \geq 0$ denote their bond holdings. Each unit earns excess return $r_T - r_s$ over the risk-free asset. Assuming that the variance of the bond return is equal to one, the representative asset manager solves

$$\max_{D_A \geq 0} \quad D_A(r_T - r_s) - \frac{1}{2A} D_A^2,$$

where $A > 0$ is risk tolerance. The asset manager's optimal demand is increasing in the term premium and in risk tolerance:

$$D_A^* = A(r_T - r_s).$$

2.3 The Repo Dealer

The representative dealer is only active on the repo market, where it chooses the quantity $D_R^D \geq 0$ of bonds to lend. For each unit lent, the dealer earns the specialness spread χ, but incurs a convex cost of sourcing securities. This reduced-form cost captures balance-sheet charges, search frictions, and operational costs associated with locating and delivering scarce collateral.[2] The dealer solves

$$\max_{D_R^D \geq 0} \quad D_R^D \chi - \frac{\gamma}{2}(D_R^D)^2,$$

where $\gamma > 0$ governs the marginal cost of supplying bonds. The first-order condition implies the dealer's optimal supply, which is upward-sloping in specialness:

$$D_R^{D*} = \frac{\chi}{\gamma}. \tag{4}$$

2.4 The Central Bank

The central bank lends securities through a securities lending facility associated with a legacy portfolio of asset purchases $\bar{Q} > 0$. We model central-bank lending as a reduced-form tradeoff between alleviating repo-market distortions and limiting the use of its balance sheet to avoid crowding out private market intermediation. Specifically, the central bank chooses D_R^{CB} to solve

$$\min_{D_R^{CB} \in [0, \bar{Q}]} \frac{1}{2}\chi^2 + \frac{\lambda}{2}(D_R^{CB})^2, \tag{5}$$

where $\lambda > 0$ captures the cost of lending. The first term reflects the central bank's desire to limit deviations of repo rates from the policy rate; the second captures operational or institutional costs of providing collateral to the market, or the political cost of crowding out the private security lenders.

[2] We can think of these dealers as custodian banks that lend the asset managers' holdings, while keeping any profit from security lending.

2.5 The Cash Market Equilibrium

We next characterize cash-market clearing. Let S_T denote the exogenous physical supply of the bond available to the private sector, net of any central-bank holdings. The cash market clears when asset-manager holdings plus hedge fund holdings equal net supply. When the basis trade is profitable, the hedge funds accommodate the excess demand of asset managers by shorting the bond. In that case, their equilibrium position is pinned down by cash-market clearing:

$$D_H^* = S_T - D_A^*.$$

In the empirically relevant case in which asset managers demand more bonds than are available physically, $D_A^* > S_T$, and hence $D_H < 0$: hedge funds supply bonds to the cash market through short sales. By contrast, if the basis trade is not profitable, hedge funds are absent from the cash market and asset managers hold the available supply.

Lemma 3 (Cash-market equilibrium)**.** *Suppose the hedge fund's equity constraint does not bind.*

(i) Profitable basis trade: *If $x > \chi + mk$, the basis trade is profitable and the hedge fund's supply of bonds to the cash market is perfectly elastic. The hedge fund earns the same per-unit riskless profit $x - \chi - mk$ on every bond, so its supply curve in the cash market is horizontal. The hedge fund's bond supply in equilibrium is determined entirely by the asset manager's excess demand with respect the physical supply S_T :*

$$D_H^* = S_T - D_A^* < 0.$$

(ii) Unprofitable basis trade: *If $x \leq \chi + mk$, the hedge fund's supply of bonds to the cash market is perfectly inelastic at $D_H = 0$, regardless of the prevailing price. Asset managers can only hold the physical supply: $D_A = S_T$.*

Lemma 3 highlights the key asymmetry we want to capture with this model. Conditional on a profitable basis trade and no capital limits, the hedge fund's cash-market position is pinned down by the cash-market imbalance created by asset-manager demand for the physical bond, which the hedge fund is willing to accommodate in full.

2.6 The Repo Market Equilibrium

On the repo market, hedge funds borrow bonds to support their short cash positions. Dealers and the central bank supply those bonds through securities lending. Repo-market

clearing requires that hedge fund bond borrowing equal the total securities-lending supply:

$$|D_H^*| = D_R^D + D_R^{CB}. \tag{6}$$

Substituting (4) into (6) and assuming that $|D_H^*| > D_R^{D*}$, yields equilibrium specialness as a function of hedge fund borrowing and central-bank lending:

$$\chi = \gamma \left(|D_H^*| - D_R^{CB} \right). \tag{7}$$

Specialness is therefore the dealer's marginal cost evaluated at the residual demand that the central bank does not absorb. The central bank internalizes this relationship when choosing how much to lend. Substituting (7) into (5), the interior solution is

$$D_R^{CB*} = \frac{\gamma^2}{\gamma^2 + \lambda} |D_H^*|. \tag{8}$$

The central bank absorbs a larger share of repo borrowing demand when its lending cost λ is low and when dealer supply is steep, i.e., when γ is high. The interior solution is valid whenever $D_R^{CB*} \leq \bar{Q}$; otherwise the portfolio constraint binds and $D_R^{CB} = \bar{Q}$.

We can now state the central implication of the model. When the basis trade is profitable, the hedge fund's repo borrowing is determined by the equilibrium in the cash-market, as it must borrow exactly the quantity of bonds that it shorts. Thus, hedge funds' repo borrowing is pinned down by the cash-market imbalance and is therefore insensitive to repo specialness, i.e., inelastic. Therefore, hedge fund elasticity in the repo market is bimodal, as described in the following proposition.

Proposition 1 (Repo borrowing demand)**.** *Suppose the hedge fund's equity constraint does not bind.*

(i) Profitable basis trade: *If $x > \chi + mk$, the hedge fund's supply of bonds to the cash market is perfectly elastic and determined by asset managers excess demand $D_H = S_T - D_A^* < 0$. Since the quantity of short position D_H is determined entirely by cash-market clearing, the repo bond borrowing demand by hedge funds, $|D_H|$, is therefore inelastic to the specialness of the bond in the repo market.*

(ii) Unprofitable basis trade: *If $x \leq \chi + mk$, the hedge fund does not trade the basis or borrow bonds in the repo market $|D_H| = 0$.*

Finally, we characterize repo supply. Combining the dealer and central-bank problems yields simple upward-sloping supply schedules.

Proposition 2 (Repo-market supply)**.** *In the repo market, securities-lending supply is upward-sloping in specialness.*

(i) Dealer supply is

$$D_R^D = \frac{1}{\gamma}\chi.$$

A lower dealer cost parameter γ makes private supply more elastic.

(ii) Central-bank supply is

$$D_R^{CB} = \frac{\gamma}{\lambda}\chi$$

for the interior solution. A lower central-bank lending cost λ or a higher dealer sourcing cost γ makes public supply more elastic.

(iii) Aggregate repo supply is

$$D_R^D + D_R^{CB} = \left(\frac{1}{\gamma} + \frac{\gamma}{\lambda}\right)\chi = \frac{\gamma^2 + \lambda}{\gamma\lambda}\chi. \tag{9}$$

Aggregate supply becomes less elastic when central-bank lending costs (λ) increase.

The equilibrium specialness is determined by the intersection of the hedge fund's perfectly inelastic demand (Proposition 1) at $|D_H|$ with the aggregate upward-sloping supply schedule (9).

Taken together, Propositions 1–2 deliver the mechanism that underlies our empirical analysis. Asset manager demand makes the cash bond relatively rich compared to futures. Hedge funds respond by shorting the bond and going long futures whenever the basis exceeds repo and margin costs, and their supply in the cash bond market is perfectly elastic. Because maintaining that arbitrage position requires borrowing the bond in repo, the cash-market imbalance translates directly into repo borrowing demand, which, in turn, is independent of specialness, i.e., inelastic. As the supply of security lending from dealers and the central bank is not perfectly elastic, the equilibrium specialness is positive.

In this sense, specialness is not driven by collateral scarcity in a mechanical sense; it reflects the interaction between cash-market demand for the physical bond and the elasticity of repo-market supply. This means that any change in the demand in the cash bond market—through the asset manager's risk tolerance, A, or the term premium, $r_T - r_s$—or supply of bonds S_T translates into changes in specialness in the repo market. Naturally, specialness also depends on frictions arising from dealers' balance sheet charges, search frictions, and operational costs, as well as on changes in the implementation of the central bank's securities lending facilities.

The benchmark results above are derived under the assumption that the hedge fund's equity constraint does not bind. When capital becomes scarce, the scale of the basis trade also depends on available equity and on the profitability of alternative futures positions. We treat that case in the appendix. Appendix A.1 also derives the joint equilibrium implications for specialness and the basis.

3 The Repo Market: Data and Topology

We analyze the repo market for German central government collateral from March 2021 to June 2024. This section presents the main datasets used in our analysis—with a specific focus on the most novel source, the Securities Financing Transactions Data Store (SFTDS)—and a first look at the data's descriptive statistics.

3.1 Data

The Securities Financing Transactions Regulation (SFTR), introduced in 2016 following Financial Stability Board recommendations, mandates reporting of securities financing transactions—including repos, buy–sell backs, securities lending, and margin lending—to authorized trade repositories.[3] As a result, SFTDS provides a near-exhaustive view of repo activity involving euro-area counterparties, substantially improving upon earlier datasets such as MMSR, which covered only selected dealers and did not allow for CCP look-through.

Because each transaction is reported multiple times by different counterparties, deduplication is required. A single CCP-cleared transaction typically generates four reports when all parties are euro-area domiciled. We describe our deduplication algorithm in Appendix A.2. In brief, it links ultimate securities lenders and borrowers, tracks any CCP intermediation, and consolidates all reports corresponding to the same economic transaction. Central banks and government debt management offices are exempt from reporting, although their counterparties must still report transactions conducted with them.

From the cleaned transactions, we construct daily stock positions that account for repo maturities. The methodology is detailed in Appendix A.2. Counterparties are identified by Legal Entity Identifier (LEI), country of domiciliation, and ESA 2010 sector classification. Because this classification does not distinguish dealers from other deposit-taking monetary

[3] See Financial Stability Board, *Policy Framework for Addressing Shadow Banking Risks in Securities Lending and Repo*, and EU Regulation 2015/2365.

(MFIs) or other financial institutions (OFIs), we supplement it with Bloomberg data to identify dealers explicitly. We refer to non-dealer banks as MFIs throughout.

We thus group counterparties into eight sectors: banks (MFIs excluding central banks), hedge funds (investment funds excluding MMFs), government (primarily euro-area debt management offices), other financial institutions (OFIs), dealers, central banks, insurance corporations and pension funds (ICPFs), and money market funds (MMFs). Non-financial corporations and residual sectors are excluded, as their presence on this market is minimal. Details are provided in Appendix A.3.

To address missing reporting by central banks and government entities, we supplement SFTDS with two additional sources. For the eurosystem, we use confidential data on securities lending operations from the ECB's Market Operations Database (MOPDB). For government activity, we rely on public institutional information. In the case of the Deutsche Finanzagentur, securities lending is primarily conducted via Eurex on a limited set of retained-issuance bonds. Because neither Eurex nor the Deutsche Finanzagentur reports these transactions, but final borrowers report trades with Eurex, we attribute such lending activity to the Deutsche Finanzagentur.[4]

SFTDS reporting is restricted to transactions involving at least one EU-domiciled counterparty. This limits visibility into repo positions of non–euro area dealers. As illustrated in Figure A-2, when a euro-area dealer intermediates between a euro-area bank and a non–euro area hedge fund, both legs of the transaction are observed. By contrast, when the dealer itself is non–euro area domiciled, only the initial sourcing of the bond is reported. This asymmetry mechanically inflates the net borrowing positions of non–euro area dealers, which largely mirror the positions of their hedge fund counterparties. Consequently, non–euro area dealers appear as net borrowers rather than operating matched books.

Overall, through transaction-level cleaning, harmonization, and reconstruction of stock positions, this paper provides the first comprehensive and granular view of investor participation in the repo market for German collateral.

We complement the repo data with bond-level characteristics from the Centralised Securities Database (CSDB) and sectoral bond holdings from the eurosystem's Securities Holdings Statistics (SHS). We compute asset swap (ASW) spreads for each bond as the difference between its yield (from MTS) and the interpolated Overnight Index Swap (OIS) rate at

[4]While the unreported sector may include limited CCP proprietary lending, market participants indicate that these volumes are negligible. Figure A-1 shows that the unreported sector is consistently a net lender and lends more when specialness is high.

the same remaining maturity, with €STR as the floating leg. ASWs capture cash-market expensiveness beyond interest rate and default risk and are closely related to repo-market expensiveness.

3.2 The Topology of the Repo Market for German Collateral

Figure 2 shows daily flows and stocks of repos collateralized by German government bonds. Between 2021 and 2024, outstanding repo stocks ranged from EUR 200 to EUR 500 billion per day, equivalent to roughly one-fifth of total Bund supply. These quantities hide a significant heterogeneous participation rate to the repo market. Figure 3 decomposes repo stocks into borrowing and lending positions by sector, while Table 1 reports yearly average repo positions alongside cash bond holdings. On the borrowing side, dealers, banks, and hedge funds dominate. On the lending side, the primary providers are public sector entities—central banks and debt management offices—followed by dealers and banks.

Insurance corporations and pension funds (ICPFs) exhibit almost no direct repo activity, despite holding EUR 121–144 billion in German government bonds (around 8% of total outstanding supply). This reflects the fact that ICPFs typically delegate securities lending to agent intermediaries, whose activity is recorded under banks' and dealers' repo positions. In contrast to the U.S. Treasury repo market, money market funds play only a negligible role for German collateral. Banks, OFIs, and dealers hold relatively small bond inventories—EUR 3–11 billion—but repo out more than EUR 100 billion per day, consistent with delegated and proprietary lending. Overall, repo market activity is largely decoupled from bond ownership across sectors.

To assess net positions, we compute net repo stocks separately for euro-area (EA) and non–euro area (non-EA) entities, reflecting reporting constraints. Figure 4 shows that the public sector, the eurosystem and the Deutsche Finanzagentur, is the largest net lender of securities, providing around 60% of all securities[5], while non–euro area hedge funds are the largest net borrowers, taking in nearly 50% of securities. These hedge funds are predominantly domiciled in the Cayman Islands and Bermuda (Figure A-3).

Banks and dealers primarily act as intermediaries. Euro-area banks are marginal net lenders, consistent with agent lending, while euro-area dealers operate matched books. Non–euro area dealers appear as net borrowers (37% of total demand), reflecting reporting

[5]This is consistent with the figures provided by the Finanzagentur and Ampudia et al. (2025): *"At the peak of the 2022 specialness episode, the DFA was lending close to EUR 80 billion of securities daily, substantially larger than the eurosystem's purchases and securities-lending programs volumes"*

limitations rather than true balance sheet exposure. Their net positions closely track those of non–euro area hedge funds, indicating that hedge funds are the ultimate borrowers. With full reporting coverage, we suspect that non–euro area dealers would likely also appear as matched-book intermediaries.

Finally, Figure 5 illustrates securities flows in 2022. The euro-area public sector emerges as the de facto securities lender, with foreign dealers and hedge funds as the ultimate borrowers. Banks and dealers mainly intermediate flows from euro-area entities to non–euro area investors, while euro-area banks lend more securities than they borrow, underscoring their role as agent lenders.

4 Equilibrium Model of the Repo Market: Econometric Framework

This paper estimates an equilibrium model of repo specialness that jointly incorporates investor demand across sectors and allows for heterogeneous responses to repo specialness and macroeconomic conditions. We conduct the empirical analysis using the methodological contribution of Chaudhary et al. (2024), the Optimal Granular Instrumental Variable (O-GIV). O-GIV extends the standard GIV framework introduced by Gabaix and Koijen (2024). The GIV framework constructs instruments by extracting idiosyncratic demand shocks from large investors and uses these shocks to estimate supply and demand elasticities.

GIV, like any other instrumental variable setup, relies on two assumptions, relevance and exclusion restriction. Relevance is satisfied if the idiosyncratic shocks are economically meaningful and originate from a small number of large institutions: When investors are sufficiently large, their idiosyncratic shocks to quantities can move aggregate prices. The exclusion restriction is satisfied if the shocks used as instruments are truly idiosyncratic. In particular, the variation captured by the instrument must be orthogonal to shocks that affect all investors, i.e., common factors. Under these two conditions, Chaudhary et al. (2024) provide a framework for estimating *sector-specific* elasticities. While their application focuses on the cash Treasury market, we apply O-GIV to the repo market.

Their setting is as follows. Assume sector i's demand for borrowing securities, $\Delta q_{i,t}$, can be expressed as a log-linear function of repo specialness, Δp_t—i.e., the repo price, defined as the eurosystem deposit facility rate minus the average repo rate for German government

collateral—and other demand shifters $\upsilon_{i,t}$:

$$\Delta q_{i,t} = \overline{\Delta q}_i + \zeta_i \Delta p_t + \upsilon_{i,t}. \tag{10}$$

Here, $\overline{\Delta q}_i$ denotes sector fixed effects. Equation 10 represents sector i's net demand in the repo market, and ζ_i captures the response of sector i's net securities borrowing to changes in repo prices. A large ζ_i indicates a very elastic sector, which aggressively adjusts its supplied or demanded quantity in response to price changes. By contrast, a near-zero ζ_i characterizes a sector composed of price-inelastic investors, whose security-borrowing decisions are largely insensitive to repo pricing.

We decompose demand shifters into common factors η_t and sector-specific idiosyncratic shocks $u_{i,t}$. For example, an increase in uncertainty may induce hedge funds to expand cash-market positions in an attempt to profit from price discrepancies. To increase the profitability of these positions, hedge funds rely on leverage obtained by borrowing cash or securities in the repo market. Banks may also respond to heightened uncertainty by relying more on short-term funding, potentially taking positions that mirror those of hedge funds with varying intensity, or even adopting opposite strategies. In this setting, uncertainty is a common factor: it affects repo market activity across sectors while eliciting heterogeneous sectoral responses, captured by the sector-specific coefficient λ_i. Beyond uncertainty and other common factors η_t, sector-specific "bets" are captured by the idiosyncratic component $u_{i,t}$. This yields:

$$\Delta q_{i,t} = \overline{\Delta q}_i + \zeta_i \Delta p_t + \lambda_i \eta_t + u_{i,t}. \tag{11}$$

We relate prices and quantities through market clearing: in equilibrium, net securities borrowed must equal net securities lent. Equivalently, the market-share-weighted sum of sector flows satisfies $\sum_i S_i \Delta q_{i,t} = 0$. Imposing market clearing in Equation 11 and solving for equilibrium repo specialness gives, with S denoting size-weighted aggregation across sectors,

$$\Delta p_t = \frac{1}{\zeta_S} \left(\overline{\Delta q}_S + \lambda_S \eta_t + u_{S,t} \right), \tag{12}$$

where

$$\zeta_S = \sum_i S_i \zeta_i \tag{13}$$

is the aggregate elasticity. Equation 12 links changes in repo specialness to changes in aggregate net demand for securities in the repo market, scaled by the inverse of the aggregate elasticity.

Because prices and quantities are jointly determined in equilibrium, we use an instrumental

variable approach to address simultaneity. Under the relevance and exclusion restriction conditions, the (O-)GIV framework constructs instruments by extracting investors' idiosyncratic demand shocks and using them as instruments for repo specialness faced by other sectors.

The endogenous variable is sector i's net repo position, $Q_{i,t}$. Net positions are daily outstanding stocks, computed as securities borrowed minus securities lent (EUR bn). We detrend net positions using a three-month moving average $\bar{Q}_{i,t}$, following Kubitza, Sigaux, and Vandeweyer (2025). The resulting variable, $\Delta q_{i,t}$, is expressed as a percentage deviation from the moving average:

$$\Delta q_{i,t} = \frac{Q_{i,t} - \bar{Q}_{i,t}}{|\bar{Q}_{i,t}|}. \tag{14}$$

The sample is partitioned into euro-area and non–euro area sectors, for a total of 15 sectors.[6]

We compute sector i's daily market share as its three-month moving average net position relative to the corresponding aggregate across sectors, and use the time-series average market share S_i over the sample:

$$S_i = \frac{1}{T} \sum_{t=1}^{T} \frac{|\bar{Q}_{i,t}|}{\sum_j |\bar{Q}_{j,t}|}. \tag{15}$$

Figure 6 compares value weights to equal weights by sector. Equal weights (the inverse of the number of sectors) provide a benchmark in which all sectors participate with equal footprint, while value weights S_i capture actual market shares in terms of net borrowing positions. The figure shows that the repo market for German collateral is highly concentrated in a small number of large sectors. This granularity strengthens the relevance of O-GIV, as idiosyncratic shocks from large sectors can meaningfully affect repo prices.

Common factors are central to identification because they allow us to separate idiosyncratic shocks from aggregate shocks shared across sectors, supporting the exclusion restriction. We group controls into four macro-categories: Monetary policy quantities, repo demand quantities, repo supply quantities, and bond supply quantities. We detail which measures fall in each of these categories in the next section. We apply the same transformation as in Equation 14 to all common factors.

We extract idiosyncratic shocks to sector positions by residualizing each sector's net position $\Delta q_{i,t}$ with respect to sector fixed effects and common factors. This step is central to identification: conditioning on common factors isolates sector-specific shocks that can be

[6] Owing to their limited (direct) participation to the repo market, non-financial corporations, households, and non–euro-area money market funds are excluded.

used as instruments. The first-stage regression is:

$$\Delta q_{i,t} = \alpha_i + \lambda_i \eta_t + u_{i,t}, \tag{16}$$

where α_i denotes sector fixed effects, η_t is the vector of common factors (expressed as percentage deviations from three-month moving averages), and $u_{i,t}$ captures idiosyncratic shocks. We use Newey–West standard errors to account for serial correlation.

Because prices and quantities are jointly determined, we use an instrumental variable approach to identify the effect of quantities on repo specialness and address simultaneity. Under the relevance and exclusion restriction conditions, O-GIV constructs instruments by using estimated idiosyncratic shocks from other sectors as instruments for changes in repo prices.

Formally, Chaudhary et al. (2024) introduce a generalized method of moments (GMM) estimator—the Optimal-GIV estimator—to recover sector-specific elasticities $\hat{\zeta}_i$. Identification is based on the exclusion restriction and on weighting moment conditions by sector market shares to increase instrument relevance. The exclusion restriction implies:

$$\mathbb{E}[u_{i,t} u_{-i,t}] = 0 \qquad \text{for any } i \neq -i, \tag{17}$$

i.e., idiosyncratic shocks from sector i are orthogonal to idiosyncratic shocks from any other sector $-i$. The Optimal-GIV estimator $\hat{\zeta}$ solves the moment condition:

$$\widehat{\mathbb{E}}\Big[\hat{u}_{i,t}(\hat{\zeta}_i)\, \hat{u}_{S(-i),t}(\hat{\zeta})\Big] = 0, \tag{18}$$

where $\hat{u}_{S(-i),t}(\hat{\zeta}) = \sum_{j \neq i} S_j \hat{u}_{j,t}(\hat{\zeta}_j)$ denotes the size-weighted idiosyncratic shocks of all sectors other than i. The weights S_j give more influence to sectors with larger market shares, reflecting that their shocks move prices more strongly. Accordingly, for each sector i, the estimator selects $\hat{\zeta}_i$ so that the sample covariance between $\hat{u}_{i,t}(\hat{\zeta}_i)$ and $\hat{u}_{S(-i),t}(\hat{\zeta})$ is zero.

Substituting $\hat{u}_{i,t}(\hat{\zeta}_i) = \Delta q_{i,t} + \hat{\zeta}_i \Delta p_t$ into Equation 18 yields:[7]

$$\hat{\zeta}_i = -\frac{\widehat{\mathbb{E}}\Big[\, \Delta q_{i,t}\, \hat{u}_{S(-i),t}(\hat{\zeta}) \,\Big]}{\widehat{\mathbb{E}}\Big[\, \Delta p_t\, \hat{u}_{S(-i),t}(\hat{\zeta}) \,\Big]}. \tag{19}$$

This expression corresponds to the inverse of the canonical IV estimator: the numerator

[7] For simplicity, we abstract from common factors in this derivation.

is the covariance between the endogenous variable and the instrument (constructed from first-stage residuals), and the denominator is the covariance between the price change and the same instrument.

5 The Repo Market Elasticity

In this section, we present our main results from the O-GIV estimation detailed in the previous section. We include several robustness checks and conclude with the quantification of how much each sector and factor contribute to the evolution of specialness.

5.1 Loadings on Common Factors Across Sectors

We begin by estimating the relationship between sector-level net securities borrowing positions and a broad set of common factors, controlling for sector fixed effects, as specified in Equation 16. The dependent variable is the percentage deviation of sector i's net securities borrowing from its three-month moving average. The same transformation is applied to the common factors, which we group into four macro-categories, monetary policy quantities, repo demand quantities, repo supply quantities, and bond supply quantities:

- *Monetary policy quantities:* These variables capture interest rate expectations, surprises, and duration extraction. They include: The 1-month OIS 1M; the 10Y-1Y,1Y-3M, and 3M–1M OIS spread; and the 1M OIS–deposit facility rate spread.
- *Repo supply quantities:* These varaibles proxy for capital provision by repo-dealers. We include the three-month cross-currency basis swap, which links repo supply to FX markets, and Duffie (2023)'s measure of liquidity-versus-volatility deviations for the euro-area bond market (see Besugo, Cinquin, Nguyen, Paoli, and Szydlo (2025)) as a proxy for intermediation constraints.
- *Repo demand quantities:* These measures capture repo-demand driven by arbitrage opportunities. We include the skewness of Euribor futures options-implied density; the Merrill Lynch Swaption Option Volatility Estimate (MOVE); the 3M Bund volatility premium; deviations of cash Bund prices from a Nelson-Siegel curve; and generic 10-year Bund futures open interest. We also include the Bund–KfW spread, a measure of European bank's illiquidity, and the Bund–French spread.

- *Bond supply quantities:* the eurosystem balance sheet, Deutsche Finanzagentur holdings, and the free float of German government bonds, computed as issued amounts minus holdings by the Deutsche Finanzagentur and the eurosystem.[8]

Results for the largest sectors are reported in Table 2. These sectors—euro-area government, banks, and central bank; non–euro area hedge funds, dealers, and other financial institutions (OFIs)—each account for more than 5% of average outstanding repo positions. Together, they represent 83% (91%) of aggregate repo supply (demand). Results for the remaining sectors are reported in Table A-2.

We classify a sector as a supplier (demander) of repo market liquidity if it is, on average over the sample period, a net lender (borrower) of securities. Several patterns emerge. Non–euro area hedge funds load positively on all proxies for investment opportunities and pricing dislocations, including MOVE, the Bund volatility premium, and deviations from the Nelson-Siegel yield curve. Monetary policy variables, such as the yield curve slope, also strongly explain hedge fund borrowing behavior: hedge funds increase net securities borrowing when these measures rise. Bond supply variables are likewise important. Hedge fund borrowing increases with expansions in the public sector balance sheet and declines when free float rises.

Non–euro area dealers' borrowing positions are more strongly correlated with monetary policy variables such as OIS 1M. They lend more when collateral availability—proxied by free float—is higher. The public sector, comprising the euro-area central bank and government, supplies more securities when repo market conditions deteriorate, as indicated by larger pricing deviations from the Nelson-Siegel model or elevated interest rate volatility. Higher bond holdings by these institutions are associated with greater net lending in the repo market, generating a negative correlation between their bond holdings and repo positions. Free float loads positively for both the government and the central bank, indicating that public sector lending declines when collateral becomes more readily available. Hedge funds, by contrast, display the opposite pattern.

Euro-area banks load significantly on the cross-currency basis swap and the Kreditanstalt für Wiederaufbau (KfW)–Bund yield spread, which proxy for overall euro-area banking liquidity. Overall, common factors explain a substantial share of the variation in sectoral net borrowing positions, with peak R^2 values reaching 45% for hedge funds and 42% for government.

[8] We obtain data for the common factors from Bloomberg, MTS, LSEG, and the ECB Statistical Data Warehouse. We compute a proxy for the Deutsche Finanzagentur's holdings from public information by projecting retained-at-issuance amounts to maturity, implicitly assuming no secondary-market sales.

Figure A-4 plots the daily sum of residuals across sectors from the first-stage regressions. These residuals represent idiosyncratic demand and supply shocks, which form the basis for the estimation of sector-specific elasticities in the next subsection. At this stage, net securities borrowing positions have been purged of common influences and sector fixed effects, yielding the inputs for the second-stage elasticity estimation.

5.2 Specialness Elasticity

We now turn to estimates of repo market specialness elasticities. We first present the elasticity of aggregate repo demand and then examine sector-specific elasticities. The bottow row of Table 3 reports the aggregate Bund repo market elasticity, ζ_S. We estimate an aggregate elasticity of 1.2, implying that a 1% demand shock increases repo specialness by approximately 0.83%, the inverse of the aggregate elasticity. In our sample, this corresponds to a 0.21 basis point increase in specialness for a EUR 110 million increase in net repo borrowing. This estimate is comparable in magnitude to elasticity estimates for the U.S. Treasury market (close to 1; see Kaminska and Zinna, 2020; Jansen et al., 2024; Chaudhary et al., 2024) but substantially smaller than those found for the U.S. equity market (around 5; Gabaix and Koijen, 2021), as illustrated in Figure 7.

The remainder of Table 3 reports sector-level elasticities ζ_i and corresponding market multipliers $M = 1/\zeta_i$, along with average market shares S_i. As before, sectors are classified as suppliers or demanders based on average net lending or borrowing over the sample period. The table shows the stark constrast between demand and supply elasticity.

Non–euro area hedge funds and dealers (the demand side) are by far the most price-inelastic participants, with elasticities of 0.11 and 0.05, respectively. As discussed earlier, dealers plausibly act on behalf of hedge funds. A 1% increase in net securities borrowing by non–euro area hedge funds (dealers) increases repo specialness by approximately 9% (20%). In economic terms, an additional EUR 380 million (EUR 330 million) in repo borrowing by hedge funds (dealers) raises specialness by about 2.34 (5.2) basis points.[9] As first hypothesized by Duffie (1996), the nearly perfect inelasticity of hedge funds is rational, provided that the cash bond market reflects specialness in bond prices one-to-one. When rolling over a position, hedge fund find it suboptimal to close it by buying the bond on the cash market, and prefers to roll-over on the repo market. Hedge funds, thus, do not adjust their positions based on repo rates, making them perfectly inelastic to specialness increases.

[9] In our sample, average specialness is 26 basis points, while average net positions are EUR 38 billion for non–euro area hedge funds and EUR 33 billion for non–euro area dealers.

The public sector—comprising the euro-area central bank and government—represent, on the other hand, a highly elastic supply. The government's elasticity is roughly half that of the central bank, indicating more aggressive securities supply. This difference reflects institutional design: the government's securities lending facility grants access to a broader set of investors, requiring only clearing membership, and a more favourable pricing than the eurosystem facility. By contrast, the eurosystem exhibits more elastic behavior due to the pricing structure of its securities lending facility, conceived as a backstop. The facility lends securities against cash at the deposit facility rate minus 20 basis points or the prevailing market repo rate, whichever is lower. When specialness is low, the facility supplies securities at a fixed price. Once repo rates exceed this threshold, the facility aligns with market pricing, reducing incentives for further use. As a result, central bank repo lending declines as specialness increases, potentially exacerbating scarcity episodes.

Intermediaries such as euro-area banks and dealers are highly elastic, implying limited price impact. In aggregate, the public sector and euro-area intermediaries account for 88% of repo supply, while non–euro area hedge funds and dealers account for 82% of repo demand. These six sectors alone contribute more than 85% of the aggregate elasticity. Of the overall elasticity of 1.2, approximately 13% originates from demanders and 87% from suppliers, indicating that repo demand is highly inelastic, while supply is highly elastic.

Figure 8 visualizes these findings by comparing market multipliers across sectors. Demand-side participants—non–euro area hedge funds and dealers—exhibit the largest multipliers, whereas supply-side participants—the public sector and euro-area banks—exhibit small multipliers.

Table 4 compares sector-level elasticities in the repo and cash bond markets. Cash market elasticities are taken from Koijen et al. (2021), which provides the most recent sector-level estimates for the euro area.[10] We uncover a clear negative relationship between elasticities in the two markets, illustrated in Figure 14.

In the cash market, the euro-area central bank exhibits zero price elasticity, reflecting bond purchases that are independent of prices and driven solely by monetary policy objectives. In contrast, the central bank is elastic in the repo market, limiting its ability to mitigate specialness during stress episodes. While securities lending facilities are designed not to interfere with the monetary policy stance, they could nevertheless play a stabilizing role by easing access to scarce collateral during systemic specialness episodes.

[10]The sectoral mapping is imperfect because Koijen et al. (2021) relies on ESA 2010 classifications and treats the foreign sector as a residual. Our sectoral breakdown is more granular and focuses explicitly on German government bonds. Sample periods also differ, although both cover periods of eurosystem balance sheet expansion.

The government is inelastic in the cash market and only weakly elastic in the repo market, reflecting interventions that are largely insensitive to prices and aimed at minimizing funding costs.[11]

Finally, the foreign sector—dominated by non–euro area hedge funds and their dealer intermediaries—displays the most striking asymmetry: hedge funds are highly elastic in the cash market but extremely inelastic in the repo market. This behavior is economically rational. Profits from cash market strategies dominate repo funding costs, leading hedge funds to maintain repo borrowing even when specialness rises sharply. Repo borrowing thus serves primarily to finance cash market strategies, reinforcing and amplifying specialness episodes. With these elasticity estimates in hand, Section 5.4 assesses the contribution of different sectors to repo specialness between 2021 and 2024. Before doing so, we present robustness checks for our baseline estimates.

5.3 Robustness: Common Factors and Principal Component Analysis

To assess the robustness of our price elasticity estimates, we augment the baseline specification with latent common factors extracted from the first-stage residuals. This approach captures residual common variation across sectors that may not be fully absorbed by the baseline set of controls. It provides an important robustness check, as the O-GIV identification requires idiosyncratic shocks to be orthogonal across sectors; remaining common components would otherwise violate the exclusion restriction.

We proceed in three steps. First, we estimate the baseline first-stage regression in Equation 16, including sector fixed effects and observed common factors. Second, we apply principal component analysis to the sector-level residuals from this regression and extract three principal components. Each component has an eigenvalue above 1.5, and together they explain up to 36% of the common variation in the residuals. Third, we re-estimate the first stage by augmenting the baseline specification with these three principal components, alongside the original controls and sector fixed effects.

First-stage results for the largest sectors are reported in Table 5. Relative to the baseline estimates in Table 2, the inclusion of principal components increases explanatory power across all specifications. The extracted components load significantly on both supply and

[11] This heterogeneity in elasticities is consistent with other evidence: based on an IV approach, Ampudia et al. (2025) find 1% of an ISIN outstanding lent by the DFA increases repo rate by 0.24 bps, while DFA sale of 1% of an ISIN outstanding only increases repo rates by 0.10 bps.

demand in the repo market, indicating that they capture economically relevant residual common variation.

Second-stage results for the largest repo market participants are summarized graphically in Figure 15, while sector-level elasticity estimates for all sectors are reported in Table 6. Figure 15 compares baseline elasticities (Table 3) with those obtained when principal components are included. Overall, elasticity estimates are largely unchanged, and our baseline conclusions remain intact. The only notable difference concerns euro-area banks, whose estimated elasticity falls below unity once principal components are included.

5.4 Sector Decomposition

Using sector-specific elasticities, we decompose deviations in repo specialness into contributions from individual sectors. Formally, the contribution of sector i to specialness is given by:

$$\Delta\hat{p}_{i,t} = \frac{1}{\hat{\zeta}_S} S_i \left(\widehat{\overline{\Delta q}}_i + \hat{\lambda}_i \eta_t + \hat{u}_{i,t} \right). \tag{20}$$

We compute average daily contributions at the quarterly frequency and group sectors into four categories: (i) non–euro area hedge funds and dealers, (ii) the public sector (euro-area governments and central banks), (iii) intermediaries (euro-area banks and dealers), and (iv) remaining sectors. Results are shown in Panel A of Figure 9.

Natural securities borrowers—non–euro area hedge funds and dealers—are the primary drivers of repo specialness dynamics. In the first part of the sample, their net borrowing contributes almost exclusively to positive deviations in specialness. In the second part, their contribution turns negative as they sharply reduce net borrowing and move toward balanced positions (Figure 4). By contrast, the public sector adopts the opposite stance, acting as a net lender over most of the sample. Through its securities lending facilities, it mitigates the impact of hedge fund borrowing on specialness, particularly in the first half of the sample. This offsetting role is illustrated in Panel B of Figure 9, which cumulates sectoral contributions to specialness over time, expressed in basis points.[12]

At the peak of specialness in 2022Q3, the government (central bank) reduced specialness by approximately 5 (10) basis points relative to its three-month average. Absent public sector

[12] We back out basis point contributions from the three-month percentage deviation transformation in Equation 14, applied to prices. Specifically, we scale $\Delta\hat{p}_{i,t}$ by the observed three-month average $\overline{p_t}$, divide by the number of sectors, and cumulate over time. Figure A-5 shows the strong positive correlation between predicted specialness $\Delta\hat{p}_t$ and observed deviations Δp_t, indicating good model fit.

lending facilities, specialness would have been roughly 15 basis points higher. At the same time, non–euro area hedge funds and their dealer intermediaries cumulatively increased specialness by more than 30 basis points relative to its three-month average. While this exercise does not constitute a formal counterfactual,[13] it provides intuition for how sectoral borrowing and lending translate into cumulative changes in the *level*, rather than the *change*, of specialness.

Overall, market multipliers indicate that changes in hedge fund participation exert the largest price impact. Consistent with this, the sector decomposition shows that hedge funds were the primary drivers of the 2022 specialness episode. This naturally raises the question of whether the subsequent easing reflects changes in hedge fund elasticities or instead changes in their repo positions.

The sample period spans two distinct monetary policy regimes. From January 2021 to November 2022, the euro area experienced prolonged balance sheet expansion, with elevated excess liquidity reflecting pandemic-era interventions such as the PEPP, PSPP, and large-scale TLTROs. This regime shifted in mid-2022, when the ECB initiated a tightening cycle, raised policy rates in July, and returned to positive rates in September. In October 2022, the Governing Council recalibrated TLTRO pricing to better align central bank operations with tighter monetary conditions. This triggered substantial early repayments, with nearly EUR 300 billion—about 14% of the outstanding EUR 2 trillion—repaid in November 2022, marking the effective start of balance sheet contraction.

While our baseline specification controls for common factors such as the central bank balance sheet and the monetary policy stance, elasticities are estimated as averages over the full sample and evaluated at period-average sector sizes. Consequently, declining specialness in the second half of the sample could reflect either changes in hedge fund elasticities or changes in their net repo positions. To distinguish between these mechanisms, we re-estimate the O-GIV separately for the balance sheet expansion period (January 2021–November 2022) and the contraction period (December 2022–June 2024).

Results, shown in Figure 11, indicate that hedge fund elasticities remain virtually unchanged across regimes. This robust finding implies that the decline in specialness is driven primarily by reduced hedge fund borrowing—or increased lending—rather than by changes in price sensitivity. With the exception of the central bank, repo supply becomes slightly more elastic during quantitative tightening, while demand becomes more inelastic. The market-wide elasticity increases modestly from 1.2 to 1.4.

[13] A full counterfactual would require recursively recomputing three-month average specialness in the absence of specific sectors.

5.5 Factor Decomposition

Equation 20 also allows us to disentangle the contributions of common factors and sector-specific shocks to repo specialness. The contribution of the k-th common factor is:

$$\Delta\hat{p}_{\eta(k),t} = \frac{1}{\hat{\zeta}_S} S_i \hat{\lambda}_i(k) \eta_t(k). \tag{21}$$

Importantly, this decomposition does not measure the direct effect of common factors on specialness. Instead, it captures how common factors affect sector-level repo borrowing and how these quantity responses transmit to prices. Contributions are computed as the product of sector-level first-stage coefficients $\hat{\lambda}_i(k)$ (Tables 2 and A-2), factor realizations $\eta_t(k)$, and sector market shares.

Figure 10 presents the factor decomposition aggregated to the quarterly frequency, grouping factors into five categories: bond supply quantities, window-dressing dummies, repo supply quantities, monetary policy variables, and repo demand variables. Figure A-6 reports contributions of individual factors.

Bond supply quantities. Bond supply is decomposed into eurosystem holdings, Deutsche Finanzagentur holdings, and free float. Up to June 2022, these factors jointly contributed to a decline in specialness (Figure 10), driven primarily by central bank holdings (Figure A-6). While balance sheet expansion is often associated with higher specialness, our decomposition captures an alternative channel: larger central bank holdings are associated with increased securities lending through central bank facilities, mitigating specialness. As balance sheet expansion ended in mid-2022 and contraction began, this mechanism reversed, and bond supply factors contributed positively to specialness. Overall, bond supply effects tended to reduce specialness over the sample, consistent with increased collateral circulation via public sector facilities.

Window-dressing. Month-end and quarter-end effects are captured using countdown dummies for the final 18 days of each month. Aggregated to the quarterly frequency, window-dressing contributes positively to specialness (Figure 10). Figure 12 examines sector-specific contributions during the three weeks preceding quarter-end, distinguishing periods before and after March 2022. Prior to March 2022, euro-area intermediaries benefited from leverage ratio exemptions that reduced balance sheet costs. After the exemption expired, intermediaries' contributions to specialness became more pronounced, a pattern

confirmed in Figure 12. Figure A-6 further shows that euro-area banks and dealers are the primary drivers of specialness during post-exemption quarter-ends. Overall, these results highlight the role of balance sheet constraints and demonstrate that quarter-end effects reflect both common and sector-specific dynamics.

Repo supply quantities. Among repo supply variables, the one-year EUR/USD cross-currency basis swap accounts for the largest contribution (Figure A-6). The basis turned from negative to positive in late 2023, possibly reflecting the end of the euro-area tightening cycle. This shift indicates strong demand for euro funding and translated into a large negative contribution to specialness between 2023Q4 and 2024Q1. As shown in Table 2, these effects are driven by increased securities lending (or reduced borrowing) by non–euro area hedge funds and dealers, as well as by the euro-area government.

Monetary policy quantities. Contributions in this category are dominated by the spread between the one-year and three-month OIS rates, which proxies short-term interest rate expectations. The spread widened early in the sample, remained elevated through early 2023, and then narrowed as expectations shifted toward the end of the tightening cycle. In late 2023, the spread turned negative, consistent with anticipated rate cuts in 2024. Table A-2 shows that this factor loads significantly on non–euro area banks' lending activity. Correspondingly, Figure A-6 shows negative contributions to specialness in the first half of the sample and positive contributions in the second half.

Repo demand quantities. This group proxies broader financial conditions affecting repo borrowing across sectors, including volatility (MOVE), hedging activity (Bund futures open interest), and flight-to-quality and flight-to-safety episodes. While common demand factors explain only a limited share of specialness at the quarterly frequency (Figure 10), this reflects offsetting effects across individual factors. The French–German government bond spread, capturing flight to safety, contributes positively to specialness and loads strongly on hedge fund borrowing. By contrast, flight-to-quality effects load on central bank lending, contributing negatively to specialness. Volatility measures load negatively on euro-area public sector and intermediaries, as these sectors increase lending during volatile periods. Finally, pricing errors from the Nelson-Siegel model correlate negatively with securities borrowing by both the public sector and non–euro area hedge funds, implying that higher pricing errors are associated with increased lending and lower specialness.

6 The Role of Hedge Funds

Previous sections estimate an equilibrium model of demand and supply in the repo market. We show that the repo market for German government collateral features an elastic supply—largely provided by the public sector—and a highly inelastic demand. This demand inelasticity is driven by non–euro area hedge funds. In the sectoral decomposition in Section 5.4, we show that these investors were responsible for the sharp increase in repo specialness in 2022. During this period, hedge funds became the largest net borrowers of securities and thus the marginal investors shaping specialness. This role of hedge funds in 2022 is consistent with evidence based on confidential Bund auction group data presented by Ampudia et al. (2025) suggesting that hedge funds were net sellers during this period in the cash Bund market.

To understand why hedge funds borrowed so aggressively, Panel A of Figure 13 documents a concurrent increase in several measures of mispricing across markets, including the cash–futures bond basis, asset swap spreads, and pricing errors from the Nelson-Siegel model.[14] The widening of these measures indicates the emergence of profitable arbitrage opportunities.

In what follows, we use the cash–futures bond basis as an illustrative example.[15] A widening of the positive cash–futures basis—shown in Panel B of Figure 13—implies that the cash price of a deliverable bond exceeds the implied bond price embedded in the corresponding futures contract. A hedge fund seeking to exploit this mispricing would sell the bond in the cash market and buy the corresponding futures contract, a strategy commonly referred to as the *basis trade*. The short cash position is financed by borrowing the bond in the repo market. Large short positions in the cash market are therefore consistent with large net borrowing positions in the repo market.

Crucially, hedge funds access the repo market as price-inelastic investors, sustaining elevated borrowing even as funding costs rise. As long as arbitrage profits exceed repo specialness—i.e., the cost of funding the trade—this behavior is economically rational. Basis-trade

[14] The observed mispricing likely reflects the interaction of several concomitant factors. The rapid pace of monetary policy tightening following the inflation surge induced abrupt repricing across the yield curve and elevated interest rate volatility, which may have limited arbitrageurs' ability to enforce price parity between cash and derivatives markets. At the same time, pressures on dealers' balance sheets were increasing during this period (Besugo, Nguyen, Poinelli, and Scheicher, 2025), potentially impairing their intermediation capacity, which is central to the implementation of arbitrage trades.

[15] This relative-value trade is only illustrative. We acknowledge that other trading strategies that require securities borrowing may also have contributed to hedge funds' elevated repo demand.

positions are maintained as long as cash-market profits dominate repo-market costs.[16] As discussed in Section 5.2, while hedge funds are inelastic in the repo market, the existing literature finds them to be elastic in the cash market: when arbitrage opportunities narrow, both cash and repo positions unwind.

Consistent with this mechanism, by the end of 2022 mispricing measures had declined, hedge fund borrowing in the repo market had fallen, and repo specialness had receded. More generally, elevated repo borrowing by hedge funds reflects equilibrium demand for cash-market positions that require securities borrowing, i.e., hedge funds short-selling bonds to accommodate strong cash-market demand. Repo specialness therefore emerges as a by-product of securities borrowing associated with cash-market clearing and should be interpreted as a macroeconomic outcome rather than an idiosyncratic feature of individual securities.

7 Conclusion

In this article, we use instrumental variables to causally identify how the participation of different sectors in the repo market shapes specialness. Building on the methodological contribution of Chaudhary et al. (2024), we implement, for the first time in the literature, a demand-system estimation for the repo market. Applied to German government collateral, our estimates reveal a highly elastic supply of repo—i.e., securities lending—and a markedly inelastic demand—i.e., securities borrowing. Supply elasticity is driven primarily by the euro-area public sector, namely the central bank and the government. In contrast, repo demand is dominated by non–euro area entities, most notably hedge funds.

Hedge funds exhibit the greatest degree of price inelasticity and therefore exert the largest impact on specialness per unit of securities borrowed. Using our causal framework, we show that hedge funds were responsible for the pronounced increase in repo specialness observed in 2022. During this episode, virtually all German government bonds lent by the public sector ultimately flowed outside the euro area, largely to hedge funds domiciled in jurisdictions such as the Cayman Islands and Bermuda. We attribute the large net borrowing positions accumulated by hedge funds to the emergence of profitable arbitrage opportunities and widespread mispricing across asset classes. These conditions incentivized leveraged trading strategies that required borrowing securities in the repo market in order to short-sell bonds in the cash market. Consistent with this mechanism, we document

[16] When repo specialness increases, the funding leg of the trade becomes more expensive, limiting arbitrage capacity and allowing the basis to persist; see, e.g., Pelizzon et al. (2025).

a widening of the positive cash–futures basis for German government bonds during this period, in line with the elevated levels of repo borrowing we observe.

Our findings establish a direct link between participation in the bond and repo markets, showing that repo prices are driven by trading strategies implemented in the cash market. We provide preliminary evidence that investor elasticities in the cash and repo markets are negatively related. Building on these results, an important direction for future research is to investigate the joint determination of investor elasticities across the two markets in greater depth. Overall, our results highlight the strong integration between cash and repo markets and indicate that monetary policy transmission in euro-area collateral markets—through repo pricing—increasingly depends on the participation of non–euro area entities such as hedge funds.

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Figures

Figure 1. Free float of bonds, repo market quantities, and prices

In this figure, we show a set of quantities for the German governmnet cash bond and repo markets. The top panel plots the free float for the bond market, defined as the nominal value outstanding of bonds issued by the German government net of the holdings of the european and German Central banks (collectively, the eurosystem). In the same panel, we also report the volume-weighted difference between the repo rates and the eurosystem' Deposit Facility rate, the main monetary policy rate for the eurozone. In the middle panel, we show the eurosystem's net purchases of euro area government bonds. The bottom panel reports the net securities borrowing positions of hedge funds. Repo data are from MMSR and Brokertec, hedge funds positions are from MMSR, and they aggregated daily. The eurosystem' net purchases are monthly and are obtained from the ECB, the German treasury free float is from the ECB's Securities Holding Statistics. The sample period is from January 2012 to June 2024.

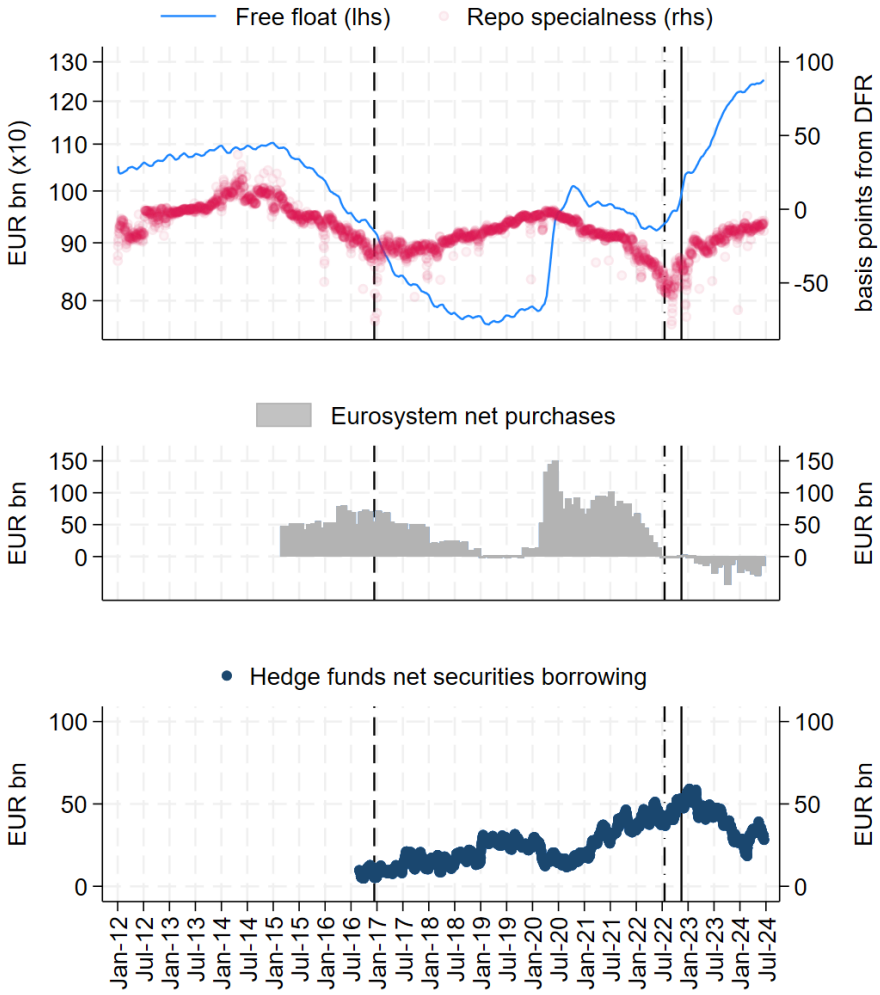
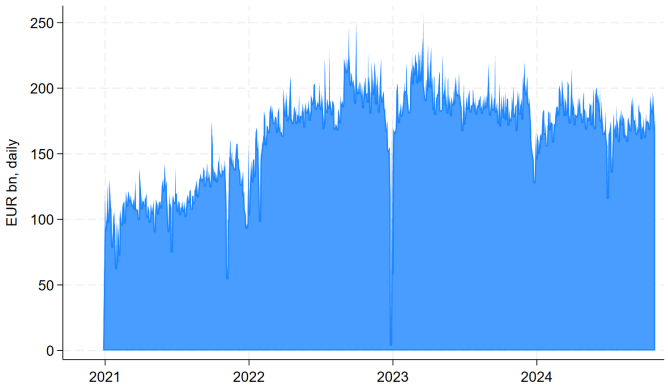


Figure 2. Flows and stock quantities in the repo market

In this figure, we show the size of the repo market for German government collateral, using two different metrics, a flow measure and a stock measure. In Panel A we show the flow of repo transactions, which quantifies the size of new trades happening on a given day, regardless of the term of the cotract. In Panel B, we report the stock measure, which captures the quantity of securities currently on loan on any given day. For example, a three-day transaction will be counted three times in the measure shown in Panel B, but only once, on the day the trade was initiated, in Panel A. Repo volumes date are from SFTDS, and eurosystem repo lending data are from MOPDB. Data are limited to repo transactions that use German central government bonds as collateral. The sample period is from January 2021 to June 2024.

A: Flows



B: Stocks

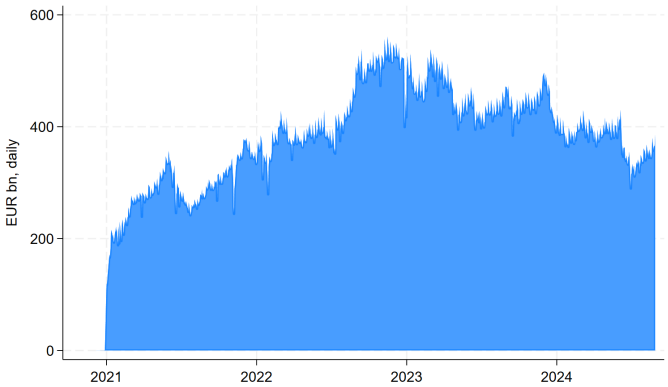
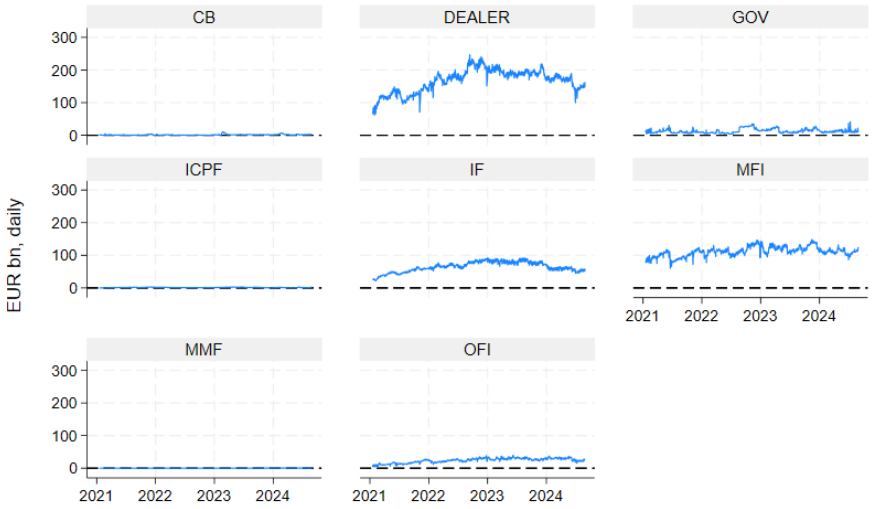


Figure 3. Gross outstanding amounts of securities lent and borrowed by sector

In this figure, we show the repo gross positions of different sectors on the repo market, measured as the stock of securites borrowed (Panel A) or lent (Panel B), in billions of euro. We net out intra-sector transactions, so that we can interpret the quantities as measuring the obligation of a sector toward the rest of the world. We do not report volumes of money-market funds, as they are minimal. Repo transactions data are from SFTDS, while data for the position by the euro area's central banks are from MOPDB and capture the eurosystem securities lending facility's outstanding volume. For the latter, we only consider securities lent against cash, to better approximate repo the economic exposure of a repo transaction. We focus on transactions collaterlized by German government bonds, and the subsample covers the period from March 2021 to June 2024.

A: Borrowed stocks of securities



B: Lent stocks of securities

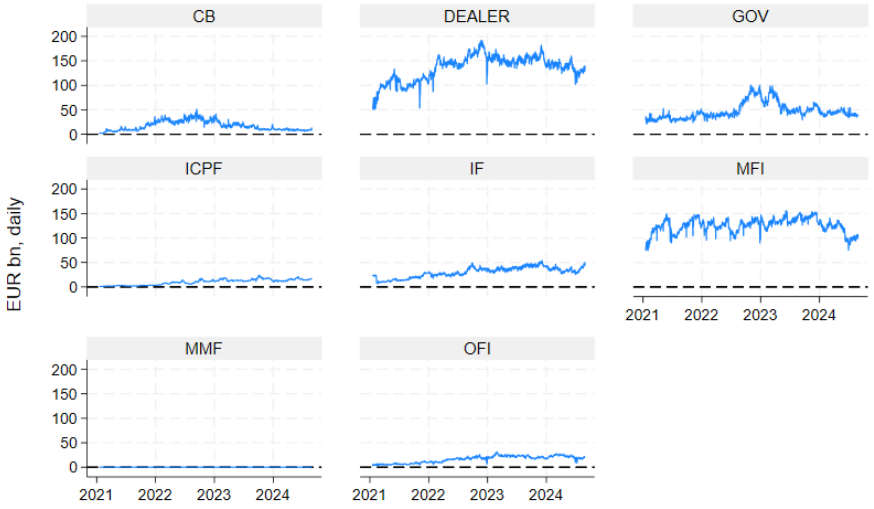


Figure 4. Securities lending positions by sector and geography

In this figure, we show the net position on the repo market, by sector, calculated as the amount of securities lent minus securities borrowed. A positive (negative) amount means a sector is a net-security lender (borrower) on the repo market. The measure captures the stock positions on the repo market, i.e., the outstanding amount of repo transactions taking into account the term of each repo contract. We show the quantity for euro-area and non-euro Area sectors, separately. We exclude positions of money market funds, insurance companies, and pension funds, as they are minimal. Repo data are sourced from SFTDS. Data for the securities lending by the central bank are obtained from MOPDB and are limited to cash-collateralized securities-lending transactions. All transactions in the sample are collateralized with German government bonds. The sample covers March 2021 to June 2024.

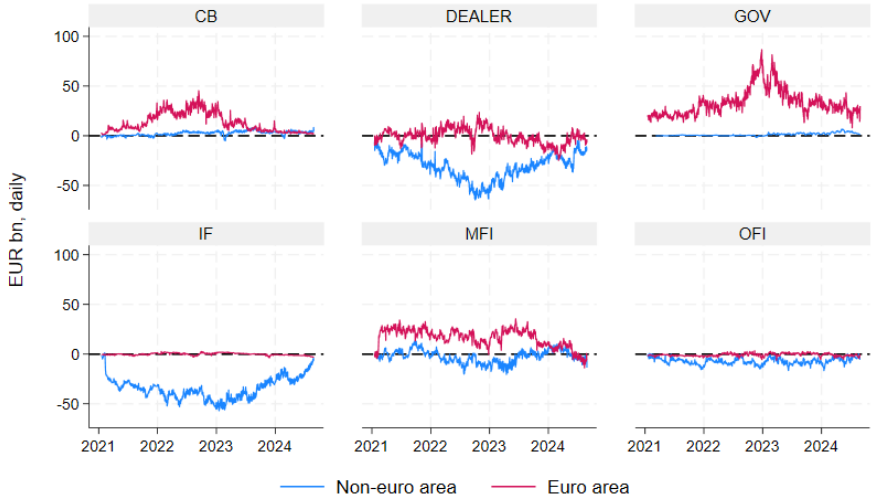


Figure 5. The structure of the repo market

In this figure, we show the structure of the repo market. For each couple of investors, we show the average end-of-day oustanding amount of securities on loan, in billions of euro, for 2022. Sectors on the left are net securities lenders, sectors on the right are net securiites borrowers. The "Other" includes the smaller players, i.e., money market funds, non-euro area banks, euro-area hedge funds, insurance companies and pension funds, and foreing government and central banks. We consider repo transactions that have German government bond as collateral, and source repo data from SFTDS, while the eurosystem's cash-against-collateral securities lending data are from MOPDB.

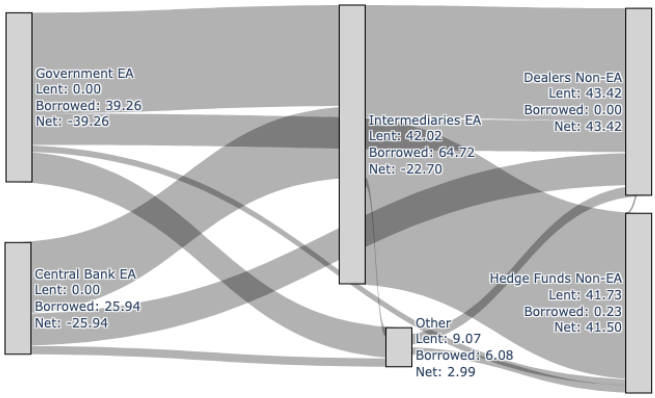


Figure 6. The concentration of the repo market for German government collateral

In this figure, we compare the equal weights versus the value weights - the repo market participation shares - by sector. Equal weights are computed as the inverse of the number of sectors and represent a theoretical benchmark where all sectors participate in the repo market for German collateral with equal footprint. The value weights are the actual participation shares of the different sectors in terms of net securities borrowing positions, see Equation 15. We consider repo transactions that have German government bond as collateral, and source repo data from SFTDS, while the eurosystem's cash-against-collateral securities lending data are from MOPDB.

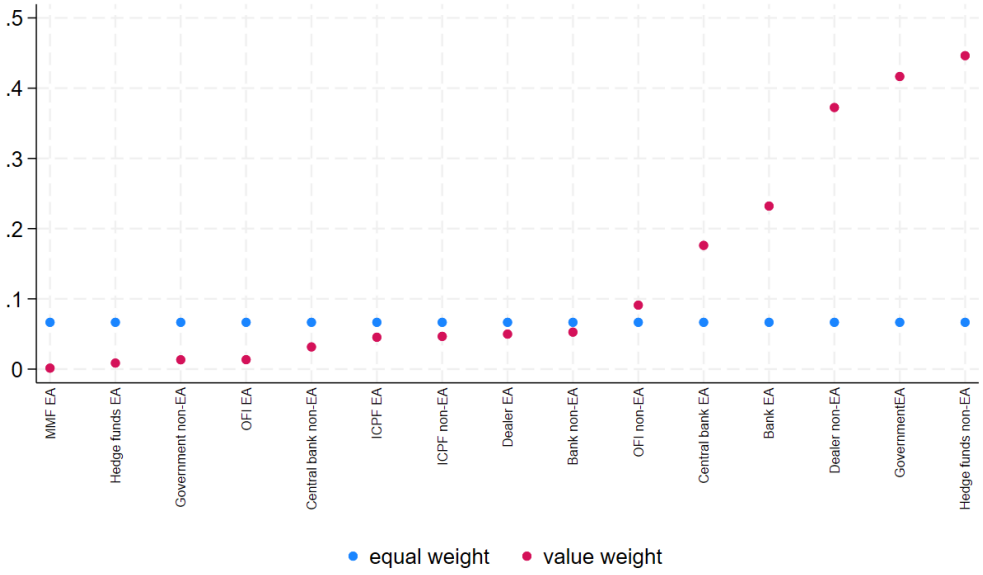


Figure 7. Market multipliers in the literature

In this figure, we compare our estimated market multiplier—i.e., the inverse of the price-elasticity ζ from Eq. 13—for the repo market to existing estimates in the literature for several asset classes. Jansen et al. (2024), Chaudhary et al. (2024), and Kaminska and Zinna (2020) estimate the elasticity for the US Treasury market, Kubitza et al. (2025) for the FX derivatives market and Gabaix and Koijen (2021) for the U.S. stock market.

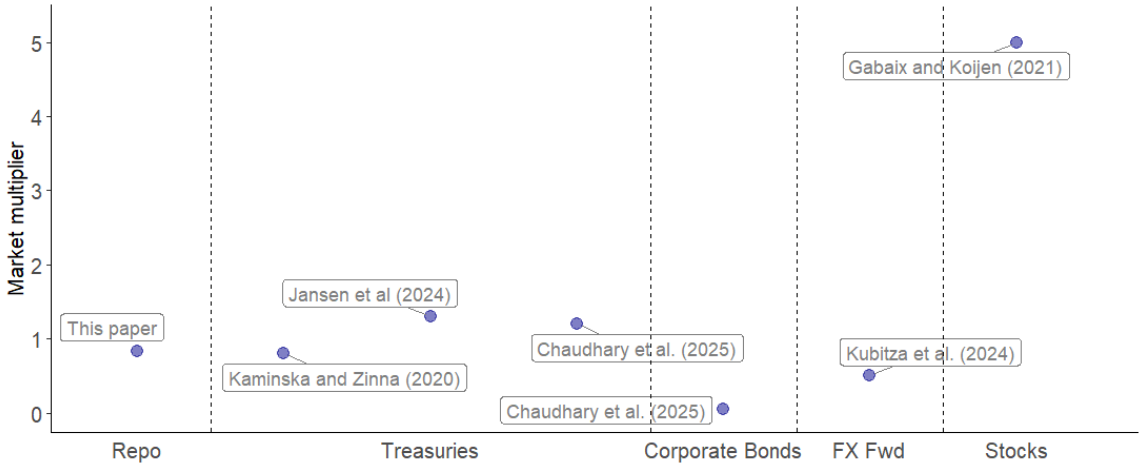


Figure 8. Market multiplier by sector

In this figure we compare the market multipliers, the inverse of the price-elasticity ζ_i, for the largest participants to the repo market. We exclude sectors whose outstanding positions make up less than 5% of the total. These sectors cumulatively represent 83% (91%) of the supply (demand) in the market. We allocate a sector to supply (demand) if the sector is a net lender (borrower) of securities, on average, over our sample period. The market multipliers are estimates of $1/\zeta_i$ from Eq. 10. Our data includes repo transactions that use German government bonds as collateral for the March 2021–June 2024 period. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB

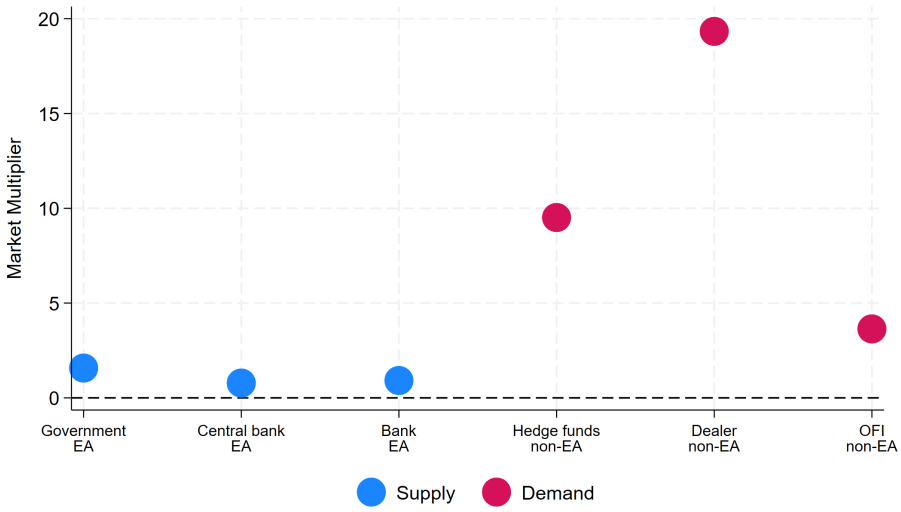
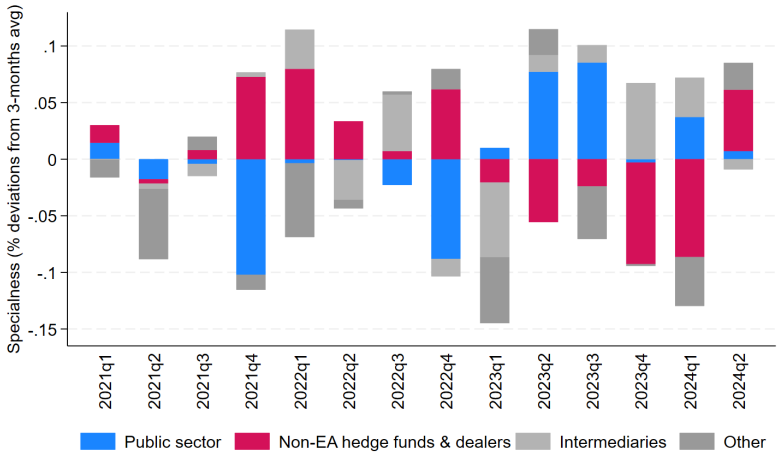


Figure 9. Contribution to repo specialness changes by sector

This figure shows the decomposition of the changes in the specialness spread among the contributions of different sectors. We define changes in specialness as the relative deviation from the three-month moving average, and changes in quantities accordingly. In Panel A, we average the daily contributions at the quarter level, and classify the sectors into the public sector, the euro-area government and central bank; intermediaries, euro-area banks and dealers; and non-euro Area hedge funds and their dealers. The "Other" sector aggregates the contributions of non-euro Area central bank, governments, and banks, and insuarance companies, pension funds, and money market funds. The sector decomposition is calculated as $\Delta\hat{p}_{i,t} = \frac{1}{\hat{\zeta}_S} S_i(\hat{\Delta q}_i + \hat{\lambda}_i \eta_t + \hat{u}_{i,t})$, for sector-$i$ and day-t, where $\hat{\zeta}_S$ is reported in Table 3. In Panel B, we report the cumulated contribution of each sector. To obtain this, we scale $\Delta\hat{p}_{i,t}$ by the observed three-month average $\overline{p_t}$, divide it by the number of sectors, and cumulate it across time. In the same panel, we also show the 3-month moving average of specialness. We estimate the demand-system using outstanding positions in repo contracts collaterlized by German government bonds, for the period betwee from March 2021 to June 2024. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB.

A: Specialness change by quarter



B: Cumulative specialness innovations

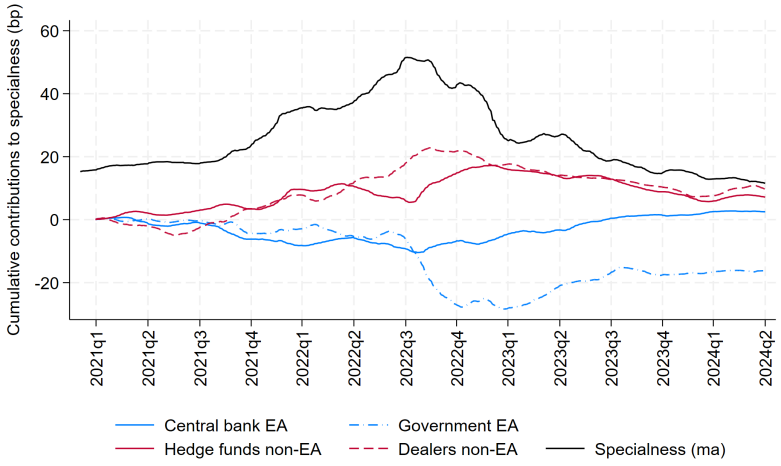


Figure 10. Decomposition of repo specialness contributions by common factors

This figure shows the decomposition of the changes in the specialness spread among common factors. We define changes in specialness as the relative deviation from the three-month moving average, and changes in quantities accordingly. We average the daily contributions at the quarter level, and classify the factors into monetary policy, repo demand, repo supply, and bond supply factors. The factor decomposition for factor $\eta(k)$ is calculated as $\Delta\hat{p}_{\eta(k),t} = \frac{1}{\hat{\zeta}_S} S_i \hat{\lambda}_i(k)\eta_t(k)$, for and day-$t$, where $\hat{\zeta}_S$ is reported in Table 3. The sample period goes from March 2021 to June 2024 and the sample consists of repos with underlying collateral a German government bond. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB.

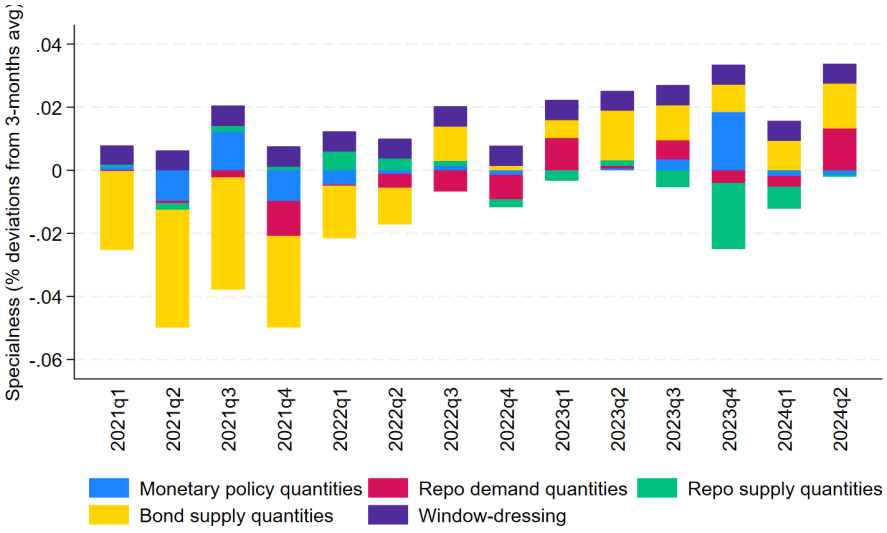


Figure 11. Repo market elasticities during QE and QT

In this figure, we compare the price-elasticity ζ_i of the largest sectors in the repo market across periods of varying monetary policy. The first sub-sample covers the eurosystem' balance sheet expansion, which terminated with the large repayment of targeted long-term refinancing operations, March 2021–November 2022, while in the second period the ECB's balance sheet is reducing, December 2022–June 2024. We include sectors whose positions account for at least 5% of the total repo outstanding, which cumulatively represent 83% (91%) of the supply (demand). The price elasticities ζ_i in Eq. 10 are estimated using the optimal GIV method shown in Section 4. The estimation weights S_i are sample-specific. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB. We estimate the model on repo transactions collateralized by German government bonds.

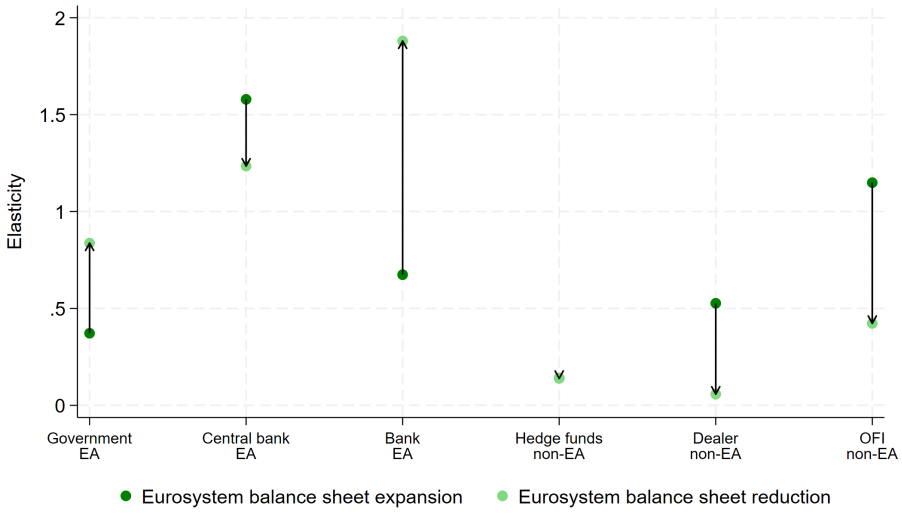


Figure 12. Decomposition of repo specialness contributions of EA intermediaries at quarter-end

In this figure, we show the cyclicality of sectoral contribution to specialness within a quarter. That is, we calculate the contribution $\Delta\hat{p}_{i,t} = \frac{1}{\hat{\zeta}_S} S_i(\hat{\Delta q}_i + \hat{\lambda}_i \eta_t + \hat{u}_{i,t})$, for sector-$i$ and day-t, where $\hat{\zeta}_S$ is reported in Table 3, aggregate it by sector type, and average it by the number of days to the end of the quarter. We group investors in euro-Area intermediaries (banks and dealers) and the rest. We show the results separately for two sub-samples, before and after March 2022. In the earlier part of the sample, euro-area intermediaries benefitted from a leverage ratio exemption, which allowed them to exclude sizeable central bank exposures, contributing to lower balance sheet costs. The sample consists of repos with underlying collateral a German government bond. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB.

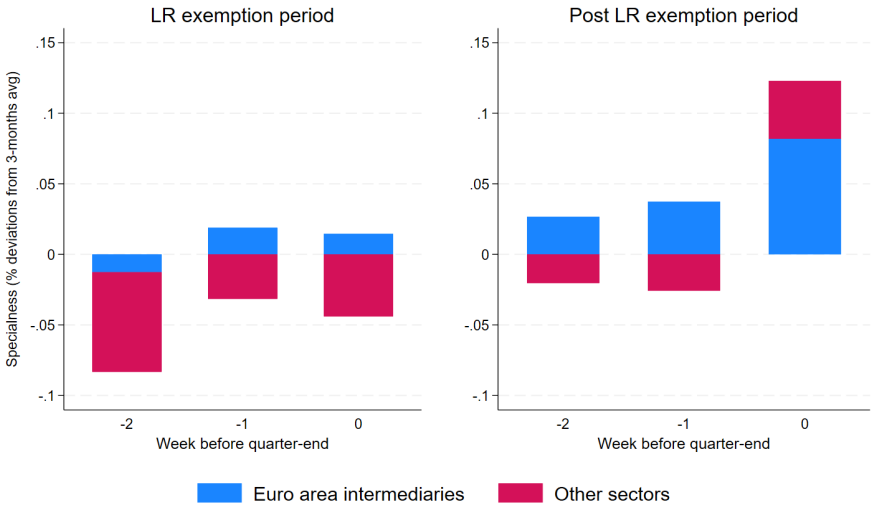
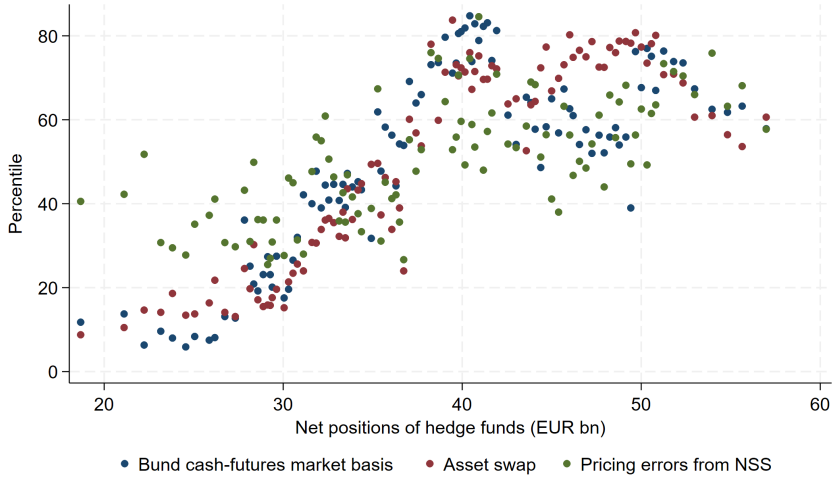


Figure 13. Mispricing measures and hedge funds positions

In Panel A, we show three measures of asset mispricing against the net aggregate securities borrowing positions by non-euro Area hedge funds. The three measures consist of the cash-futures bond basis, the average government-OIS spread (asset swap), and the pricing errors of a Nelson-Siegel curve. The future-bond basis is calculated for the next-next-delivery 10-year contract, while the other two measures are based on the universe of traded German government bonds. The mispricing measures are expressed as percentiles over the sample period, to allow for a comparison across measures. The hedge fund net-borrowing positions are in billion of euros of German governmnet bonds borrowed on the repo market. In Panel B, we show the development of repo specialness and the cash-futures bond basis. The former is measured in basis points, while the latter is annualized and shown as percentage difference between futures and cash bond price. Repo volumes and prices are from SFTDS, pricing errors and asset swaps are calculated using MTS pricing data, and the Bund cash-futures basis is sourced from Bloomberg and uses the euro short-term rate (ESTR) as funding rate.

A: Mispricing measures against hedge fund repo positions



B: Cash-future bond basis and specialness

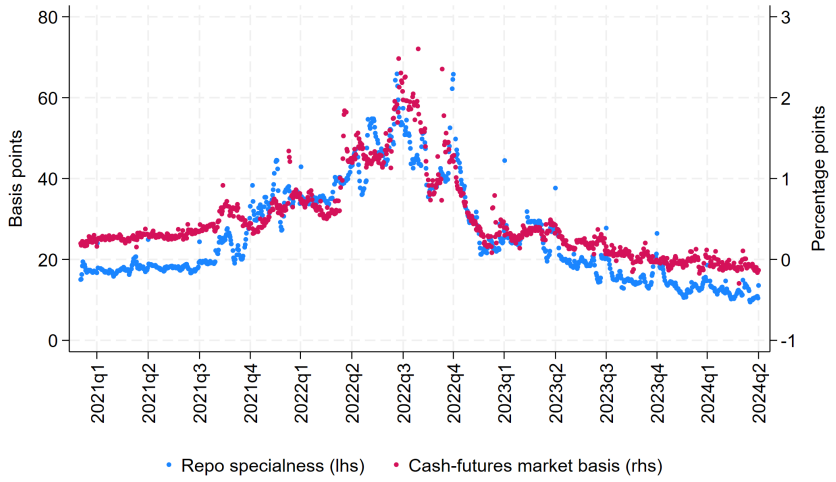


Figure 14. The inverse relation between cash- and repo-market elasticity

In this figure, we plot a sector's price elasticity in the cash market from Koijen et al. (2021) against its price elasticity of the repo market from Table 3. We impute an elasticity of zero for the eurosystem in the cash market and for a sector when its elasticity in either the cash or repo market is negative. The foreign sector' elasticity in the repo marker is the average of the repo market elasticity of non-EA dealers and hedge funds.

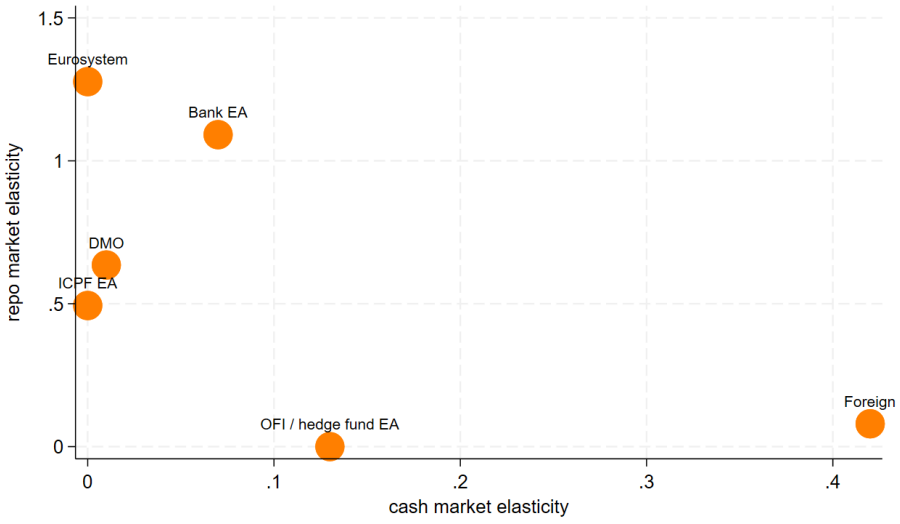
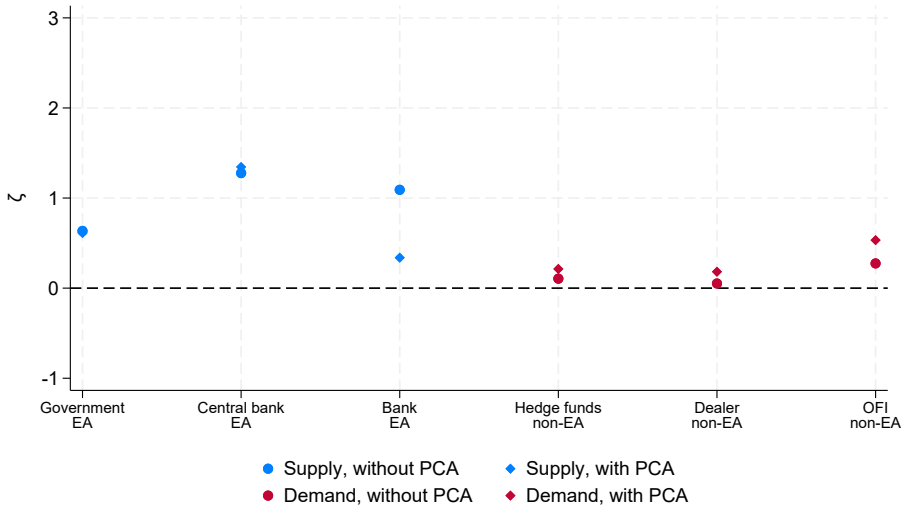


Figure 15. Elasticity by sector: estimation with PCA

In this figure we compare the price-elasticity ζ_i for the largest participants to the repo market when three principal components are added to the common factors. The principal components are calculated on the residuals from the first stage, see Eq. 16. We first estimate the first stage equation with common factors and sector fixed effects, we extract sector's residuals, we apply the PCA on these residuals and we re-estimate the first stage using common factors, sector fixed effects and the three principal components. We exclude sectors whose outstanding positions make up less than 5% of the total. These sectors cumulatively represent 83% (91%) of the supply (demand) in the market. We allocate a sector to supply (demand) if the sector is a net lender (borrower) of securities, on average, over our sample period. The elasticities are computed from Eq. 19. Our data includes repo transactions that use German government bonds as collateral for the March 2021–June 2024 period. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB



Tables

Table 1
Securities holdings and amounts borrowed and lent on the repo market, by sector

In this table, we show the amount of securities held, and the amounts of securities lent and borrowed on the repo market. We report the average by sector at the yearly level, and restrict the sample to German government bonds and repo transactions that use them as collateral. The amounts borrowed and lent on the repo market represents averages of end-of-day stocks against all counterparties. All quantities are expresse in billion of euros. eurosystem borrowing and lending figures are limited to cash-collateralized transactions. Holdings of dealers, banks (monetary financial institutions, MFI), and other financial institutions (OFI) are reported as one, as the holding dataset does not distinguish between them. Non-euro area holdings are computed as a residual of the nomial value oustanding of German bonds. We exclude money market funds, households and non-financial corporations from the euro area, as their participation to the repo market is negligible. Our sample extends from January 2021 to June 2024. Holdings data are from SHSS, repo volumes from SFTDS, and eurosystem repo lending data are from MOPDB.

Year	Area	Sector	Holdings	Borrowed	Lent
2021	**euro Area**	ICPF	121	0.2	0.2
		Bank	11	61.5	83.0
		OFI		3.5	2.1
		Dealer		65.7	65.1
		Hedge funds	117	1.9	1.6
		Government	172	10.0	32.0
		Central Bank	554	0.0	9.1
	Non-euro Area		554	142.0	92.0
2022	**euro Area**	ICPF	121	0.1	3.9
		Bank	3	67.0	83.9
		OFI		6.3	5.7
		Dealer		108.1	113.9
		Hedge funds	148	1.8	2.3
		Government	169	13.6	53.0
		Central Bank	655	0.0	25.9
	Non-euro Area		534	215.9	124.3
2023	**euro Area**	ICPF	141	0.1	7.1
		Bank	3	80.0	99.4
		OFI		6.9	7.2
		Dealer		122.4	119.2
		Hedge funds	178	2.2	2.7
		Government	203	14.2	56.2
		Central Bank	621	0.0	10.6
	Non-euro Area		616	215.4	139.3
2024	**Euro Area**	ICPF	144	0.3	6.5
		Bank	3	81.8	88.3
		OFI		7.1	6.0
		Dealer		111.9	103.0
		Hedge funds	178	2.2	1.2
		Government	208	11.0	40.3
		Central Bank	577	0.0	3.7
	Non-euro Area		700	172.4	137.8

Table 2
First stage of Optimal-GIV - large sectors

In this table, we show the coefficients resulting from the first stage of the O-GIV where sector i net securities borrowing volumes in the repo market are residualised against a broad set of common factors and sector fixed effects, see equation 16. The dependent variable is the percentage deviation of sector i ' net securities borrowing volumes from its 3-months moving average. The same transformation is applied to common factos, which are listed in Section 3. We exclude sectors whose outstanding positions make up less than 5% of the total. These sectors cumulatively represent 83% (91%) of the supply (demand) in the market. We allocate a sector to supply (demand) if the sector is a net lender (borrower) of securities, on average, over our sample period. *, **, and *** indicate that parameters are significantly different from zero at the 10%, 5%, or 1% level, respectively. Significance is based on autoregression and heteroskedasticity-robust Newey-West standard errors.

	Government EA	Central Bank EA	Banks EA	Dealers non-EA	OFI non-EA	Hedge funds non-EA
OIS 1M	-0.021^{*}	-0.054^{***}	-0.018	0.039^{***}	0.022	-0.012
OIS1M DFR spread	-0.001	-0.008	0.000	0.003	0.002	-0.002
3M1M OIS spread	-0.019^{**}	0.001	0.004	0.008	0.005	-0.018^{**}
1Y3M OIS spread	-0.002	-0.021^{***}	-0.005	0.011^{**}	0.009	0.011^{***}
Slope YC	-0.085^{***}	0.004	-0.053	-0.006	0.120^{*}	0.056^{***}
Cross-ccy basis	-0.047^{**}	-0.002	0.077^{**}	-0.043^{*}	-0.066	-0.019^{*}
Duffie	0.002	0.003	0.002	0.004	-0.011	0.000
KFW vs DE spread	0.023	-0.207^{***}	0.164^{**}	-0.069^{*}	-0.172^{*}	-0.020
OID skew	-0.019	0.113^{*}	0.005	-0.009	0.197^{**}	-0.067^{**}
SMOVE	-0.168	-0.038	-0.345	0.492^{**}	-0.042	0.233^{**}
Bund vol prem	0.030	-0.094^{**}	0.053	-0.043^{*}	0.026	-0.052^{***}
NSS dev	-0.103	-0.414^{**}	0.088	0.088	0.607^{***}	-0.237^{***}
Bund OpenInt	-0.034	0.552^{*}	-0.344	-0.120	1.421^{**}	0.243
DE vs FR spread	0.052	0.130	0.685	-0.337	-0.075	0.187^{*}
Free float	3.700^{***}	3.080^{**}	-1.913	-2.155^{**}	-3.363	-1.773^{***}
ECB holdings	1.508^{**}	-2.506^{*}	-3.714^{*}	-1.655	-1.912	1.135^{*}
DFA holdings	-3.127^{***}	2.324^{**}	2.901^{**}	0.921^{*}	1.312	2.018^{***}
Constant	-0.005	0.036	0.007	0.063	0.107	0.004
R-squared	0.43	0.42	0.14	0.30	0.17	0.48
Observations	823	823	823	823	823	823
Day-of-the-month FE	Yes	Yes	Yes	Yes	Yes	Yes
Weights	42%	18%	23%	37%	9%	45%
Side	Supply	Supply	Supply	Demand	Demand	Demand

Table 3
Sector Elasticities ζ_i

In this Table, we show the sector-level elasticities ζ_i. The table reports the market share of the sector calculated as in Eq. 15, the sector price-elasticity ζ_i calculated from Eq. 19, the market multiplier or the inverse of the price-elasticity and the contribution to the aggregate elasticity. We allocate a sector to supply (demand) if the sector is a net lender (borrower) of securities, on average, over our sample period.

Sector	**Share**	ζ	**M**	$\zeta\times$**Share**
Supply				
Euro area				
Government	42%	0.64	1.56	21%
Central bank	18%	1.28	0.78	18%
Bank	23%	1.09	0.91	20%
Dealer	5%	5.38	0.18	21%
ICPF	5%	0.49	2.04	2%
Hedge funds	1%	−0.85	−1.17	−1%
Non-euro area				
Government	1%	−1.41	−0.70	−1%
Central bank	3%	2.50	0.40	6%
ICPF	5%	0.48	2.08	2%
Demand				
Euro area				
OFI	1%	−0.89	−1.12	−1%
MMF	0%	0.11	9.10	0%
Non-euro area				
Bank	5%	1.60	0.62	7%
Dealer	37%	0.05	20.00	1%
OFI	9%	0.27	3.70	2%
Hedge funds	45%	0.11	9.10	4%
Aggregate	200%	1.20	0.83	100%

Table 4
Repo vs. Cash Market Elasticities

In this table, we compare a sector's price elasticity in the cash market from Koijen et al. (2021) against its price elasticity of the repo market from Table 3.

	Linzert et al. (2025) *Repo market elasticity*	**Koijen et al. (2021)** *Cash market elasticity*	
Non-euro area			
Government	−1.41		0.42
Central bank	2.50		
Bank	1.60		
Dealer	0.05		
OFI	0.27		
Hedge funds	0.11		
ICPF	0.48		
Euro area			
Government	0.64	0.01	
Central bank	1.28	–	
Bank	1.09	0.07	
Dealer	5.38	–	
OFI	−0.89		0.13
Hedge funds	−0.85		
ICPF	0.49	−0.34	
MMF	0.11	–	
Households	–	0.01	

Table 5
First stage of Optimal-GIV with PCs - large sectors

In this table, we show the coefficients resulting from the first stage of the O-GIV where sector i net securities borrowing volumes in the repo market are residualised against a broad set of common factors and sector fixed effects, see equation 16. The dependent variable is the percentage deviation of sector i ' net securities borrowing volumes from its 3-months moving average. The same transformation is applied to common factos, which are listed in Section 3. We exclude sectors whose outstanding positions make up less than 5% of the total. These sectors cumulatively represent 83% (91%) of the supply (demand) in the market. We allocate a sector to supply (demand) if the sector is a net lender (borrower) of securities, on average, over our sample period. *, **, and *** indicate that parameters are significantly different from zero at the 10%, 5%, or 1% level, respectively. Significance is based on autoregression and heteroskedasticity-robust Newey-West standard errors.

	Government EA	Central Bank EA	Banks EA	Dealers non-EA	OFI non-EA	Hedge funds non-EA
OIS1M DFR spread	−0.001	−0.008*	0.000	0.003	0.002	−0.002
3M1M OIS spread	−0.019**	0.001	0.004	0.008	0.005	−0.018***
1Y3M OIS spread	−0.002	−0.021***	−0.005	0.011***	0.009*	0.011***
KFW vs DE spread	0.023	−0.207***	0.164***	−0.069**	−0.172**	−0.020
DE vs FR spread	0.052	0.130	0.685**	−0.337***	−0.075	0.187***
OIS 1M	−0.021**	−0.054***	−0.018	0.039***	0.022	−0.012
Slope YC	−0.085***	0.004	−0.053	−0.006	0.120***	0.056***
OID skew	−0.019	0.113*	0.005	−0.009	0.197***	−0.067***
SMOVE	−0.168	−0.038	−0.345	0.492***	−0.042	0.233***
Bund vol prem	0.030*	−0.094***	0.053*	−0.043**	0.026	−0.052***
NSS dev	−0.103*	−0.414***	0.088	0.088	0.607***	−0.237***
Bund OpenInt	−0.034	0.552*	−0.344	−0.120	1.421***	0.243**
Cross-ccy basis	−0.047**	−0.002	0.077***	−0.043**	−0.066*	−0.019**
Duffie	0.002	0.003	0.002	0.004	−0.011	0.000
Free float	3.700***	3.080***	−1.913	−2.155***	−3.363*	−1.773***
ECB holdings	1.508**	−2.506**	−3.714**	−1.655*	−1.912	1.135***
DFA holdings	−3.127***	2.324***	2.901***	0.921***	1.312	2.018***
PC 1	−0.003	0.047***	0.121***	−0.081***	0.008	−0.049***
PC 2	−0.007	0.075***	0.016	−0.012	−0.046***	0.012***
PC 3	−0.048***	0.013	0.108***	0.017*	0.191***	0.003
Constant	−0.005	0.036	0.007	0.063**	0.107	0.004
R-squared	0.56	0.59	0.56	0.63	0.55	0.79
Observations	823	823	823	823	823	823
Day-of-the-month FE	Yes	Yes	Yes	Yes	Yes	Yes
Weights	42%	18%	23%	37%	9%	45%
Side	Supply	Supply	Supply	Demand	Demand	Demand

Table 6
Sector Elasticities ζ_i with PCs

In this Table, we show the sector-level elasticities ζ_i for the baseline estimation of the first stage (Table 2) and for the estimation of the first stage with three pricipal components (Table 5). The table reports the market share of the sector calculated as in Eq. 15, the sector price-elasticity ζ_i calculated from Eq. 19, and an alternative estimate of ζ_i using principal component analysis (PCA). We allocate a sector to supply (demand) if the sector is a net lender (borrower) of securities, on average, over our sample period.

Sector	**Share**	ζ	ζ with PCA
Supply			
euro area			
Government	42%	0.64	0.61
Central bank	18%	1.28	1.34
Bank	23%	1.09	0.34
Dealer	5%	5.38	1.17
ICPF	5%	0.49	−0.32
Hedge funds	1%	−0.85	−1.99
Non-euro area			
Government	1%	−1.41	−0.47
Central bank	3%	2.50	1.65
ICPF	5%	0.48	−0.12
Demand			
euro area			
OFI	1%	−0.89	0.02
MMF	0%	0.11	−0.67
Non-euro area			
Bank	5%	1.60	2.44
Dealer	37%	0.05	0.18
OFI	9%	0.27	0.53
Hedge funds	45%	0.11	0.21
Aggregate	200%	1.20	0.97

Appendix

A.1 Model Equilibria

Proposition 3 (Equilibrium specialness)**.** *The equilibrium specialness is determined by the intersection of the hedge fund's perfectly inelastic demand (Proposition* **??***) at* $|D_H|$ *with the aggregate upward-sloping supply schedule* (**??**)*, solving:*

$$\chi = \frac{\gamma\lambda}{\gamma^2 + \lambda} |D_H|, \tag{A-22}$$

Specialness is always positive (for $|D_H| > 0$ *and* $\lambda > 0$*): the central bank reduces but never fully eliminates scarcity. The dealer lends:*

$$D_R^D = \frac{\chi}{\gamma} = \frac{\lambda}{\gamma^2 + \lambda} |D_H|. \tag{A-23}$$

The dealer and the central bank split hedge fund demand according to their respective costs: the dealer's share is $\frac{\lambda}{\gamma^2+\lambda}$ *and the central bank's share is* $\frac{\gamma^2}{\gamma^2+\lambda}$*. If the central bank lends its whole portfolio,* $D_R^{CB} = \bar{Q}$*, the dealer intermediates the full residual and* $\chi = \gamma\big(|D_H| - \bar{Q}\big)$*.*

By Proposition **??**, hedge funds supply any quantity of bonds to the cash market when the basis trade is profitable. By Proposition **??**, the quantity they borrow in repo is fixed by cash market clearing. From (**??**), the equilibrium hedge fund position is:

$$D_H = S_T - D_A^* = S_T - A(r_T - r_s) < 0. \tag{A-24}$$

The quantity of bonds borrowed in repo is:

$$|D_H| = D_A^* - S_T = A(r_T - r_s) - S_T > 0. \tag{A-25}$$

Competition among hedge funds drives the basis down until the per-unit profit from the basis trade is zero. The zero-profit condition accounts for both repo specialness and the margin cost:

$$x = \chi + mk. \tag{A-26}$$

The central bank and the dealer jointly satisfy hedge fund demand. Specialness is positive

but reduced by central bank lending. If $D_R^{CB*} < \bar{Q}$, the equilibrium basis is:

$$x = \frac{\gamma\lambda}{\gamma^2 + \lambda}\big(A(r_T - r_s) - S_T\big) + mk \tag{A-27}$$

Or equivalently:

$$x = \frac{\gamma\lambda}{\gamma^2 + \lambda}\,|D_H| + mk \tag{A-28}$$

The basis is determined by two components: the specialness $\frac{\gamma\lambda}{\gamma^2+\lambda}|D_H|$, which reflects the interaction between the dealer's sourcing cost (γ) and the central bank's lending cost (λ), and the margin cost mk. The coefficient $\frac{\gamma\lambda}{\gamma^2+\lambda}$ is increasing in both γ and λ: a costlier dealer or a more reluctant central bank both widen the basis.

If $D_R^{CB*} \geq \bar{Q}$, the central bank exhausts its portfolio. The dealer intermediates all residual demand. The equilibrium basis is:

$$x = \gamma\big(A(r_T - r_s) - S_T - \bar{Q}\big) + mk \tag{A-29}$$

Or equivalently:

$$x = \gamma\big(|D_H| - \bar{Q}\big) + mk \tag{A-30}$$

In this regime, the central bank's lending cost λ no longer matters—it is the portfolio constraint, not the cost, that limits lending. The basis depends on the dealer's cost γ applied to the full shortfall $|D_H| - \bar{Q}$.

The threshold for the central bank's to exhaust its portfolio $(1 + \lambda/\gamma^2)\bar{Q}$ is increasing in λ: a reluctant CB lends less per unit of demand, so a larger demand is needed before the portfolio constraint binds.

A.2 SFTDS De-duplication Algorithm

This appendix is intended to provide a detailed overview of the de-duplication algorithm employed for the analysis of SFTDS transaction data and report the external validity cross-checks conducted to ensure the data quality of this deduplication.

A.2.1 Regrouping observations belonging to the same economical transaction

The first step consists of a light cleaning of the raw SFTDS data, namely the exclusion of transactions above EUR 50 bn and below EUR 1000 and the exclusion of trades which

do not report at least volumes, counterparties, collateral and rates. We focus on new repo transactions (`report_type = 'New'` and `trade_type='RpTrad'`). SFTDS identifies transactions based on Unique Transaction Identifiers ('UTI') that are usually not directly exploitable. For instance, UTIs keep information about the direction of trade ('B' or 'S'), or use sometimes incremental numbering depending on the reporting counterparty. We first clean the UTI by identifying these patterns, namely removing leading and trailing '0','X','B','S','BO' and 'SO' from the UTI strings, and removing the numbering in the last 5^{th} and 6^{th} digits for the UTI strings registered by LCH. To further ensure that we indeed regroup observations related to the same transaction, we check the exact matching of the trade characteristics, using a MD5 hash function (from the R package `openssl`) that recreates a unique identifier from the following variables:

Variable Name	**Description**
`exctndt`	Execution date
`valdt`	Value date
`term_fxd_mtrtydt`	Maturity date
`trunc_prncplamt_valdtamt_eur`	Truncated principal amount
`round_intrst_rate_derived_sdw`	Repo rate, rounded at the second decimal
`assttp_scty_id`	ISIN of the collateral

The creation of the hash allows us to detect double-counting that even cleaned UTI cannot flag. This is the case, for instance, for interoperability, which trades. Interoperability refers to arrangements between two CCPs to intermediate a single repo transaction. They allow clearing members of one CCP to centrally clear trades carried out with members of another CCP, without needing to be a member of the second CCP. LCH and CC&G, both members of LSE Group have an interoperability agreement for Italian government bonds collateral. In SFTDS, an interoperability transaction involving LCH and CC&G and two final non-CCP counterparties in EEA would feature 6 observations, but with different UTIs. Observable patterns in the UTI would not allow to match the observations for a given transaction. We then proceed by creating the hash as explained above, check whether both LCH and CC&G appear as reporting agents or counterparties, override the UTI with the hash when it is the case.

A.2.2 Building repo positions from transaction flows

After cleaning all transactions, we compute the outstanding amounts of repos for each investor. For each unique transaction identifier (UTI), we calculate the number of days between the settlement date and the maturity date, and expand the dataset accordingly by

adding one row for each business day during which the repo remains outstanding. Since accurate information on the maturity dates of open repos is unavailable, we exclude these transactions from the analysis.

A.3 Bloomberg Sector Classification

Our sector classification uses a mix of Bloomberg sector classifications (Sector 4 and Fund type) and ESA 2010 classification. Investors (LEIs) are allocated to hedge funds when fund type is "Hedge Fund","FCP","OEIC","SICAV","Open-End Fund","Closed-End Fund","ETF","Fund of Funds","Private Equity Fund","Unit Trust","Variable Annuity","Investment Trust" or sector level 4 is "Private Equity". Investors are allocated to ICPF using ESA classification "S129" and "S128" we also add investors with Bloomberg sector 2 classification "Insurance" or fund type "Open-End Pension". We use ESA sector S123 for MMFs. For NFC we use Bloomberg sector 2 "Utilities","Consumer Discretionary Products","Consumer Discretionary Services","Health Care","Industrial Services","Materials","Media","Oil & Gas", "Real Estate","Retail & Wholesale - Staples","Retail & Whsle - Discretionary","Software & Tech Services","Telecommunications","Consumer Staple Products". For Central Bank we use the Bloomberg industry subgroup "Central Bank". For Government we use sector 2 "National","Regional & Local" and ESA sector classification S1311 and S1312. We also allocate to Government all the transactions where the counterparty is unreported, see Section 3. For OFI, we use Bloomberg sector 4 "Consumer Finance","Instl Trust, Fiduciary & Custody","Commercial Finance","Diversified Banks","Institutional Brokerage","Investment Companies","Investment Management","Other Financial Services","Unknown","Wealth Management","Mortgage Finance","Security & Cmdty Exchanges". MFI are investors belonging to Bloomberg sector 4 "Banks". The remaining non-allocated investors are hedge funds. Some LEIs of international institutions and banks are re-allocated manually, we refer to our online code for details.

Table A-1
Securities holdings and borrowing and lending flows on the repo market, by sector

In this table, we show the amount of securities held, and the amounts of securities lent and borrowed on the repo market. We report the average by sector at the yearly level, and restrict the sample to German government bonds and repo transactions that use them as collateral. The amounts borrowed and lent on the repo market represents daily flows. All quantities are expresse in billion of euros. eurosystem borrowing and lending figures are limited to cash-collateralized transactions. Holdings of dealers, banks (monetary financial institutions, MFI), and other financial institutions (OFI) are reported as one, as the holding dataset does not distinguish between them. Non-euro area holdings are computed as a residual of Bund. We exclude money market funds, households and non-financial corporations, as their participation to the repo market is minimal. Our sample extends from January 2021 to June 2024. Holdings data are from SHSS, repo volumes from SFTDS, and eurosystem repo lending data are from MOPDB. The repo contract sample includes only fixed-rate, single-collateral–backed repos.

Year	Area	Sector	Holdings	Borrowed	Lent
2021	**euro Area**	ICPF	121	0.1	0.1
		Bank	11	26.5	30.4
		OFI		1.8	0.7
		Dealer		35.0	33.3
		Hedge funds	117	0.5	0.1
		Government	172	3.9	11.6
		Central bank	554	0.0	3.0
	Non-euro Area		554	55.0	43.3
2022	**euro Area**	ICPF	121	0.1	0.4
		Bank	3	32.0	33.0
		OFI		3.6	3.9
		Dealer		53.4	62.5
		Hedge funds	148	0.7	1.2
		Government	169	3.7	19.1
		Central bank	655	0.0	9.0
	Non-euro Area		534	95.6	60.0
2023	**euro Area**	ICPF	141	0.0	0.6
		Bank	3	35.9	39.3
		OFI		4.4	5.7
		Dealer		57.3	57.8
		Hedge funds	178	1.7	2.0
		Government	203	6.3	19.1
		Central bank	621	0.0	4.0
	Non-euro Area		616	91.0	67.8
2024	**euro Area**	ICPF	144	0.2	0.4
		Bank	3	23.3	34.1
		OFI		3.7	3.4
		Dealer		48.6	45.1
		Hedge funds	178	1.4	0.8
		Government	208	6.6	11.6
		Central bank	577	0.0	0.9
	Non-euro Area		700	66.0	53.9

Table A-2
First stage of Optimal-GIV - other sectors

In this table, we show the coefficients resulting from the first stage of the O-GIV where sector i net securities borrowing volumes in the repo market are residualised against a broad set of common factors and sector fixed effects, see equation 16. The dependent variable is the percentage deviation of sector i ' net securities borrowing volumes from its 3-months moving average. The same transformation is applied to common factos, which are listed in Section 3. We include sectors whose outstanding positions make up more than 5% of the total. These sectors cumulatively represent 17% (9%) of the supply (demand) in the market. We allocate a sector to supply (demand) if the sector is a net lender (borrower) of securities, on average, over our sample period. *, **, and *** indicate that parameters are significantly different from zero at the 10%, 5%, or 1% level, respectively. Significance is based on autoregression and heteroskedasticity-robust Newey-West standard errors.

	ICPF EA	Hedge funds EA	MMF EA	OFI EA	Dealer EA	Central bank non-EA	Government non-EA	Bank non-EA	ICPF non-EA
OIS1M DFR spread	−0.005	−0.014	0.048*	0.020	0.001	−0.004	0.003	0.016	0.000
3M1M OIS spread	−0.037	0.042	0.050	−0.083	0.186***	0.107**	0.064*	0.043	−0.006
1Y3M OIS spread	−0.072*	−0.052	−0.060**	0.065***	0.042	0.002	0.009	−0.172***	−0.044**
KFW vs DE spread	0.357*	0.531*	0.011	0.490*	0.299	−0.149	−0.319	−0.050	0.031
DE vs FR spread	−1.092	−0.554	1.673*	0.013	−1.324	−2.183***	0.781	2.526***	−0.658**
OIS 1M	−0.015	0.003	−0.203**	−0.013	0.388***	0.040	0.078	−0.142**	−0.020
Slope YC	0.213*	−0.197	−0.596***	0.360	−0.283*	0.037	0.025	0.205	0.022
OID skew	0.478**	−0.368*	0.084	−0.309	0.513*	−0.147	−0.157	−0.388	−0.172
SMOVE	−2.602**	−1.466	−1.586*	−0.751	−2.482**	1.947**	1.387*	0.967	−0.475
Bund vol prem	−0.027	0.315**	−0.014	0.029	0.075	0.069	0.233	0.061	−0.019
NSS dev	−0.537	0.781	−0.324	−0.427	2.024***	0.566	0.402	−1.512***	0.694***
Bund OpenInt	0.054	−1.060	−0.266	−4.607***	1.559	−1.143	1.455	−3.741**	−0.939**
Cross-ccy basis	0.108	−0.009	0.090	0.471***	0.452***	0.082	0.007	−0.434***	−0.054
Duffie	−0.032	−0.001	0.031	−0.002	−0.014	−0.019	0.013	0.046	−0.009
Free float	0.441	16.224***	9.916*	−10.341*	14.309**	8.811**	−8.325	−13.369***	4.426***
ECB holdings	3.822	1.689	7.096	−0.009	8.229	−7.646	−16.932***	−11.275	3.404
DFA holdings	0.529	−13.165***	−6.940***	−7.235	−24.268***	−0.797	5.959	7.686***	−3.684***
Constant	−0.311	−0.021	0.085	0.224	−0.196	−0.349*	−0.134	−0.232	−0.145*
R-squared	0.26	0.23	0.23	0.20	0.29	0.22	0.19	0.34	0.39
Observations	823	823	823	823	823	823	823	823	823
Weights	5%	1%	0%	1%	5%	3%	1%	5%	5%
Side	Supply	Demand	Demand	Demand	Supply	Supply	Supply	Demand	Supply

Figure A-1. The Unreported Sector

In this figure, we show the characteristics of cleared trades for which one of the two counterparties is missing (the "missing" sector). In Panel A, we show the net securities lending of the unreported sector as a function of the asset's specialness. The binscatter is based on bond-day level observations. Panel B shows the aggregate net securities lending (securities lent minus securities borrowed) by the missing sector at the daily level. Data are sourced from SFTDS and are limited to fixed-rate single-collateral–backed repo transactions for German central government bonds, for the 2021–2024 sample.

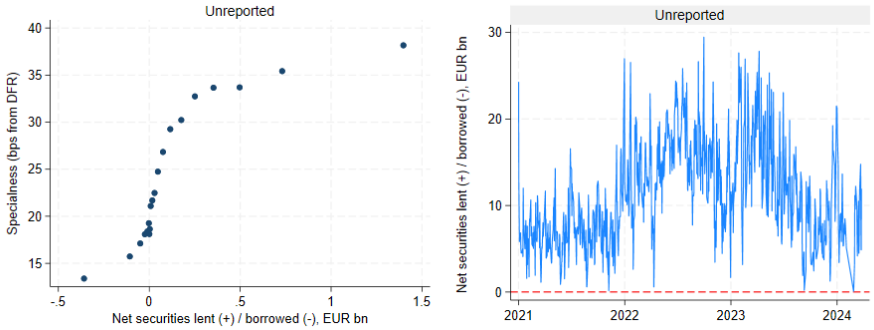


Figure A-2. Implications of SFTDS reporting rules

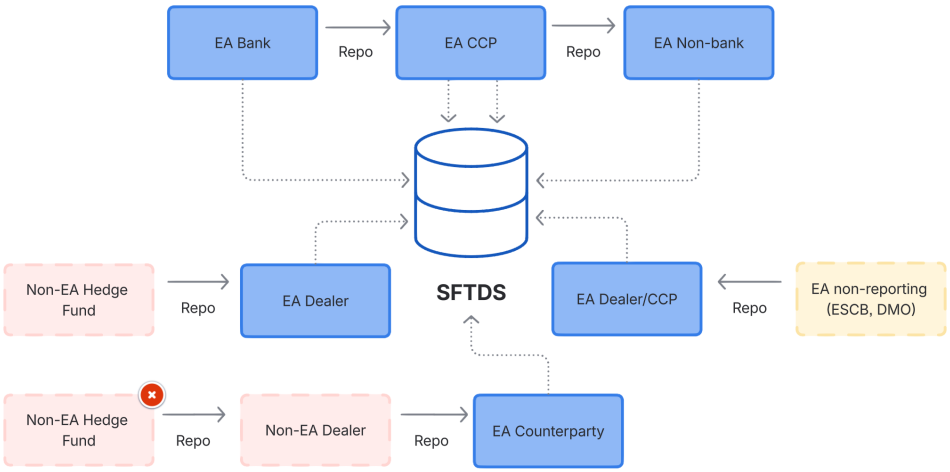


Figure A-3. Volumes of securities borrowed by location of hedge funds (IF)

In this figure, we show the distribution of securities borrowed by hedge fund based on the country of incorporation of the fund. Data are sourced from SFTDS and are limited to fixed-rate single-collateral–backed repo transactions for German central government bonds, for the 2023 sample.

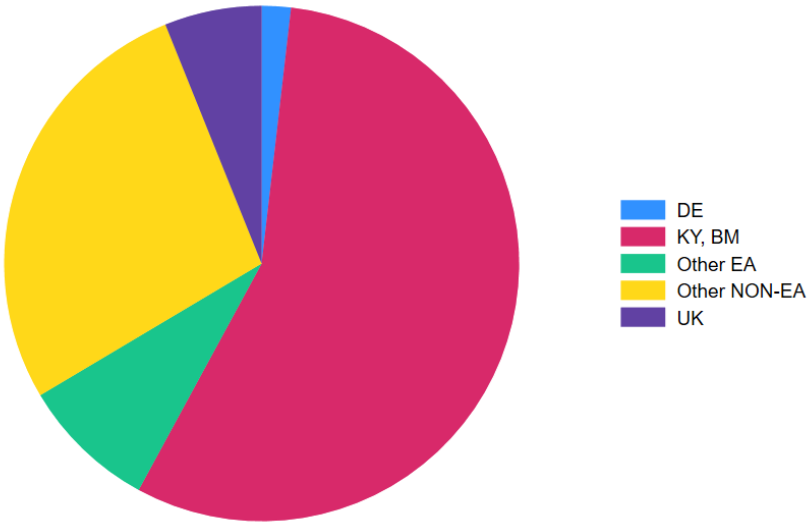


Figure A-4. Idiosyncratic shocks

In this figure, we show the daily time series of the residuals (i.e. idiosyncratic shocks) from the first stage of the O-GIV where sector i net securities borrowing volumes in the repo market are residualised against a broad set of common factors and sector fixed effects, see equation 16 and Table 2 and Table A-2. The dependent variable is the percentage deviation of sector i ' net securities borrowing volumes from its 3-months moving average. The same transformation is applied to common factos, which are listed in Section 3. We aggregate the shocks from all sectors by taking the daily sum.

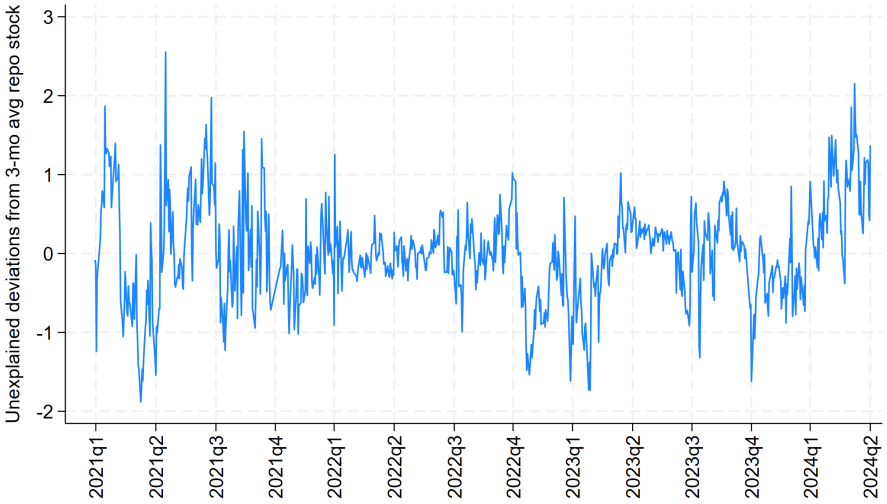


Figure A-5. Actual and predicted specialness deviations from 3-months moving average

In this figure, we show the strong positive correlation between the predicted values from our model $\Delta\hat{p}_t$ - calculated from Eq. 20 - and observed deviations Δp_t as evidence of the good fit of our empirical specification.

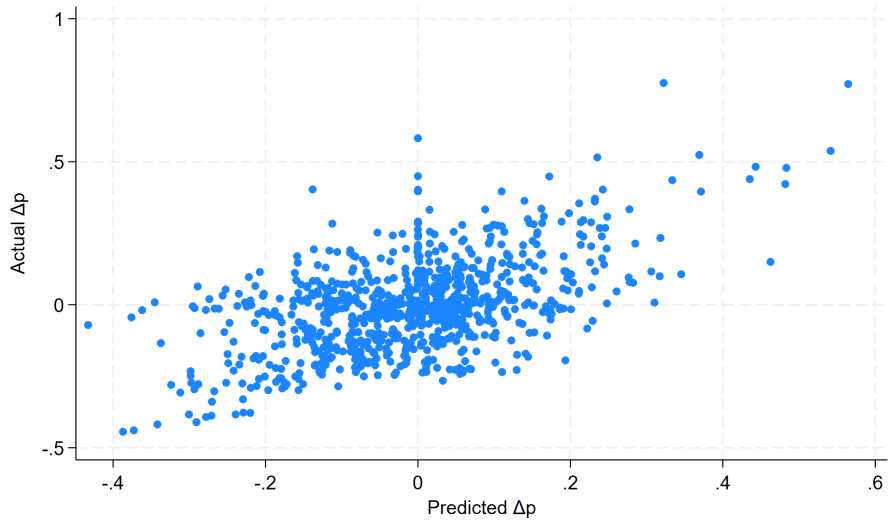


Figure A-6. Decomposition of repo specialness contributions by common factors

This figure shows the decomposition of the changes in the specialness spread among common factors. We define changes in specialness as the relative deviation from the three-month moving average, and changes in quantities accordingly. We average the daily contributions at the quarter level, and classify the factors into monetary policy, repo demand, repo supply, and bond supply factors. The factor decomposition for factor $\eta(k)$ is calculated as $\Delta\hat{p}_{\eta(k),t} = \frac{1}{\hat{\zeta}_S} S_i \hat{\lambda}_i(k) \eta_t(k)$, for and day-$t$, where $\hat{\zeta}_S$ is reported in Table 3. The sample period goes from March 2021 to June 2024 and the sample consists of repos with underlying collateral a German government bond. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB

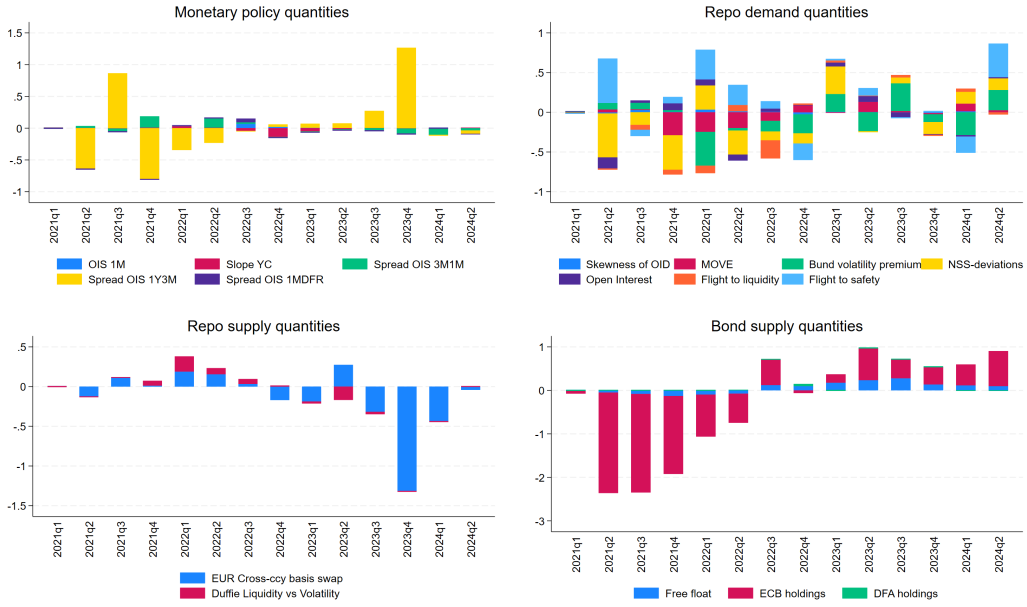


Figure A-7. Decomposition of repo specialness contributions of EA intermediaries at quarter-end

In this figure, we show the cyclicality of sectoral contribution to specialness within a quarter. That is, we calculate the contribution $\Delta\hat{p}_{i,t} = \frac{1}{\hat{\zeta}_S} S_i(\hat{\Delta q}_i + \hat{\lambda}_i \eta_t + \hat{u}_{i,t})$, for sector-$i$ and day-t, where $\hat{\zeta}_S$ is reported in Table 3, aggregate it by sector type, and average it by the number of days to the end of the quarter. We group investors in euro-Area intermediaries (banks and dealers) and the rest. We show the results for the period from March 2022 to June 2024. In this sample, euro-area intermediaries exited from special exemption period, which allowed them to exclude sizeable central bank exposures from the calculation of the leverage ratio, contributing to lower balance sheet costs. The sample consists of repos with underlying collateral a German government bond. Repo data are from SFTDS, and eurosystem repo lending data are from MOPDB.

