



EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

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Stop believing in haircuts - at least the
way you think about them

No 3301 / October 2026



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Abstract

We study how frictions impact haircut setting in repo markets. Using transaction-level supervisory data and exploiting the 2021 introduction of the binding leverage ratio requirement, we show that three frictions jointly shape haircuts in the bilateral dealer-to-client segment: dealer balance sheet constraints, collateral convenience yields, and client outside options. In collateral-driven repos, binding leverage constraints and broader client outside options both raise haircuts, while higher convenience yields push them down. In funding-driven trades, the leverage constraint has no effect, higher convenience yields raise haircuts through the rehypothecation channel, and broader client outside options lower them. We rationalise these patterns in a bilateral bargaining model with periodic haircut renegotiation. Consistent with the model, constrained dealers exhibit higher repo-rate volatility and weaker pass-through of ECB policy rate changes in the collateral-driven segment. Post-crisis bank regulation thus carries potential unintended consequences for repo market functioning and the transmission of monetary policy.

J.E.L. classification: C78, E43, E52, E58, G12, G21, G28.

Keywords: Bilateral repo, haircuts, dealer balance sheet, convenience yield, client outside options, leverage ratio, monetary policy pass-through.

Non-technical Summary

Repo is the largest segment of money markets: cash is borrowed against securities pledged as collateral, most often government bonds. Market participants use repo either to obtain cash (funding-driven repos) or to borrow specific securities (collateral-driven repos). In both cases, the haircut — the difference between the value of the collateral and the cash exchanged — is commonly viewed as a risk-management tool. It should be positive when a dealer lends cash, protecting it against having to sell the collateral at a loss if the client defaults, and negative when a dealer lends a security, protecting it against having to buy the security back at a higher price if it is not returned. In practice, haircuts in bilateral repo are mostly zero and often carry the opposite sign. This paper asks what explains these patterns.

Using transaction-level data on euro area bilateral dealer-to-client repos from 2019 to 2024, we show that haircuts are shaped by three frictions. First, dealer balance-sheet constraints matter. The Basel III leverage ratio makes it costly for dealers to receive cash in collateral-driven repos, so dealers closer to their regulatory minimum set higher haircuts in these trades. This effect emerges once the leverage ratio becomes binding in June 2021, is present throughout the quarter rather than only at reporting dates, and is absent in funding-driven repos, which do not expand the dealer's balance sheet in the same way. Second, the convenience yield of the collateral matters. Scarce, highly valued government bonds lower haircuts in collateral-driven trades, where dealers seek protection against the cost of replacing them, but raise haircuts in funding-driven trades, where dealers can re-use the bonds they receive. Third, clients' outside options matter as clients with more dealer relationships obtain more favourable haircut terms.

A bargaining model between dealer and client rationalises these findings. It recovers the textbook risk-management haircuts when the frictions are absent and shows that zero and opposite-sign haircuts are equilibrium outcomes once regulation, collateral scarcity and client bargaining positions are taken into account. Consistent with the model, leverage-constrained dealers exhibit more volatile repo rates and pass changes in the ECB's deposit facility rate through to their clients less completely in collateral-driven trades. Post-crisis bank regulation therefore has consequences not only for repo contract terms but also for the transmission of monetary policy in the repo market.

1. Introduction

Repurchase agreements (repo) — short-term loans secured by securities pledged as collateral, most often government bonds — are the main segment of the money market and play a central role in the efficient allocation of short-term funding, securities financing, and circulation of collateral. A deep and well-functioning repo market allows financial intermediaries to manage liquidity, enables non-bank financial institutions to finance leveraged portfolios, and as the largest segment of the money market is an essential step to transmit monetary policy to the broader financial system. Given its importance for market efficiency, financial stability, and the real economy, understanding the frictions that arise in the repo market — and the mechanisms through which they shape market outcomes — is essential.

Haircuts applied to the collateral leg of repo transactions are generally assumed to be a key risk-management tool. Yet a growing body of evidence documents that haircuts in bilateral repo are systematically at zero or even negative across major jurisdictions — Europe ([Hermes, Schmeling, and Schrimpf, 2025a,b](#); [Panzarino and Spolaore, 2026](#)), the United States ([Hempel, Kahn, Mann, and Paddrik, 2023](#); [Bejarano, Lu, and Wallen, 2025](#); [Kahn and McCormick, 2025](#); [Cenicola, Mann, and Paddrik, 2025](#)), and the United Kingdom ([Julliard, Pinter, Todorov, and Yuan, 2026](#)). This pattern has revived the policy debate over the financial-stability risks posed by repo and the associated leverage of non-bank financial institutions, and has led the Financial Stability Board to propose, for instance, the imposition of minimum haircut floors ([Financial Stability Board, 2025](#); [Grill, Hermes, and Wedow, 2025](#)). This paper identifies three money-market frictions — dealer balance-sheet constraints, collateral convenience yields, and client outside options — that jointly determine haircut design in bilateral repo markets, and analyses what these design choices imply for funding conditions, monetary policy transmission, and financial stability.

In our analysis, we focus on the bilateral dealer-to-client segment of the repo market where haircuts are the result of a negotiation between the dealer bank and a client such as a hedge fund.¹ Repos serve a *dual purpose* in either providing cash or collateral. We

¹By contrast, transactions in the inter-dealer segment tend to be centrally cleared with standardized haircuts. Because dealers have access to a centrally cleared interdealer market—offering capital netting benefits, anonymous centralized trading, homogeneous counterparty risk, and efficient price discovery—we assume that most trades in the dealer-to-client segment are client-initiated.

classify transactions in which a dealer provides cash to a client as *funding-driven* and those in which a dealer provides collateral as *collateral-driven*. The haircut is defined as the percentage difference between the market value of the collateral pledged and the cash lent. The basic intuition behind collateralised lending is that haircuts should protect the cash- or collateral-lender from the counterparty’s default, and that rates are a function of supply and demand for cash and scarce collateral. If a dealer lends out cash (in a *funding-driven* transaction), we would expect haircuts to be positive to protect the dealer against a borrower default; if the borrower defaults, the dealer must sell the collateral at a potentially lower price than at inception. We refer to this risk as *liquidation risk*. By contrast, if a dealer lends out collateral (in a *collateral-driven* transaction), we would expect haircuts to be negative to protect dealers against the risk of the collateral not being returned. If the collateral is not returned, the dealer must re-source it in the market at a potentially higher price. We refer to this risk as *replacement risk*.²

For our empirical analysis, we exploit the ECB’s Money Market Statistical Reporting (MMSR), a confidential supervisory database of the transaction-level activity of the largest dealer banks in the euro-area money market. MMSR offers an exceptionally rich window into the bilateral repo market: for each transaction we observe both counterparties, the specific security pledged as collateral (at the ISIN level), the volume, maturity, repo rate, and haircut. Coverage runs from January 2019 to June 2024 and spans both the June 2021 introduction of the binding leverage-ratio requirement and multiple ECB rate-change events. Crucially, transactions can be linked to dealer- and collateral-level characteristics, allowing us to bring the three frictions we study together in a single empirical framework.³ Consistent with existing evidence (Hempel et al., 2023; Bejarano et al., 2025; Julliard et al., 2026; Hermes et al., 2025b; Panzarino and Spolaore, 2026), the data confirm that trade-level haircuts in the bilateral segment are frequently zero, occasionally carry the “wrong” sign relative to

²Repo contracts embed additional risk management tools beyond the initial haircut, most notably daily margining. Margining refers to the daily mark-to-market adjustment of the collateral value, which requires the posting of variation margin when price changes alter the exposure between counterparties. While the haircut provides an ex ante buffer against potential losses in the event of default, daily margining manages ex post exposure by ensuring that the collateral value remains aligned with the outstanding cash position over the life of the transaction. Thus, although both mechanisms mitigate counterparty and market risk, they address distinct dimensions of risk: haircuts protect against liquidation and replacement risk, whereas margining limits the accumulation of mark-to-market losses.

³Dealer leverage ratios are sourced from the ECB’s harmonised financial reporting FINREP dataset.

the direction of the trade, and depart from a monotonic dependence on collateral risk. For example, there are periods in which haircuts on collateral from less risky countries are higher than those on collateral from riskier countries. In short, we observe that many repo contracts are priced as if there is no liquidation or replacement risk, and are even priced contrary to ex ante expectations.

To rationalise these patterns and derive testable predictions, we develop a bilateral bargaining model of the dealer-to-client repo market. Dealer and client jointly negotiate the contract (r, h) through Nash bargaining in the spirit of [Infante \(2019\)](#). The model applies to both collateral-driven and funding-driven segments, and embeds three frictions known to shape repo markets in a single framework: dealer balance-sheet constraints (e.g., [Ranaldo, Schaffner, and Vasios, 2021](#)), collateral convenience yields (e.g., [Buraschi and Menini, 2002](#); [Corradin and Maddaloni, 2020](#); [Arrata, Nguyen, Rahmouni-Rousseau, and Vari, 2020](#); [Ballsensiefen, Ranaldo, and Winterberg, 2023](#)), and client outside options (e.g., [Eisenschmidt, Ma, and Zhang, 2024](#)). The model recovers the textbook risk-management haircuts when the frictions vanish and delivers sharp segment-specific sign predictions: leverage constraints raise haircuts in collateral-driven repos only, convenience yields flip sign across the two segments through a rehypothecation channel, and client outside options do the same through the shadow value of the conserved resource (cash in collateral-driven trades, collateral in funding-driven trades). Within this framework, zero and wrong-sign haircuts are equilibrium contracting outcomes under regulatory and intermediation frictions, not departures from rational risk management.

We test these predictions in the MMSR data. First, we show that dealer balance-sheet constraints put upward pressure on haircuts in collateral-driven repos. From a dealer's perspective, the regulatory treatment of repos and reverse repos is asymmetric: in collateral-driven repos, the cash leg increases total assets and enters the non-risk-weighted leverage ratio, making these trades balance-sheet intensive, whereas funding-driven repos do not tighten the leverage constraint in the same way.⁴ Moreover, haircuts also carry capital cost. Lower haircuts in collateral-driven repos increase the amount of cash received by the dealer and

⁴This is because, under standard accounting treatments, securities received as collateral remain on the balance sheet of the collateral provider, whereas the cash leg of the transaction is recognized as an asset on the bank's balance sheet.

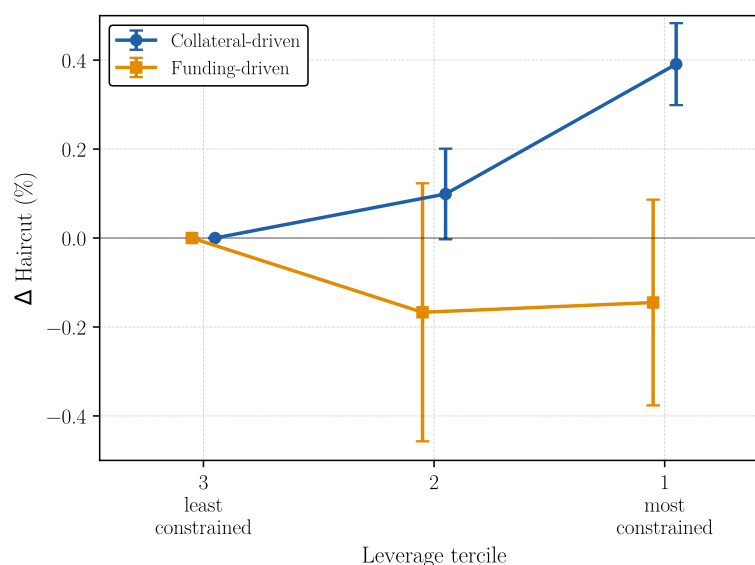
thus the balance-sheet usage, giving capital-constrained dealers an incentive to raise haircuts. Consistent with this mechanism, we find, in the *cross-section*, that dealers with lower leverage ratios increased haircuts compared to less-constrained dealers after the introduction of the binding leverage ratio requirements in 2021. Interestingly, dealers in German collateral are — on average — more balance-sheet constrained than dealers in Italian securities, which provides an intuition for why haircuts on collateral countries with higher convenience yields and replacement risk can still be higher. In the *time-series*, we show that this effect has only emerged since the leverage ratio requirements for dealer banks in the euro area have become binding. Importantly, the leverage ratio in the euro area becomes binding only on reporting days (quarter-end days), however, euro area banks are also required to report an “averaging” version of their leverage ratio. In line with this, we show that the effect of the leverage ratio on haircuts is present not only on quarter-end days but throughout the entire quarter. As the leverage ratio regulation does not penalize reverse repos, there is no effect on funding-driven repos.

We document these empirical patterns both at the transaction level and at the dealer–client–day level. This dual approach mitigates concerns that haircuts are determined at the client portfolio level rather than at the level of individual transactions. Consistent with this interpretation, we show that the distribution of transaction-level haircuts closely mirrors the distribution implied by dealer–client–day aggregated cash and collateral positions. The tight correspondence between these measures suggests that our haircut estimates are not materially distorted by portfolio-level margining practices and is consistent with institutional features documented for the U.S. Treasury repo market (Hempel et al., 2023).⁵ Figure 1 illustrates these results: after the introduction of the leverage ratio requirement, the most leverage-constrained dealers increased haircuts relative to less-constrained dealers, but only in collateral-driven trades.

Second, we show that the same collateral characteristic can push haircuts in opposite directions across collateral- and funding-driven trades. In collateral-driven trades, the dealer lends the bond to the client and bears the replacement risk of not receiving it back at maturity.

⁵For example, Hempel et al. (2023) highlight that in bilateral repo transactions transaction-level haircuts determine margins collected for that transaction, whereas for centrally cleared repos, margins are calculated on the portfolio level.

Figure 1: Haircut adjustments to leverage constraints



Note: The figure plots estimated differences in repo haircuts across leverage-ratio terciles relative to the least-constrained tercile (tercile 3, omitted) after the 3% leverage-ratio requirement became binding for all EU banks on June 28, 2021. Coefficients and standard errors are obtained from regressions of the volume-weighted mean haircut (in %) on $\text{tercile} \times \text{Post}$ interactions, estimated on bilateral dealer-to-client repos collateralised by euro-area government bonds over January 2019–June 2024. Transactions are aggregated to (dealer, client, day) cells. Dealers are sorted into terciles within each quarter based on their leverage ratio; tercile 1 denotes the most constrained and tercile 3 (omitted baseline) the least constrained dealers. All specifications include client and leverage-tercile fixed effects and a control for cell-level total volume. Blue line: collateral-driven repo sample. Orange line: funding-driven repo sample, defined from the perspective of the dealer’s clients. Vertical bars denote 95% confidence intervals based on standard errors clustered at the dealer-client level.

Bonds with higher convenience yields are scarcer and more valuable to market participants (Krishnamurthy and Vissing-Jorgensen, 2012; Ballensiefen and Ranaldo, 2023), which makes them costlier to re-source in the case of counterparty default. Higher convenience yields therefore push haircuts down in the collateral-driven segment, as dealers demand more cash upfront to insure against this replacement cost. In funding-driven trades, by contrast, the dealer receives the bond from the client and holds it for the term of the repo. Because the dealer can rehypothecate the bond during that time, receiving a scarcer or more valuable bond is more profitable. Higher convenience yields therefore raise haircuts in the funding-driven segment: dealers require the client to post more collateral per unit of cash lent, allowing them to accumulate more of the valuable bond. This sign flip reflects the fundamentally different economic role of the haircut in each segment.

Third, we show that client outside options push haircuts in opposite directions across the two segments. In funding-driven trades, the client borrows cash from the dealer and posts collateral. The client prefers a lower haircut, as this means posting less collateral per unit of cash borrowed. Consistent with this, clients with a broader network of active dealer relationships negotiate systematically lower haircuts. In collateral-driven trades, by contrast, the client lends cash to the dealer and receives a specific security. The client prefers a higher haircut, as this means receiving more collateral per unit of cash lent. Consistent with this, clients with broader outside options negotiate systematically higher (less negative) haircuts. The same underlying client characteristic therefore pushes haircuts in opposite directions across the two segments. Overall, this result implies that haircut levels are relationship-specific and shaped by client outside options, rather than adjusting only to time-varying collateral risk.

Building on these frictions, the model yields two testable predictions for repo rates in the collateral-driven segment: (i) constrained dealers exhibit higher repo-rate volatility, and (ii) they transmit ECB deposit-facility-rate changes less completely to their clients. We confirm both in the data. Funding-driven trades, in which dealer leverage constraints have no effect on the haircut, serve as natural placebos: rate volatility and pass-through in the funding-driven segment are unrelated to dealer leverage. These results suggest that post-crisis leverage-ratio regulation carries unintended consequences for monetary policy transmission, operating through the composition of the repo contract.

In sum, we provide evidence that haircuts in repo markets are shaped by different frictions across collateral- and funding-driven segments. The remainder of the paper proceeds as follows. After introducing the related literature, Section 2 describes the institutional setting. Section 3 develops the bargaining model and derives its haircut and rate predictions. Section 4 introduces our data, Section 5 tests the model's haircut predictions on transaction-level data, documenting how the three frictions shape haircut design in the collateral-driven and funding-driven segments. Section 6 tests the model's rate-level predictions on volatility and monetary policy pass-through. Section 7 concludes.

Related literature. Our analysis mainly contributes to two strands of the literature. First, we add to work on haircut determination in bilateral repo markets. [Dang, Gorton, and Holm-](#)

ström (2011) argue theoretically that haircuts exist to make collateralised debt “information-insensitive.” A growing empirical literature, however, documents that trade-level haircuts in bilateral repo are systematically zero or negative across jurisdictions — Europe (Hermes et al., 2025a,b; Panzarino and Spolaore, 2026), the United States (Hempel et al., 2023; Bejarano et al., 2025; Kahn and McCormick, 2025; Cenicola et al., 2025), and the United Kingdom (Julliard et al., 2026). Recent contributions have advanced several explanations: competition among lenders (Bittner and Jank, 2025), excess balance-sheet capacity (Bejarano et al., 2025), portfolio-level margining that substitutes for trade-level haircuts (Hempel et al., 2023; Hill and Westphal, 2025; Panzarino and Spolaore, 2026), wrong-way-risk premia between borrower and collateral (Barbiero, Schepens, and Sigaux, 2024), and dealer market power over less-connected clients (Hau, Hoffmann, Langfield, and Timmer, 2021).

We contribute several distinct channels in explaining these repo haircut patterns by systematically distinguishing between *collateral*- and *funding*-driven repo transactions: the Basel III leverage ratio as a first-order regulatory friction shaping haircut design in the collateral-driven segment of the euro-area bilateral repo market. We further document the first systematic evidence of segment-level asymmetry: convenience yields and client outside options act in opposite directions across collateral- and funding-driven repos. These channels operate alongside, and are distinct from, the portfolio-margining channel documented by Panzarino and Spolaore (2026) and the wrong-way-risk channel of Barbiero et al. (2024). Whereas Bejarano et al. (2025) document how the zero risk-weight of Treasury repo enables U.S. dealers to supply leverage to non-bank clients through negative haircuts, we identify the opposite margin — the leverage ratio constrains euro-area dealers and pushes haircuts upward in collateral-driven trades. The paper also relates to work on collateral demand and specialness in repo markets (e.g., Mancini, Ranaldo, and Wrampelmeyer, 2016; Arrata et al., 2020; Corradin and Maddaloni, 2020; Coen, Coen, and Hüser, 2024).⁶

Second, we add to the literature on monetary policy, financial regulation, and the transmission process (e.g., Duffie and Krishnamurthy, 2016; Drechsler, Savov, and Schnabl, 2017; Ballensiefen et al., 2023; Eisenschmidt et al., 2024). Post-crisis bank regulation has been shown

⁶Studies on safe-asset scarcity show that high-quality government bonds in Europe command convenience yields that translate into repo pricing (Krishnamurthy and Vissing-Jorgensen, 2012; Ballensiefen and Ranaldo, 2023). Gorton and Metrick (2012) document how repo haircuts spiked during the 2008 financial crisis.

to distort short-term funding markets: [Ranaldo et al. \(2021\)](#) document quarter-end window dressing by European banks around the Basel III leverage ratio, [Du, Tepper, and Verdelhan \(2018\)](#) document persistent covered-interest-parity deviations attributable to bank balance-sheet constraints, and [Eisenschmidt et al. \(2024\)](#) show that dealer market power in OTC repo reduces policy-rate pass-through. We advance this literature on two dimensions. First, we show that the leverage ratio reshapes euro-area repo not only at quarter-ends but throughout the entire quarter, and that it operates through haircut design rather than only through rates. Second, we identify a distinct within-dealer-sector transmission channel: because constrained dealers cannot use haircuts as an adjustment margin, the shock is displaced onto repo-rate volatility and onto the pass-through of policy rates to non-bank clients. These findings resonate with [Duffie and Krishnamurthy \(2016\)](#) and [Drechsler et al. \(2017\)](#) on the imperfect transmission of central-bank rates through frictions in intermediary balance sheets.

Lastly, we develop a theoretical model that rationalises our empirical findings. Our framework is a bilateral Nash bargaining model in the spirit of [Infante \(2019\)](#), reflecting the OTC search-and-bargaining structure of the dealer-to-client segment ([Duffie, Gârleanu, and Pedersen, 2005](#)). It jointly determines the equilibrium haircut and repo rate under dealer balance-sheet costs, collateral convenience yields, and client outside options, and is augmented with a framework-commitment refinement that delivers closed-form predictions for rate volatility and monetary-policy pass-through. This complements existing theoretical work on haircuts as information-insensitive risk mitigants ([Dang et al., 2011](#)), on margin-driven amplification of financial cycles ([Geanakoplos, 2010](#); [Brunnermeier and Pedersen, 2009](#)), and on the intermediary-balance-sheet view of asset pricing ([Adrian and Shin, 2010](#); [He and Krishnamurthy, 2013](#)), by embedding a specific regulatory friction — the leverage ratio — as a first-order determinant of equilibrium contract terms.

2. Institutional background

Repurchase agreement. A repurchase agreement, or repo, is a short-term secured financing transaction in which one counterparty sells a security (most commonly a sovereign bond) to another, with an obligation to repurchase it at a predetermined price after an agreed period. A repo contract is characterised by four key terms, each negotiated at the transaction level:

(i) the volume of cash exchanged, (ii) the repo rate, (iii) the specific security posted as collateral, and (iv) the haircut applied to the collateral.⁷ The collateralised nature of repos means they serve a dual function: they provide a vehicle both for obtaining short-term funding and for sourcing specific securities.

Euro area repo market structure. The euro area repo market comprises two broad segments: an *inter-dealer* segment, in which dealers trade with one another, and a *dealer-to-client* segment, in which dealers intermediate trades with non-dealer institutions such as investment funds, hedge funds, money market funds, insurance companies, and pension funds. The inter-dealer segment is predominantly centrally cleared. Transactions in the inter-dealer market are executed on electronic platforms (such as BrokerTec, Eurex Repo, and MTS Repo) and novated to a central counterparty (CCP), which becomes the legal counterparty to both sides of each trade. Central clearing allows dealers to net their positions against a single counterparty across many trades, substantially reducing gross balance-sheet exposures. Moreover, the CCP applies standardised risk-management tools, including initial and variation margin, and facilitates efficient price formation through anonymous order books.⁸ The dealer-to-client segment, by contrast, is an over-the-counter (OTC) bilateral market. Because netting is only possible within each individual dealer–client relationship, gross exposures remain larger and balance-sheet constraints are more binding than in centrally cleared markets. There is no centralised price formation mechanism; instead, contract terms are negotiated bilaterally and are relationship-specific.

The focus of this paper is on the bilateral dealer-to-client segment of the euro area money market, which provides a uniquely suitable setting to study how repo haircuts are set in collateral- and funding-driven environments. This segment is characterised by bilateral contracting, relationship-specific bargaining, and limited transparency, making market frictions particularly salient. Moreover, the dealer-to-client segment represents the primary channel through which monetary policy is transmitted from regulated dealer banks to non-bank financial institutions, allowing us to study directly how regulatory constraints affect both con-

⁷The cash lender in a repo transaction becomes the legal owner of the collateral for the term of the repo, and may use it for example, to settle delivery obligations or to re-pledge in a subsequent transaction (Duffie, 1996).

⁸For cleared transactions, it is common practice to report a zero haircut because risk management is handled through the CCP's initial and variation margin framework. Our focus on the bilateral segment avoids this confound. See also Schaffner, Ranaldo, and Tsatsaronis (2019) for evidence on dealer trading patterns and home bias in the inter-dealer segment.

tract design and policy pass-through. Overall, the bilateral dealer-to-client segment is a subset of the broader bilateral repo market, which itself accounts for a substantial share of euro-area repo activity (Panzarino and Spolaore, 2026).

Funding-driven versus collateral-driven repos. A key distinction for this paper is between *funding-driven* and *collateral-driven* repo transactions. In a funding-driven repo, the initiating party seeks cash; in a collateral-driven repo, the initiating party seeks a specific security or, more broadly, eligible collateral. This distinction matters fundamentally for the economics of haircut-setting. In a funding-driven repo, the haircut protects the cash lender against the liquidation risk of the collateral in the event of borrower default. The cash lender, therefore, has an incentive to demand overcollateralisation, implying positive haircuts. In a collateral-driven repo, the haircut protects the collateral provider (the dealer) against the replacement risk of the security: should the cash lender default and fail to return the collateral, the dealer must repurchase it in the open market, potentially at a premium. The dealer, therefore, has an incentive to deliver less cash than the collateral is worth, implying negative haircuts.

3. Theoretical Framework

We develop a bilateral bargaining model in which a dealer and a client jointly negotiate the haircut and the repo rate, matching the institutional structure of the euro-area bilateral *dealer-to-client* repo market segment. The model embeds three frictions in a single framework: dealer balance-sheet constraints, collateral convenience yields, and client outside options. It applies to both the collateral-driven and funding-driven segments, recovers the textbook risk-management haircuts when the three frictions vanish, and shows *how* each friction shifts haircuts within each segment.

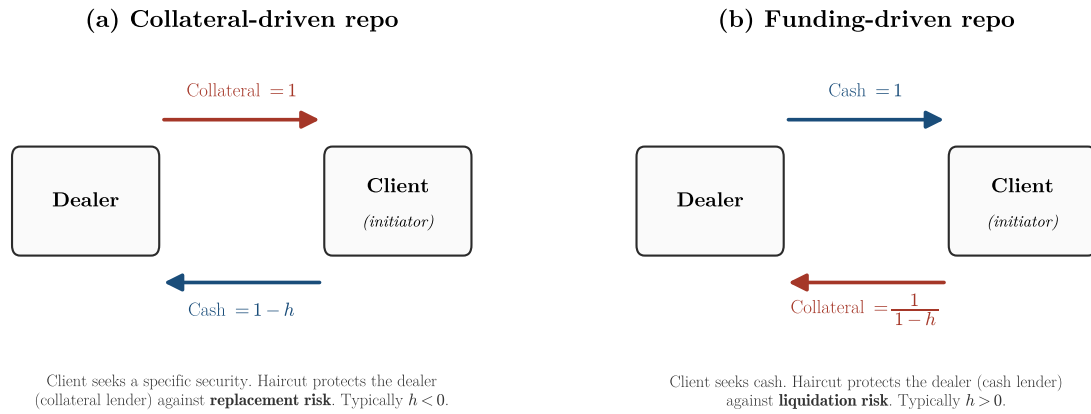
A dealer d and a client c negotiate the contract (r, h) over collateral issued by country j . Let C and V denote the cash exchanged and the market value of the collateral at inception. The haircut is defined as

$$h \equiv 1 - \frac{C}{V}, \quad (1)$$

so that $h > 0$ corresponds to overcollateralisation of the cash lender and $h < 0$ to undercollateralisation. For ease of presentation, we normalise the trade size: collateral-driven trades

are normalised per unit of collateral ($V = 1$), so the cash leg equals $1 - h$; funding-driven trades are normalised per euro of cash lent ($C = 1$), so the collateral posted equals $1/(1 - h)$. Figure 2 illustrates the two contract structures.

Figure 2: Cash and collateral flows at trade inception



Note: **(a)** In a collateral-driven repo, the dealer lends a specific security to the client and receives cash of $1 - h$; a negative haircut leaves the dealer with more cash than the bond is worth, insuring the dealer against replacement risk should the security fail to be returned at maturity. **(b)** In a funding-driven repo, the dealer lends cash to the client and receives collateral of market value $1/(1 - h)$; a positive haircut over-collateralises the loan and protects the dealer against liquidation risk should the client default.

Throughout, $\Gamma_j \equiv \gamma_d \mu_j$ denotes the dealer's balance-sheet cost, with γ_d increasing in the tightness of the leverage constraint and μ_j a country multiplier; y_j is the convenience yield of country- j collateral, p the client default probability, and θ_j the dealer's bargaining share.

3.1. The client's problem

The client initiates the trade to obtain one of two resources, a specific security or cash, and pays for it with the other. Her payoff is quasi-linear in the repo rate and depends on the haircut through the shadow value of the resource she conserves.

In a *collateral-driven* trade, the client obtains a specific security from the dealer and posts cash $1 - h$ in return. Because $C = 1 - h$, a higher haircut reduces the cash the client must post per unit of collateral received, freeing cash for other uses. Her utility is

$$U_c^{CD} = v + (1 - p)r + \underbrace{\left[\lambda h - \frac{\varphi}{2} h^2 \right]}_{\text{shadow value of freed cash}}, \quad (2)$$

where v is her private valuation of obtaining the specific security and $(1 - p)r$ is the expected rate transfer she receives from the dealer, discounted by the probability that the client does not default. The bracketed term captures the value the client places on the cash she does not have to post: $\lambda > 0$ is the marginal shadow value of freed cash, reflecting the alternative uses to which it can be redeployed (other collateralised trades, unencumbered balance sheet, funding elsewhere), and $\varphi > 0$ captures the finite redeployment capacity, so that the marginal value of freed cash declines as more of it is freed. The client, therefore, prefers a higher rate and a higher (less negative) haircut.

In a *funding-driven* trade, the client borrows cash from the dealer and posts collateral of market value $\frac{1}{1-h}$ per unit of cash received. Because $V = \frac{1}{1-h}$, a higher haircut increases the collateral the client must post per unit of cash borrowed, encumbering more of her collateral pool. Her utility is

$$U_c^{FD} = v_c - (1 - p)r - \underbrace{\left[\lambda_c \left(\frac{1}{1-h} - 1 \right) + \frac{\varphi_c}{2} \left(\frac{1}{1-h} - 1 \right)^2 \right]}_{\text{shadow cost of encumbered collateral}}, \quad (3)$$

where v_c is her private valuation of the funding and $(1 - p)r$ is the expected rate transfer she pays to the dealer, discounted by the probability of no default at maturity. The bracketed term captures the shadow cost of the collateral she must lock up beyond the unit of cash received, in amount $\frac{1}{1-h} - 1$. Here $\lambda_c > 0$ is the marginal shadow value of unencumbered collateral, reflecting the alternative uses to which it could otherwise be put (posting elsewhere in the repo market, rehypothecation, regulatory buffer), and $\varphi_c > 0$ captures the finite size of the collateral pool, so that the marginal cost of additional encumbrance rises as more collateral is locked up. The client, therefore, prefers a lower rate and a lower haircut.

The two problems share a common structure: a linear valuation of the conserved resource with a convex adjustment cost. They differ only in which resource is conserved: cash in the collateral-driven segment, collateral in the funding-driven segment. The shadow value λ and curvature φ of freed cash are, therefore, distinct fundamentals from the shadow value λ_c and curvature φ_c of unencumbered collateral, though a common client characteristic drives them both. A client with broader outside options can redeploy either resource across more venues, raising both λ and λ_c . As we show below, this common force generates opposite

haircut effects across the two segments: higher λ pushes the collateral-driven haircut up, while higher λ_c pushes the funding-driven haircut down. In neither case does the client have access to the deposit facility.⁹

3.2. The dealer's problem

The dealer's payoff has the mirrored components: the rate transfer, the carry on the position, a convex exposure to client default, and a balance-sheet penalty where regulation binds.

In a *collateral-driven* trade, the dealer lends the specific bond to the client and receives cash $1 - h$ in return. Her payoff is

$$\pi^{CD} = \underbrace{r^{DFR}(1-h)}_{\text{cash-leg carry}} - \underbrace{(1-p)r}_{\text{rate paid}} - \underbrace{y_j}_{\text{forgone conv. yield}} - \underbrace{\frac{pm}{2}(h+s(y_j))^2}_{\text{replacement risk}} - \underbrace{\frac{\Gamma_j}{2}(1-h)^2}_{\text{balance-sheet penalty}}. \quad (4)$$

The first term is the carry on the cash leg: the dealer holds the received cash overnight and earns the deposit facility rate r^{DFR} , her marginal return on unencumbered reserves. The second is the expected rate she pays to the client, discounted by the probability of no default at maturity. The third captures the convenience yield y_j she forgoes while the bond is out on loan. The fourth prices replacement risk: with probability p the client defaults and fails to return the bond, and the dealer, still holding the cash $1 - h$, must source a replacement in the market at the scarcity-inflated price $1 + s(y_j)$, where $s'(y_j) > 0$ reflects that scarcer bonds are more costly to re-source. Her uninsured shortfall $h + s(y_j)$ enters the payoff as the convex price-impact cost $\frac{m}{2}(h + s(y_j))^2$, scaled by the default probability. The fifth is the balance-sheet penalty: under the leverage-ratio requirement, the cash leg $1 - h$ expands the dealer's non-risk-weighted exposure measure one-for-one, so a larger cash leg consumes more balance-sheet capacity. The convex form $\frac{\Gamma_j}{2}(1 - h)^2$ captures the disproportionately higher marginal cost of leverage as the dealer approaches her leverage-ratio floor.

In a *funding-driven* trade, the dealer lends one unit of cash to the client and receives

⁹This means neither shadow value is anchored to the deposit facility rate: the client has no access to the DFR, so her opportunity cost is set entirely by the alternative uses captured by λ and λ_c .

collateral of market value $1/(1-h)$ in return. Her payoff is

$$\pi^{FD} = \underbrace{(1-p)r}_{\text{rate received}} + \underbrace{\omega y_j \frac{1}{1-h}}_{\text{rehypothecation value}} - \underbrace{\frac{pq}{2} \left(1 - \frac{1-\ell(y_j)}{1-h}\right)^2}_{\text{liquidation risk}} - \underbrace{r^{DFR}}_{\text{funding cost}}. \quad (5)$$

The first term is the expected rate she receives from the client, discounted by the probability of no default at maturity. The second is the rehypothecation value: as legal owner of the collateral, the dealer can re-use it during the term of the trade, whether by pledging it in another repo, delivering it against a short, or posting it as regulatory margin. She captures a fraction $\omega \in [0,1]$ of its convenience yield y_j per unit of collateral held, and holds $1/(1-h)$ units per unit of cash lent. The third prices liquidation risk: with probability p the client defaults, and the dealer must liquidate the collateral at the discounted price $1 - \ell(y_j)$ per unit, where $\ell'(y_j) \leq 0$ reflects that more liquid, higher-convenience bonds liquidate at smaller discounts. Her loss per unit of cash lent is $1 - (1 - \ell(y_j))/(1-h)$, entering the payoff as the convex covering cost $\frac{q}{2} (1 - (1 - \ell(y_j))/(1-h))^2$, scaled by the default probability. The fourth is the funding cost: by lending the cash, the dealer forgoes the deposit facility rate r^{DFR} she would have earned had she left it at the central bank overnight. No balance-sheet penalty enters: under standard accounting, the reverse-repo leg does not expand the dealer's non-risk-weighted exposure measure, so this trade consumes no leverage-ratio capacity.

The mirrored default exposures already pin down the frictionless risk-management benchmarks: the exposure-minimising haircut is $-s(y_j) < 0$ in the collateral-driven segment; in the funding-driven segment the exposure vanishes at $h = \ell(y_j) > 0$. Negative when the dealer lends the bond, positive when she lends the cash.

3.3. *Equilibrium*

In each segment, the dealer-client pair maximises the Nash product $(\pi)^{\theta_j} (U_c)^{1-\theta_j}$ over (r, h) , with disagreement payoffs normalised to zero. One participant pays r , the other receives r . Hence, the sum of profits/surpluses does not depend on r . We first optimize the total surplus (which only depends on h and thus determines h^*), then, the bargaining determines how that surplus is split by determining r^* . In other words, both payoffs are quasi-linear in r with the common coefficient $(1-p)$, so utility is transferable and the bargaining

problem separates: the haircut maximises joint surplus $S = \pi + U_c$, and the rate implements the split, $U_c = (1 - \theta_j) S(h^*)$. The haircut is thus the efficiency instrument, set where the two parties' marginal rates of substitution between haircut and rate coincide, and the rate is the distributional instrument. Appendix A carries out both steps in full.

In solving the funding-driven segment we linearise the collateral leg, $\frac{1}{1-h} = 1 + h$, a first-order approximation exact up to $O(h^2)$ and immaterial at observed haircut magnitudes. It is imposed only in the equilibrium computation: the payoffs (3) and (5) and the risk-management benchmarks above retain the exact $1/(1-h)$. Under this linearisation both segments are linear-quadratic in the haircut, each pinned down by a single tangency condition.

Proposition 1 (Equilibrium haircut): Write $\Phi \equiv \varphi + pm$ and $D_j \equiv \varphi_c + pq(1 - \ell(y_j))^2$. The equilibrium haircuts satisfy

$$h_{CD,j}^* = \frac{\lambda + \Gamma_j - r^{DFR} - pm s(y_j)}{\Phi + \Gamma_j}, \quad h_{FD,j}^* = \frac{\omega y_j + pq \ell(y_j)(1 - \ell(y_j)) - \lambda_c}{\varphi_c + pq(1 - \ell(y_j))^2}, \quad (6)$$

each pinned down by the tangency condition equating joint marginal benefit and cost of the haircut.

Frictionless benchmark. Setting the three frictions to zero ($\Gamma_j, \lambda, \varphi \rightarrow 0$ in the collateral-driven segment and $\lambda_c, \omega y_j, \varphi_c \rightarrow 0$ in the funding-driven segment, with $r^{DFR} = 0$), the equilibrium haircuts collapse to $h_{CD,j}^* = -s(y_j)$ and $h_{FD,j}^* = \ell(y_j)/(1 - \ell(y_j)) = \ell(y_j) + O(\ell(y_j)^2)$, i.e., approximately $\ell(y_j)$ for the small liquidation discounts observed in the data. These are the risk-management haircuts: in the collateral-driven segment, the dealer takes just enough undercollateralisation to cover *replacement risk*, the scarcity premium $s(y_j)$ she would pay to buy the bond back should the client default; in the funding-driven segment, she takes just enough overcollateralisation to cover *liquidation risk*, the discount $\ell(y_j)$ at which she would sell the collateral should the client default. Without frictions, the collateral-driven haircut is negative and the funding-driven haircut is positive, as counterparty-protection intuition predicts.

Sign flips. Frictions can push either haircut across zero. The collateral-driven haircut is non-negative when $\lambda + \Gamma_j \geq r^{DFR} + pm s(y_j)$: the client's shadow value of freed cash plus the dealer's balance-sheet cost outweigh the dealer's forgone deposit-facility return plus the

scarcity-adjusted replacement cost. Symmetrically, the funding-driven haircut turns negative when $\lambda_c > \omega y_j + p q \ell(y_j)(1 - \ell(y_j))$: the client's shadow value of unencumbered collateral outweighs the dealer's rehypothecation gain plus the liquidation-risk benefit of overcollateralisation. Haircuts carrying the “wrong” sign relative to a pure counterparty-protection reading are, therefore, natural equilibrium outcomes when these inequalities hold, not evidence of irrational contracting.

Proposition 2 (Equilibrium rate): *Write the equilibrium joint surplus as $S_j^{CD} = A_j^{CD} + \frac{1}{2}(\Phi + \Gamma_j)(h_{CD,j}^*)^2$ and $S_j^{FD} = A_j^{FD} + \frac{1}{2}D_j(h_{FD,j}^*)^2$ with intercepts $A_j^{CD} \equiv v - y_j + r^{DFR} - \frac{pm}{2}s(y_j)^2 - \frac{\Gamma_j}{2}$ and $A_j^{FD} \equiv v_c - r^{DFR} + \omega y_j - \frac{pq}{2}\ell(y_j)^2$. The negotiated rate is, in closed form,*

$$\begin{aligned} r_{CD,j}^* &= \frac{1}{1-p} \left[(1 - \theta_j) S_j^{CD} - v - \lambda h_{CD,j}^* + \frac{\varphi}{2}(h_{CD,j}^*)^2 \right], \\ r_{FD,j}^* &= \frac{1}{1-p} \left[v_c - \lambda_c h_{FD,j}^* - \frac{\varphi_c}{2}(h_{FD,j}^*)^2 - (1 - \theta_j) S_j^{FD} \right]. \end{aligned} \quad (7)$$

The bargaining share, while it does not affect the haircut, enters the rate linearly: $\partial r_{CD,j}^* / \partial \theta_j = -S_j^{CD} / (1 - p) < 0$ and $\partial r_{FD,j}^* / \partial \theta_j = +S_j^{FD} / (1 - p) > 0$: a more powerful dealer pays away less in the collateral-driven segment and charges more in the funding-driven segment.

The corresponding derivations including the equilibrium rate are presented in Appendices A.1, A.2, and A.3.

3.4. Comparative statics

The equilibrium haircuts are explicit ratios of the fundamentals, so differentiation gives sign predictions for how each friction shifts the haircut in each segment. We state these as three corollaries, one for each friction.

Corollary 1 (Balance-sheet constraints): *The collateral-driven haircut increases with the dealer's balance-sheet cost, $\partial h_{CD,j}^* / \partial \Gamma_j = (1 - h_{CD,j}^*) / (\Phi + \Gamma_j) > 0$ whenever the cash leg is positive, while the funding-driven haircut is unaffected, $\partial h_{FD,j}^* / \partial \Gamma_j = 0$. The asymmetry follows from the regulatory treatment: only the cash leg $1 - h$ received in a collateral-driven trade expands the dealer's non-risk-weighted exposure measure. A constrained dealer, therefore, raises the collateral-driven haircut to reduce her cash intake and free up balance-sheet capacity. She has no analogous margin in the funding-driven segment, where the reverse-repo leg does not consume leverage-ratio capacity.*

Corollary 2 (Convenience yields): *The convenience yield lowers the collateral-driven haircut and raises the funding-driven haircut whenever the rehypothecation motive dominates the liquidation-risk improvement. Formally, $\partial h_{CD,j}^*/\partial y_j = -p m s'(y_j)/(\Phi + \Gamma_j) < 0$, while $\partial h_{FD,j}^*/\partial y_j > 0$ if and only if $\omega > p q |\ell'(y_j)| [1 - 2\ell(y_j) + 2(1 - \ell(y_j)) h_{FD,j}^*]$. The sufficient condition $\omega \geq p q |\ell'(y_j)|$ holds whenever frictions compress the funding-driven haircut below its risk-management benchmark, the empirically relevant region. The same collateral characteristic, therefore, carries opposite signs across the two segments. In the collateral-driven segment, the dealer lends the bond and bears replacement risk: scarcer bonds are more costly to source in the market should the client default, so the dealer demands a larger cash cushion. In the funding-driven segment, the dealer receives the bond and holds it during the term of the repo, capturing a fraction ω of its convenience yield through rehypothecation: scarcer bonds are more valuable to hold, so she demands more of them per unit of cash lent.*

Corollary 3 (Market power and client outside options): *While bargaining power affects the negotiated rate but not the haircut, broader client outside options push haircuts in opposite directions across the two segments. Formally, under transferable utility $\partial h_{*,j}^*/\partial \theta_j = 0$ in both segments, while client-level variation enters through preferences: $\partial h_{CD,j}^*/\partial \lambda = 1/(\Phi + \Gamma_j) > 0$ and $\partial h_{FD,j}^*/\partial \lambda_c = -1/D_j < 0$. Broader outside options raise the shadow value of the conserved resource, cash in the collateral-driven segment (λ) and collateral in the funding-driven segment (λ_c), so a better-connected client secures a higher haircut in the collateral-driven segment (posting less cash per unit of collateral received) and a lower haircut in the funding-driven segment (encumbering less collateral per unit of cash borrowed). The same underlying client characteristic, therefore, generates opposite haircut effects across the two segments.*

Table 1: Model-implied signs of equilibrium haircut responses

Friction	Collateral-driven	Funding-driven
Balance-sheet cost Γ_j	+	0
Convenience yield y_j	–	+ if rehypothecation dominates
Client outside options (λ, λ_c)	+	–
Bargaining share θ_j	0	0 (rate only)

Note: Model-implied signs of the equilibrium haircut response to each friction, separately for collateral-driven and funding-driven trades. A “+” (“–”) indicates that a marginal increase in the friction raises (lowers) the equilibrium haircut. A “0” indicates no effect. The bargaining share θ_j enters the negotiated repo rate but not the haircut. The convenience-yield sign in the funding-driven segment is conditional on the rehypothecation motive dominating the liquidation-risk improvement.

Table 1 summarizes the comparative statics. The proofs are presented in Appendix A.4.

3.5. Framework commitment and residual rate adjustment

The equilibrium in Proposition 1 treats (h, r) as jointly renegotiated on each trade. In practice, bilateral repo relationships are governed by master framework agreements, most commonly the Global Master Repurchase Agreement (GMRA), which specify haircut schedules at the dealer–client level and are refreshed at agreed intervals, typically quarterly. Each schedule indexes haircuts by collateral characteristics (issuer country, rating, maturity, size), and every trade evaluates the schedule at its own coordinates. Between refresh dates, the haircut at any given schedule row is effectively committed; only the rate is renegotiated on each trade. This institutional feature is compatible with our empirical strategy: the transaction-level heterogeneity we exploit reflects variation across schedule rows (different collateral) and across dealer–client pairs (different schedules), not trade-level renegotiation of a fixed schedule entry.

We accommodate this feature with a two-stage refinement that preserves the comparative statics on h from Corollaries 1–3 and adds closed-form predictions for the rate. At Stage 0, the dealer–client pair Nash-bargains over h given expected fundamentals $(\bar{\Gamma}_j, \bar{y}_j, \bar{\lambda}, \bar{\lambda}_c)$. Because payoffs remain quasi-linear in r , the transferable-utility separation applies unchanged, and the commitment haircut is the tangency solution of Proposition 1 evaluated at expectations,

$$\bar{h}_{CD,j} = \frac{\bar{\lambda} + \bar{\Gamma}_j - r^{DFR} - p m s(\bar{y}_j)}{\Phi + \bar{\Gamma}_j}, \quad \bar{h}_{FD,j} = \frac{\omega \bar{y}_j + p q \ell(\bar{y}_j)(1 - \ell(\bar{y}_j)) - \bar{\lambda}_c}{\varphi_c + p q (1 - \ell(\bar{y}_j))^2}. \quad (8)$$

All comparative statics on h carry over to $\bar{h}$: constrained dealers set higher $\bar{h}_{CD}$; scarcer collateral compresses $\bar{h}_{CD}$ and expands $\bar{h}_{FD}$; better client outside options raise $\bar{h}_{CD}$ and lower $\bar{h}_{FD}$.

At Stage t , fundamentals realize as $(\Gamma_j^t, y_j^t, \lambda^t, \lambda_c^t)$, possibly different from their period-0 expectations. The haircut is fixed at $\bar{h}$; the rate is renegotiated on the current surplus subject to the same Nash split. Solving through the client's payoff in each segment yields

$$\begin{aligned} r_{CD,j}^{*,t} &= \frac{1}{1-p} \left[(1 - \theta_j) S_j^{CD}(\bar{h}, \Gamma_j^t, y_j^t, \lambda^t, r^{DFR}) - v - \lambda^t \bar{h} + \frac{\varphi}{2} \bar{h}^2 \right], \\ r_{FD,j}^{*,t} &= \frac{1}{1-p} \left[v_c - \lambda_c^t \bar{h} - \frac{\varphi_c}{2} \bar{h}^2 - (1 - \theta_j) S_j^{FD}(\bar{h}, y_j^t, \lambda_c^t, r^{DFR}) \right]. \end{aligned} \quad (9)$$

When fundamental values coincide with their period-0 expectations, these reduce to the Proposition 2 rates; when they deviate, the rate is the only margin available to reflect the change. All within-period variation in the parameters must, therefore, be absorbed by the rate. This structure delivers two closed-form implications, both of which we test empirically.

Proposition 3 (Implications): *Under the two-stage structure above:*

- (i) **Rate volatility.** *Under independent fundamental shocks with within-period variances σ_x^2 , the variance of the trade-date collateral-driven rate decomposes as*

$$\text{Var}(r_{CD,j}^{*,t}) = \left(\frac{1-\theta_j}{1-p}\right)^2 \left[(1-\bar{h})^2 \sigma_{r^{DFR}}^2 + \frac{1}{4}(1-\bar{h})^4 \sigma_{\Gamma}^2 + \Psi(\bar{h}; y) \sigma_y^2 \right] + \left(\frac{\theta_j \bar{h}}{1-p}\right)^2 \sigma_{\lambda}^2, \quad (10)$$

where $\Psi(\bar{h}; y) \equiv [1 + p m s'(y) (\bar{h} + s(y))]^2$. *Constrained dealers, which operate closer to the leverage-ratio corner and therefore face larger within-period variances σ_{Γ}^2 and σ_{λ}^2 , exhibit higher collateral-driven rate volatility. In the funding-driven segment Γ_j enters neither the haircut nor the rate, so the leverage-driven volatility channel is absent: funding-driven rate volatility is independent of dealer leverage.*

- (ii) **Pass-through.** *The trade-date rate response to a change in the deposit facility rate is*

$$\frac{\partial r_{CD,j}^{*,t}}{\partial r^{DFR}} = \frac{(1-\theta_j)(1-\bar{h}_{CD,j})}{1-p}, \quad \frac{\partial r_{FD,j}^{*,t}}{\partial r^{DFR}} = \frac{1-\theta_j}{1-p}. \quad (11)$$

Collateral-driven pass-through is strictly decreasing in $\bar{h}_{CD,j}$: because Corollary 1 implies constrained dealers set higher $\bar{h}_{CD}$, they exhibit weaker pass-through in the collateral-driven segment. Funding-driven pass-through is independent of $\bar{h}_{FD,j}$: constrained and unconstrained dealers transmit deposit facility rate changes identically in the funding-driven segment.

Corollaries 1–3 and Proposition 3 together deliver five segment-specific sign predictions: three on haircut levels, one per friction, and two on rate behavior, volatility and pass-through. The remainder of the paper takes each of these predictions to transaction-level data on the euro-area bilateral repo market.

4. Data

This section describes the data used in our analysis.

4.1. Data

MMSR. Our primary data source is the Money Market Statistical Reporting (MMSR) dataset, a confidential supervisory dataset collected by the European Central Bank. The MMSR requires 53 euro area banks to report daily transaction-level information on all their euro-denominated money market activity, covering both secured (repo) and unsecured segments.¹⁰ The secured segment covers all repo transactions with a maturity of up to one year.¹¹ For each transaction, we observe the repo rate, the volume, the maturity, the haircut, the collateral security at the ISIN level, and identifiers for both the reporting dealer and the counterparty, including the counterparty's sector classification. Our sample covers the period from January 2019 to June 2024.¹²

SFTDS. We cross-check our results using the Securities Financing Transaction Data Store (SFTDS) dataset used, for instance, by [Hermes et al. \(2025b\)](#). SFTDS data only start in 2021. Due to the longer time frame, we, therefore, focus on the MMSR sample for the main part of our analysis. As we show in the paper, SFTR-based evidence on bilateral margin levels and counterparty composition ([Panzarino and Spolaore, 2026](#)) is directionally consistent with our haircut evidence, supporting external validity.

Sample restrictions. We impose several restrictions to obtain a sample that is well suited to studying haircut determination in the bilateral dealer-to-client segment. First, we restrict the sample to bilateral (non-CCP-cleared) repo transactions in which the reporting agent is the dealer and the counterparty is a non-dealer client. This excludes inter-dealer trades and CCP-cleared transactions, where haircuts follow standardised schedules and margining is handled by the clearing house rather than negotiated bilaterally. Second, we focus on transactions

¹⁰See the list of reporting agents at https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/money_market/html/index.en.html. The MMSR data is described in detail by [Eisenschmidt et al. \(2024\)](#).

¹¹Defined as transactions with a maturity date of not more than 397 days after the settlement date.

¹²MMSR covers the bulk of euro-area bank-intermediated bilateral repo activity and is well suited to be linked to dealer balance-sheet characteristics via the ECB's financial reporting (FINREP) dataset that is available at quarterly frequency.

collateralised by general government bonds (ESA sector S13). These collateral class accounts for the vast majority of euro area sovereign repo activity and provide sufficient cross-sectional variation in sovereign risk characteristics. Third, we exclude transactions between dealers and the central bank in our analysis as trading incentives and terms likely follow different rules than laid out in the bilateral master agreements.¹³

Funding-driven versus collateral-driven repos. We do not directly observe in the data who initiated a given trade. However, given the netting benefits of central clearing, the superior pricing information available on centralised platforms, and the broad pool of both cash and collateral accessible through CCPs, it is considerably more likely that dealers would use the inter-dealer market to fulfill their own cash or collateral needs and balance their positions. We, therefore, assume that trades in the bilateral dealer-to-client segment are predominantly initiated by clients.¹⁴ We classify repo transactions accordingly: those in which the dealer lends cash and receives collateral are classified as *funding-driven* (the client sought cash), while those in which the dealer lends securities and receives cash are classified as *collateral-driven* (the client sought collateral).¹⁵

Our sample period spans from January 2019 to June 2024.¹⁶ Table 2 provides an overview of our sample. The dataset comprises approximately 1.36 million funding-driven and 1.80 million collateral-driven transactions, involving 17 dealers on the collateral-driven side (16 on the funding-driven side) together with more than 1,500 unique clients in the collateral-driven segment and 875 in the funding-driven segment. Non-MMF investment funds (ESA sector S124) account for the majority of clients, while other financial intermediaries (S125) contribute a smaller but non-trivial share. On average, an active dealer–client pair trades roughly 50–60 times per month, reflecting the intensity of bilateral relationships. Collateral is concentrated

¹³In the MMSR dataset, different banks have different ways of reporting haircuts or margins. We are converting the different definitions to a uniformly defined haircut as described in the MMSR reporting guidelines.

¹⁴There may be instances in which dealers initiate trades to cover short positions or to source scarce collateral. We expect such cases to be relatively rare. Our ISIN×day fixed effects in the empirical estimations also absorb any common daily demand for a given security.

¹⁵An alternative classification used in the literature distinguishes between general collateral (GC) and special collateral (SC) repos. While SC repos are more likely to be collateral-driven and GC repos more likely to be funding-driven, this mapping is imperfect, see Ballensiefen et al. (2023): a client needing any eligible collateral may enter a GC repo for collateral reasons, while a client holding scarce collateral may enter an SC repo primarily to obtain favorable funding terms.

¹⁶While MMSR data is available from October 2016, we exclude the pre-2019 period due to significant reporting inconsistencies regarding haircuts that could bias our estimates. We winsorise repo rates and haircuts at the 0.5th and 99.5th percentiles to mitigate the influence of outliers and potential reporting errors.

in the four largest euro-area sovereign issuers—Germany, France, Italy, and Spain—each contributing between 10% and 30% of volume. To limit concerns about term-spread variation, we restrict the analysis to the four short-term repo term types Overnight (O/N), Tomorrow-Next (T/N), Spot-Next (S/N), and One-Week (1W), which make up the bulk of the euro area bilateral repo market (European Central Bank, 2024). For O/N, T/N, and S/N the purchase date is tonight, tomorrow, or the day after tomorrow, respectively, with the repurchase date one day thereafter; 1W transactions settle on the spot date and mature seven calendar days later. Within this window, O/N repos dominate, accounting for roughly 55% of volume in both segments, with the remainder split across T/N, S/N, and 1W transactions.

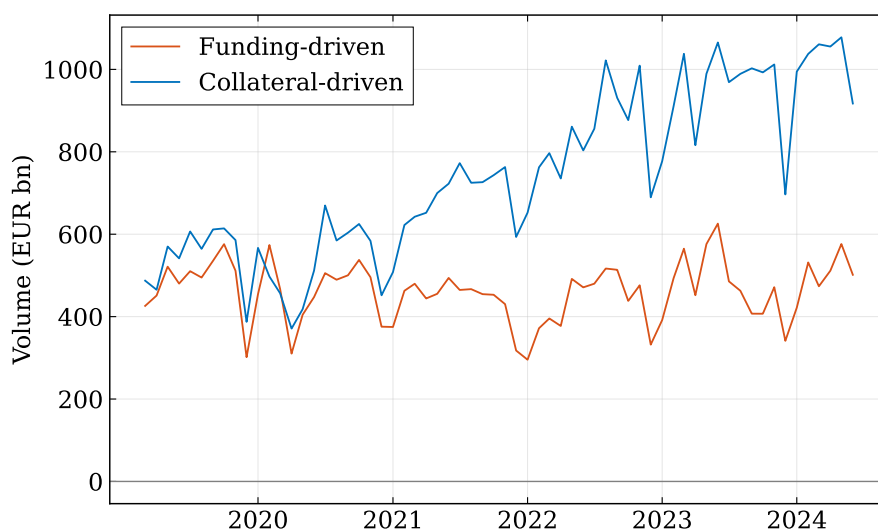
Table 2: Sample coverage

	Collateral-driven	Funding-driven
<i>Transactions</i>		
Total number of transactions	1,803,869	1,359,609
Unique dealers	17	16
Unique clients	1,529	875
of which S124	877	389
of which S125	71	71
Unique dealer–client pairs	2,792	1,820
Avg. transactions per pair per month	52.2	61.7
<i>Collateral country (% of volume)</i>		
Germany (DE)	23.0	24.5
France (FR)	19.3	17.9
Italy (IT)	25.7	29.0
Spain (ES)	14.0	11.3
<i>Maturity bucket (% of volume)</i>		
Overnight (O/N)	54.5	57.2
Tom/Next (T/N)	12.7	8.1
Spot/Next (S/N)	18.6	22.0
One week (1W)	14.2	12.7

Notes: Sample composition of bilateral dealer-to-client repos collateralised by euro-area general government bonds (ESA sector S13), January 2019 to June 2024. Under the ESA 2010 classification, S124 comprises investment funds excluding money market funds while S125 covers other financial intermediaries such as security and derivatives dealers and financial vehicle corporations. The data include O/N-to-1W maturities. Rates and haircuts are winsorised at the 0.5th and 99.5th percentiles.

Figure 3 shows the evolution of monthly trading volumes in the collateral- and funding-driven segments. At the beginning of 2019, funding-driven and collateral-driven volumes are roughly comparable. By 2024, however, collateral-driven volumes have nearly doubled while funding-driven volumes have remained largely flat. This divergence underscores the growing

Figure 3: Trading volumes in funding- and collateral-driven repos



Note: This figure shows monthly aggregated volume of O/N-to-1W repos in the bilateral dealer-to-client segment, collateralised by German, French, Italian, or Spanish general government bonds (S13 sector), January 2019 to June 2024.

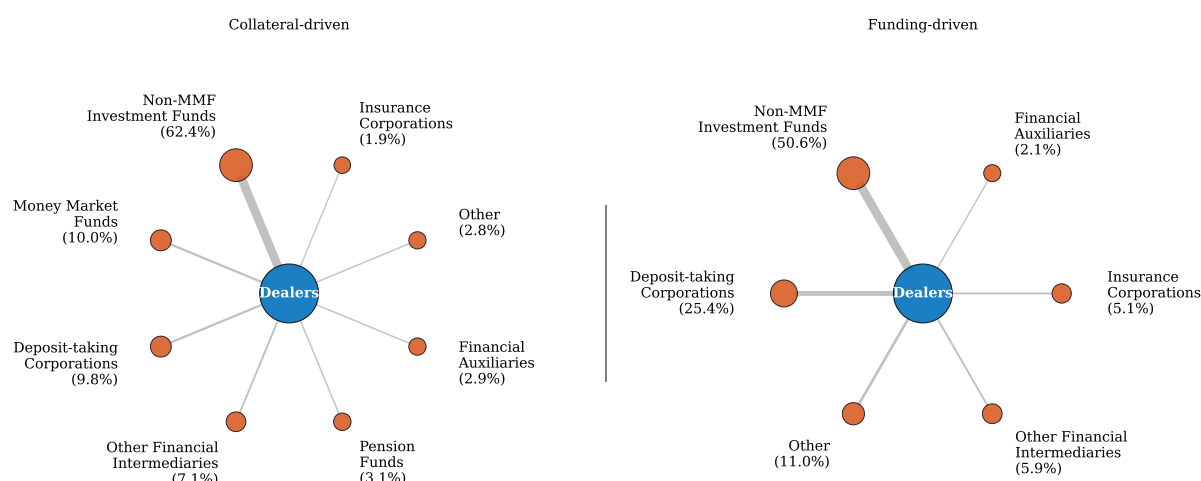
importance of the collateral motive in the euro area repo market and reinforces the relevance of understanding how haircuts are set in this segment.

Figure 4 shows the composition of dealer-to-client activity by client sector, separately for collateral-driven and funding-driven repos. In both segments, non-money-market-fund (non-MMF) investment funds are the single largest client category, accounting for 62.4% of collateral-driven volume and 50.6% of funding-driven volume. In funding-driven repos, deposit-taking corporations play a more significant role (25.4% of volume), reflecting these institutions' demand for short-term secured funding. The remaining volume is distributed across other financial intermediaries, money market funds, pension funds, insurance corporations, and other sectors.

4.2. Haircuts

Initial margin versus variation margin. It is important to distinguish between the two forms of margining in repo markets. The *initial margin*, commonly referred to as the *haircut*, is set at the inception of the trade and determines the extent to which the cash exchanged deviates from the market value of the collateral. It remains fixed over the life of the transaction

Figure 4: Client composition of dealer-to-client repos



Note: This figure displays the share of dealer-to-client repo volume by client sector, separately for collateral-driven and funding-driven repos. The sample covers bilateral repos collateralised by government bonds (S13), January 2019 to June 2024.

and serves as an ex-ante buffer against counterparty default risk—specifically, the risk that a defaulted counterparty’s collateral must be liquidated under potentially stressed market conditions (*liquidation risk*) or that the collateral must be repurchased at a cost (*replacement risk*). The *variation margin*, by contrast, addresses ex-post price fluctuations: it is exchanged on an ongoing basis as the market value of the collateral moves, ensuring that mark-to-market losses are continuously covered. Because haircuts are not adjusted during the life of a transaction, they reflect how dealers price risk, balance-sheet constraints, and market frictions at the point of contract initiation. This paper focuses on initial margins or haircuts, as these are the terms over which dealers and clients negotiate ex ante, the variation we exploit is, therefore, contractual rather than valuation-driven (cf. [Bejarano et al., 2025](#) for a discussion of valuation-driven haircut variation).

The MMSR reporting guidelines define the haircut as:

$$\text{Haircut} = 100 - \left(\frac{\text{Cash lent or borrowed at inception}}{\text{Collateral market value at inception including accrued interest}} \times 100 \right).$$

MMSR reporting explicitly permits negative haircuts, which arise when the cash amount at

inception exceeds the market value of the collateral.¹⁷ A positive haircut means the lender of cash receives collateral worth more than the cash disbursed (overcollateralisation), while a negative haircut means the cash amount exceeds the collateral value (undercollateralisation from the lender’s perspective).

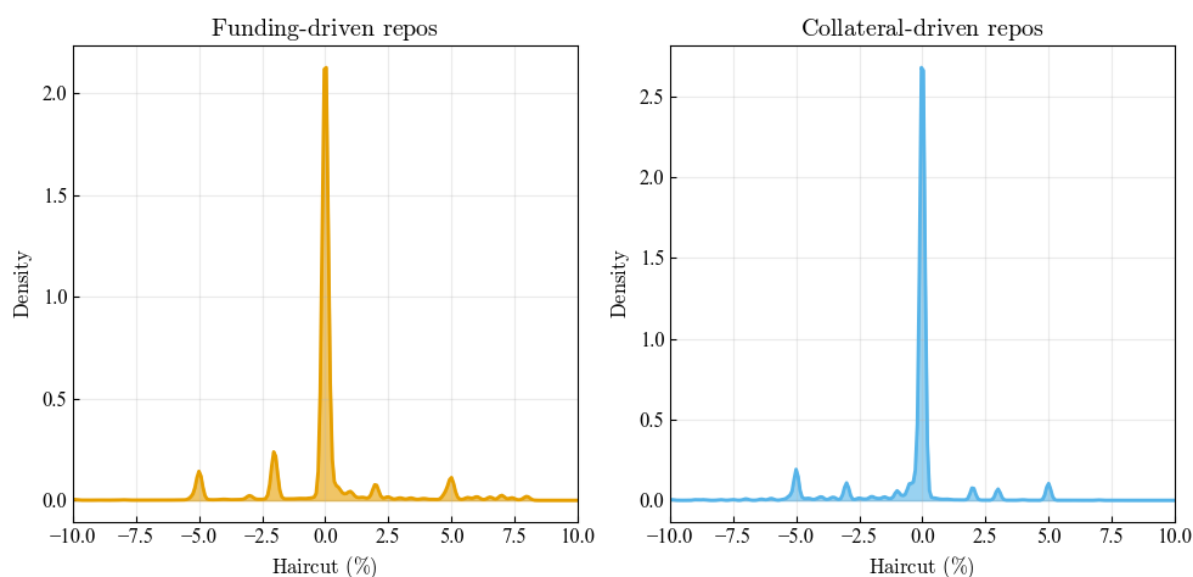
Haircut data cleaning. Reported haircuts in the MMSR data are subject to several non-uniform reporting conventions: some banks report the haircut as a direct percentage (e.g., 0.5 for a 0.5% haircut), others use a “100-shifted” convention (100.5), and a small number use its mirror image (−99.5). We retain observations falling in one of three intervals— $[-50, 50]$, $[80, 120]$, or $[-120, -80]$ —and unwrap the latter two by subtracting or adding 100 so that all haircuts are expressed in a comparable percentage-point space. Observations outside these ranges are dropped. We further winsorise the cleaned haircut at the 0.5th and 99.5th percentiles to mitigate the influence of residual outliers.

Haircut distributions. Figure 5 shows the corresponding, estimated kernel density of haircuts for funding-driven and collateral-driven repos. Both distributions sharply peak at zero, with secondary mass points visible around $\pm 2\%$ and $\pm 5\%$, likely reflecting standardised haircut schedules used by some dealer–client pairs. The collateral-driven distribution is more tightly centered around zero than the funding-driven distribution which exhibits greater dispersion and a heavier right tail. In funding-driven repos, most transactions carry a zero haircut, and only a minority display the strictly positive haircut that economic logic would predict for a cash-lending dealer. The pattern is even more pronounced in collateral-driven repos, where zero haircuts dominate and only a small share of transactions display the strictly negative haircut that the dealer’s exposure to replacement risk would suggest. In both segments, the majority of trades, therefore, carry haircuts that provide no ex-ante risk protection in the direction economic reasoning would predict.

Haircut dynamics. Figure 6 decomposes monthly repo volumes by haircut sign, separately for funding-driven and collateral-driven repos. In funding-driven repos, the composition is relatively stable over time: the majority of volume has a positive haircut, with a modest share carrying zero or negative haircuts. In collateral-driven repos, a more striking pattern emerges:

¹⁷See Reporting Instructions for the Electronic Transmission of Money Market Statistical Reporting (MMSR), version 3.6.1 (30 August 2023), available at https://www.ecb.europa.eu/stats/money/mmss/shared/files/MMSR-Reporting_instructions.pdf.

Figure 5: Distribution of repo haircuts

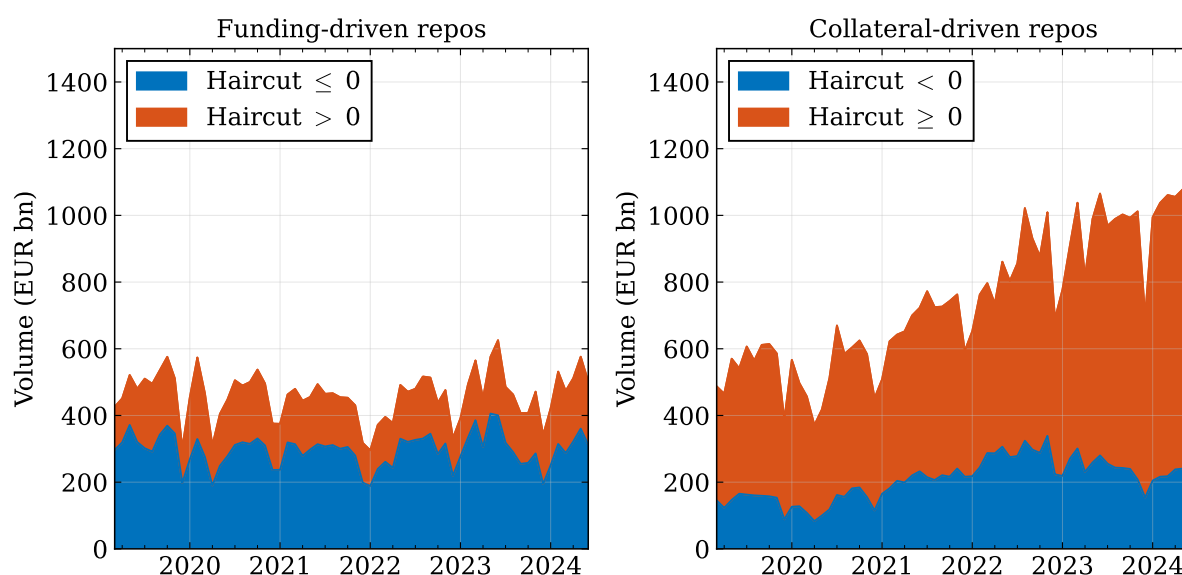


Note: This figure shows the estimated kernel density of haircuts in funding-driven and collateral-driven bilateral dealer-to-client repos, January 2019 to June 2024. The estimation uses a Gaussian kernel for confidentiality reasons.

the rapid growth in collateral-driven volumes since 2021 is almost entirely accounted for by transactions with a zero or positive haircut, while the volume of transactions with negative haircuts—the theoretically expected sign—has remained largely flat. This raises the question of whether the growing collateral-driven segment is characterised by systematically weaker risk management, or whether other forces, such as dealer balance-sheet constraints or market power, are shaping haircut outcomes.

Figure 7 adds a cross-sectional dimension by plotting the monthly volume-weighted average haircut by collateral country. In funding-driven repos, haircuts across collateral countries have converged since 2021, with slightly higher haircuts for Italian and Spanish collateral reflecting their greater sovereign credit risk. In collateral-driven repos, dispersion has increased since 2021, with haircuts for German and French collateral (which tend to be more “special” and scarce) being less negative than haircuts for Italian and Spanish collateral. This cross-country heterogeneity motivates our analysis of how collateral characteristics interact with dealer constraints to determine haircut outcomes.

Figure 6: Monthly repo volume by haircut sign



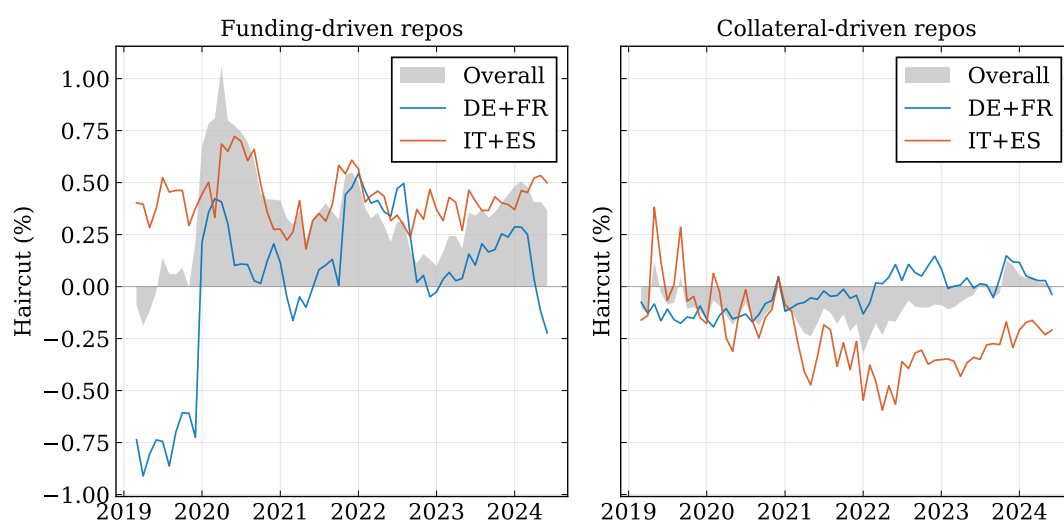
Note: This figure shows monthly aggregated repo volume in the bilateral dealer-to-client segment, collateralised by German, French, Italian, or Spanish general government bonds. Each panel is segmented by haircut sign: in the funding-driven panel, volumes are split into non-positive (≤ 0) and positive (> 0) haircuts; in the collateral-driven panel, into negative (< 0) and non-negative (≥ 0) haircuts. Time series show the trend and seasonal components for confidentiality.

Haircut robustness. We cross-check the haircut distribution with SFTDS and confirm both the prevalence of zero haircuts and of similar characteristics for funding vs collateral-driven transactions (see Figure B.1 in Appendix Section B). We also show that the distribution of transaction-level haircuts closely mirrors the distribution implied by dealer–client–day aggregated cash and collateral positions (see Figure B.2 in Appendix Section B). The tight correspondence between these measures suggests that our haircut estimates are not materially distorted by portfolio-level margining practices and is consistent with institutional features documented for the U.S. Treasury repo market (Hempel et al., 2023).

4.3. Dealer and client characteristics

Dealer and client characteristics. Table B.1 and Table B.2 in Appendix Section B report dealer and client characteristics. The average dealer leverage ratio is 4.80%, with meaningful dispersion: dealers in the most constrained tercile average 3.87%, those in the middle tercile 4.70%, and those in the least constrained tercile 5.82%. On average, a dealer trades with

Figure 7: Volume-weighted average haircuts by collateral country



Note: This figure shows the monthly volume-weighted average haircut in bilateral dealer-to-client repos, separately for funding-driven and collateral-driven transactions, January 2019 to June 2024. The shaded area represents the overall average across all countries.

more than 200 unique clients in the collateral-driven segment and around 150 in the funding-driven segment over a 12-month window. As [Schaffner et al. \(2019\)](#) document, there is a significant home bias in dealer trading, so that the average leverage ratio of dealers active in a given collateral segment varies systematically across countries: dealers trading in German and French collateral tend to be more balance-sheet constrained than those active in Italian and Spanish collateral. On the client side, the mean client trades with only one or two dealers over a rolling 12-month window showing their dependence on dealer relationships.

5. Empirical Analysis

In our analysis, we consider three main money-market frictions and their impact on repo haircuts: *(i)* dealer balance-sheet constraints, *(ii)* the convenience yield embedded in the collateral value, and *(iii)* client outside options.

5.1. Dealer balance sheet constraints

The post-crisis leverage ratio (LR) regulation treats repo transactions asymmetrically. Lending collateral against cash in a collateral-driven repo extends the dealer's balance sheet, whereas

lending cash against collateral in a funding-driven reverse repo does not. Because the cash received in a collateral-driven trade increases one-for-one with a more negative haircut, constrained dealers can free leverage capacity by raising haircuts in the collateral-driven segment. [Ranaldo et al. \(2021\)](#) document a related asymmetry for repo rates around quarter-ends; we show that the same asymmetry operates on the haircut margin, and that it is present throughout the entire quarter rather than only at reporting dates.

On June 28, 2021, the 3% LR requirement under the EU's Capital Requirements Regulation II (CRR II) became a binding Pillar 1 obligation for all ECB-supervised banks. Article 429e permits netting of securities financing transactions only under narrow conditions, notably identical counterparties and settlement dates. Matched-book intermediation across different clients, therefore, expands gross exposure on both legs and directly consumes scarce leverage capacity. The effective date of the implementation was predetermined years in advance, the timing of the shock was, therefore, exogenous to contemporaneous conditions in the repo market. Cross-sectional dispersion in how close each dealer sits to the 3% threshold generates variation in treatment intensity.

Euro-area banks must report both a *point-in-time* and an *averaged* version of the leverage ratio, we, therefore, expect dealer banks to internalise the constraint in their day-to-day haircut setting throughout the quarter, not only around reporting dates. Cross-sectional differences in dealer balance-sheet capacity should, therefore, shape haircuts throughout the entire quarter. To test this, we sort dealers each quarter into LR terciles and estimate the following transaction-level difference-in-difference estimation:

$$Haircut_{i,j,c,t} = \sum_{k=1}^2 \beta_k (Tercile_{k,j,q} \times Post_t) + \gamma' \mathbf{X}_{i,j,c,t} + \mu_{i,t} + \eta_{j,c} + \varepsilon_{i,j,c,t} \quad (12)$$

where $Haircut_{i,j,c,t}$ is the percentage haircut on a repo for security i between dealer j and client c on day t ; dealers are sorted into leverage ratio terciles each quarter, $Tercile_{1,j,q}$ identifies the most constrained dealers and $Tercile_{3,j,q}$ the omitted least-constrained group, and $Post_t$ equals one after June 28, 2021. Controls $\mathbf{X}_{i,j,c,t}$ comprise log transaction volume and maturity bucket dummies. ISIN $\times$ day fixed effects ($\mu_{i,t}$) absorb all daily bond-specific conditions, including collateral scarcity and specialness, so that β_k is identified purely from variation across dealers for the same bond on the same day. Our baseline specification includes client fixed effects

(η_c) to absorb time-invariant client characteristics; our preferred specification tightens this to dealer $\times$ client fixed effects ($\eta_{j,c}$), identifying the effect from within-relationship variation only. Standard errors are clustered at the dealer-client level, reflecting that pricing decisions are made and negotiated at the bilateral relationship level.

Table 3: Do balance sheet constraints affect repo haircuts?

	Collateral-driven						Funding-driven
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tercile 1 $\times$ Post	0.258** (0.109)	0.307*** (0.111)		0.305*** (0.111)	0.257** (0.110)	0.308*** (0.111)	−0.023 (0.284)
Tercile 2 $\times$ Post	0.217** (0.105)	0.207** (0.105)		0.206* (0.106)	0.217** (0.105)	0.210** (0.106)	0.000 (0.240)
LR headroom $\times$ Post			−0.053* (0.031)				
Tercile 1 $\times$ Post $\times$ QE					0.027 (0.056)		
Tercile 2 $\times$ Post $\times$ QE					0.015 (0.052)		
ISIN $\times$ day FE	✓	✓	✓	✓	✓	✓	✓
Client FE	✓		✓		✓		✓
Dealer $\times$ client FE		✓		✓		✓	
Dealer FE			✓				
Leverage tercile FE	✓	✓	✓	✓	✓	✓	✓
Balanced relationships				✓			
Wrong-way risk control						✓	
N	1,801,105	1,801,105	1,801,105	1,373,592	1,801,105	1,801,105	1,355,130
R ²	0.86	0.90	0.86	0.91	0.86	0.90	0.90

Note: Transaction-level regressions of repo haircuts (%) on dealer leverage-ratio constraints. The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024. Dealers are sorted into leverage-ratio terciles within each quarter; Tercile 1 denotes the most constrained dealers, Tercile 3 (omitted) the least. *Post* = 1 after June 28, 2021, when the binding 3% leverage-ratio requirement took effect. *LR headroom* is the dealer's leverage ratio minus the 3% minimum, in percentage points. *QE* = 1 on quarter-end days. *Balanced relationships* restricts to dealer–client pairs active both pre- and post-June 2021. *Wrong-way risk control* is a dummy equal to one when the country of issuance of the collateral coincides with the country of domiciliation of the client. Column (7) re-estimates the baseline specification on funding-driven repos. Controls: log volume, maturity-bucket dummies. Standard errors clustered at the dealer-client level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 reports the results of this estimation. The coefficients of interest provide clear evidence that haircuts in collateral-driven repos increase monotonically with the strictness of a dealer's leverage constraint in the post-regulatory period: because the cash received in a collateral-driven trade expands the dealer's leverage-ratio exposure one-for-one with a more negative haircut, dealers facing a tighter constraint have a stronger incentive to raise haircuts, and the strength of the response should scale with how tightly the constraint binds. In our

baseline and within-relationship specifications (Columns 1 and 2), the interaction terms are positive, monotonically ordered (*Tercile 1* > *Tercile 2*), and highly statistically significant. For example, in specification 2, the most constrained dealers apply haircuts that are about 31 basis points higher than those of the least constrained tercile after the shock, with the middle tercile at about 21 basis points. As an alternative, we replace the leverage tercile interactions with a continuous measure, $(LR_{d,t} - 3\%) \times \text{Post}_t$, where $LR_{d,t} - 3\%$ is the dealer's leverage-ratio headroom above the regulatory minimum, in percentage points. Column (3) confirms that, as balance sheet space increases, haircuts significantly decrease. Furthermore, the balanced panel estimation in Column (4) confirms that this effect is driven by active repricing within surviving relationships, rather than the entry or exit of specific counterparties.

Importantly, our results demonstrate that these haircut effects persist throughout the entire quarter rather than only at reporting dates. In Column (5), we introduce an additional quarter-end dummy (*QE*) to see if the haircut effect is different on quarter-end days. The interaction with the quarter-end dummy is small and statistically insignificant, indicating that constrained dealers apply these higher haircuts persistently throughout the entire quarter. Column (6) augments our baseline specification with a transaction-level wrong-way risk control. We define this dummy as equal to one when the country of issuance of the collateral coincides with the country of domiciliation of the client, and zero otherwise. It captures the borrower–collateral correlation that arises when a sovereign shock affects the client's home jurisdiction and the collateral value simultaneously, the pricing channel emphasized by [Barbiero et al. \(2024\)](#). The leverage-tercile coefficients are essentially unchanged; this confirms that the regulatory-spillover channel we identify is a distinct mechanism operating independently of the wrong-way risk mechanism documented in the prior literature.

Finally, Column (7) re-estimates the baseline specification for funding-driven repos. Because the leverage ratio regulation does not asymmetrically penalize the dealer's balance sheet for reverse repos (cash lending), this segment serves as a natural placebo. As expected, the leverage constraint coefficients in the funding-driven market are statistically indistinguishable from zero. This funding-driven null also serves as a falsification of a reverse-causality interpretation in which counterparties demand more protection when trading with constrained dealers. More precisely, the absence of any such effect in the funding-driven segment is

inconsistent with a symmetric reverse-causality mechanism and consistent with the dealer-side leverage-optimisation channel we identify, which, by construction, does not bind on the funding-driven leg.

Haircuts are only one of many margins through which dealers manage the leverage-ratio constraint. Two features of our estimates nevertheless make the haircut adjustment economically meaningful. First, a differential of roughly 30 basis points between the most and least constrained dealers is large relative to the typical dispersion of haircuts in the collateral-driven segment, where the median haircut is zero and the distribution is tightly concentrated around it: the leverage-ratio channel accounts for a substantial share of the observable haircut variation. Second, the response is systematic in the direction the leverage-ratio incentive predicts, appearing asymmetrically across collateral- and funding-driven trades, monotonically in the cross-section of dealer headroom, and persistently both at reporting dates and throughout the quarter. Together, these patterns indicate that the leverage-ratio shadow cost is internalised at the transaction margin, creating an incentive for constrained dealers to hand out zero or even positive haircuts in collateral-driven trades rather than the negative haircuts that would optimally hedge replacement risk. As we show in Section 6, the economic consequence of this distortion is the resulting spillover onto repo-rate volatility and the transmission of ECB policy rates to non-bank clients.

One concern may be that haircuts in bilateral repos may be negotiated at the portfolio level rather than individually for each transaction. If a dealer and client agree on a standing haircut schedule, individual transaction-level observations reflect a single underlying contracting decision observed repeatedly. To ensure that our results are not driven by this, we aggregate the data to the dealer–client–day level—collapsing all transactions between a given dealer-client pair on a given day into a single observation with a volume-weighted mean haircut—and re-estimate the main specifications on this aggregated panel. Table 4 reports the results. Consistent with our baseline estimates, the coefficient on $\text{Tercile } 1 \times \text{Post}$ remains economically and statistically significant across all collateral-driven specifications, and, if anything, somewhat larger in magnitude than in the transaction-level estimates. The funding-driven placebo again shows no effect, indicating that the pricing pattern is specific to the segment in which the leverage ratio binds.

Table 4: Do balance sheet constraints affect repo haircuts?

	Collateral-driven			Funding-driven
	(1)	(2)	(3)	(4)
Tercile 1 $\times$ Post	0.391*** (0.047)	0.403*** (0.048)	0.402*** (0.048)	−0.145 (0.118)
Tercile 2 $\times$ Post	0.099* (0.052)	0.034 (0.052)	0.082 (0.052)	−0.167 (0.148)
Client FE	✓		✓	✓
Dealer $\times$ client FE		✓		
Dealer FE			✓	
Leverage tercile FE	✓	✓	✓	✓
<i>N</i>	386,919	386,919	386,919	257,608
<i>R</i> ²	0.57	0.70	0.57	0.62

Note: Regressions of volume-weighted mean repo haircuts (%) on dealer leverage-ratio constraints at the dealer–client–day level. Transactions are aggregated to (dealer, client, day) cells with volume-weighted mean haircut. The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024. Dealers are sorted into leverage-ratio terciles within each quarter; Tercile 1 denotes the most constrained dealers, Tercile 3 (omitted) the least. *Post* = 1 after June 28, 2021, when the binding 3% leverage-ratio requirement took effect. Column (4) re-estimates the baseline specification on funding-driven repos. Controls: cell-level total volume. Standard errors clustered at the dealer–client level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Overall, the results are in line with Corollary 1 and confirm that our finding is not an artefact of transaction-level replication of a single contracting decision but confirms that the effect is present at both the transaction and the dealer–client relationship level.

5.2. Convenience yields

Having examined how dealer balance-sheet constraints shape haircuts, we now turn to the role of collateral characteristics. Assets used as collateral in bilateral repo differ substantially in their scarcity, specialness, and value to market participants. Because these characteristics affect the dealer’s risk exposure differently across collateral- and funding-driven trades, they should transmit into haircut design asymmetrically across the two segments. In the preceding analysis we examined how dealer’s balance-sheet constraints shape haircuts. Of course, client and collateral characteristics should also matter. A large literature documents that investors pay a convenience premium for the safety and liquidity services embedded in high-quality assets (Krishnamurthy and Vissing-Jorgensen, 2012; Gorton, 2017), and that this premium is reflected in repo rates (Duffie and Krishnamurthy, 2016; Ballensiefen and Ranaldo, 2023). Convenience yields vary across securities (driven by differences in issuer credit quality, re-

maintaining maturity, and benchmark status) and over time with the opportunity cost of holding money (Nagel, 2016) or macroeconomic uncertainty (Moreira and Savov, 2017). Yet, while the link between convenience yields and repo *rates* is well established, far less is known about how convenience yields affect the *haircut* margin.

We argue that convenience yields should influence haircuts in opposite directions across the two segments. In a collateral-driven repo, the dealer pledges a specific bond in exchange for cash; if the counterparty defaults and fails to return the security, the dealer must repurchase a potentially scarce asset in the open market. The higher the convenience yield on the pledged bond, the costlier this replacement and the greater the dealer's incentive to protect herself by demanding a lower haircut, i.e., demanding more cash in return for the collateral pledged. In a funding-driven repo, the dealer receives the bond from the client in exchange for cash and holds it during the term of the trade. As legal owner, she can re-use the collateral by pledging it in another repo, delivering it against a short, or posting it as regulatory margin, and thereby captures a fraction of its convenience yield through rehypothecation. This makes higher-convenience-yield collateral more valuable to hold, giving the dealer an incentive to demand more of it per euro of cash lent, i.e., a higher haircut. A standard liquidation-risk channel, in which more liquid collateral is easier to sell at a smaller discount upon default, would push in the opposite direction, but we argue that the rehypothecation channel dominates in bilateral repo. Under this framework, we expect the convenience-yield effect to be negative in the collateral-driven segment through replacement-risk protection, and positive in the funding-driven segment through the rehypothecation channel.

To test these predictions, we regress transaction-level haircuts on an ISIN-level convenience yield measure. Specifically, we estimate

$$Haircut_{i,j,c,t} = \beta CY_{i,t} + \mathbf{X}'_{i,j,c,t} \delta + \alpha_{j \times c} + \alpha_{k(i) \times t} + \varepsilon_{i,j,c,t}, \quad (13)$$

where $Haircut_{i,j,c,t}$ is the percentage haircut on a repo for security i between dealer j and client c on day t , $CY_{i,t}$ is the ISIN-level convenience yield defined as the spread between the sovereign benchmark yield (interpolated via a Nelson–Siegel curve at the bond's remaining maturity) and the corresponding OIS rate, and $\mathbf{X}_{i,j,c,t}$ collects controls for log transaction volume and maturity bucket dummies. We restrict the sample to bonds issued by the

four largest euro-area sovereigns—Germany, France, Italy, and Spain—since these are the issuers for which we can construct a sufficiently deep sovereign yield curve to compute the convenience-yield measure. The fixed effect $\alpha_{j \times c}$ absorbs all time-invariant dealer–client relationship characteristics. The fixed effect $\alpha_{k(i) \times t}$ absorbs any daily sovereign-country-level demand and supply shock. In our most strict specification, we replace $\alpha_{k(i) \times t}$ with separate ISIN and day fixed effects, which absorb time-invariant ISIN characteristics and market-wide daily conditions independently.¹⁸ Standard errors are clustered at the ISIN level, reflecting that the identifying variation in convenience yields is defined at the bond level.

Table 5: Convenience yields and repo haircuts

	Collateral-driven				Funding-driven			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Convenience yield	−0.136*** (0.016)	−0.133*** (0.014)	−0.137*** (0.016)	−0.029** (0.014)	0.263*** (0.034)	0.277*** (0.028)	0.271*** (0.031)	0.118** (0.046)
Month FE	✓	✓			✓	✓		
Country FE	✓				✓			
Country × day FE			✓				✓	
ISIN + day FE				✓				✓
Dealer × client FE		✓	✓	✓		✓	✓	✓
Leverage tercile FE	✓	✓	✓	✓	✓	✓	✓	✓
<i>N</i>	1,354,625	1,354,625	1,354,625	1,354,625	846,928	846,928	846,928	846,928
<i>R</i> ²	0.54	0.68	0.56	0.72	0.60	0.69	0.62	0.73

Note: Transaction-level regressions of repo haircuts (%) on the ISIN-level convenience yield. The convenience yield is defined as the spread between the sovereign benchmark yield (interpolated via a Nelson–Siegel curve at the bond’s remaining maturity) and the corresponding OIS rate. The sample covers bilateral dealer-to-client repos collateralised by government bonds issued by the four largest euro-area sovereigns (Germany, France, Italy, and Spain). The sample period is January 2019 to June 2024. Columns (1)–(4) use the collateral-driven sample (dealer lends securities, receives cash); columns (5)–(8) use the funding-driven sample (dealer lends cash, receives securities). All specifications include leverage-tercile fixed effects. Controls: log volume, maturity-bucket dummies. Standard errors clustered at the ISIN level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5 reports results separately for collateral-driven repos (columns 1–4) and funding-driven repos (columns 5–8). Column (1) includes month and collateral country fixed effects; Column (2) replaces the collateral country fixed effect with dealer×client fixed effects, absorbing all time-invariant relationship characteristics; Column (3) moves to country×day fixed effects alongside dealer×client effects, thereby controlling for all daily collateral country-level demand and supply shocks; Column (4) includes ISIN, day, and dealer×client fixed effects, so all remaining variation in the convenience yield is within-ISIN and within-day, i.e., net of

¹⁸We cannot include the more granular ISIN×day interaction used in Section 5.1: our convenience yield measure varies exactly at the ISIN×day level, so an ISIN×day fixed effect would absorb the identifying variation.

any time-invariant ISIN characteristics and any market-wide daily factors. In addition, all specifications include leverage-tercile fixed effects to control for dealer balance-sheet capacity. The funding-driven analysis follows the same structure.

Overall, the results are in line with Corollary 2. More precisely, in the collateral-driven segment, across all four specifications, the convenience yield enters with a negative and statistically significant coefficient. For example, the point estimate in specification 3 implies that a 100 basis-point increase in the ISIN-level convenience yield reduces haircuts by approximately 14 basis points. This is consistent with the replacement-risk channel: when the pledged bond carries a high convenience premium, the dealer demands more cash in return for parting with it, reflected in a lower haircut, so as to be better insured against the cost of replacing a scarce and valuable security in the event of counterparty default.

In the funding-driven sample (Columns 5–8), by contrast, the convenience yield enters with a positive and highly significant coefficient. This sign flip contradicts the risk-management prior: safer, more valuable collateral should require less over-collateralisation, not more. The result points instead to a different economic channel: rehypothecation. Because the dealer becomes the legal owner of the received bond for the term of the repo, they can rehypothecate it in ways that scale with its specialness: re-pledging it in a subsequent collateral-driven trade at the specialness premium, delivering it against a short position, or lending it in the securities-lending market. The higher the convenience yield on the received bond, the more profitable these re-use opportunities and the greater the dealer’s incentive to accumulate more collateral per euro of cash lent, which translates into a higher haircut. Our results seem to suggest that, in the funding-driven segment, the rehypothecation channel dominates the risk-management channel.

5.3. *Client outside options*

A third key friction in the bilateral money market arises from market power. Establishing and maintaining trading relationships in OTC markets is costly and time-consuming, limiting the number of dealer links that clients can form. As a result, dealer banks may exercise market power over their OTC counterparties (Eisenschmidt et al., 2024; Bittner and Jank, 2025). To analyze the impact of dealer market power on repo haircuts, we estimate transaction-

level panel regressions using both collateral-driven and funding-driven samples. We proxy a client's *outside options* by the number of distinct dealers a customer has traded with over the previous twelve months, which captures the *active* trading relationships supported by master agreements and trading infrastructure. We interpret a larger set of active dealer connections as broader client outside options and hence weaker dealer market power in negotiating repo terms.¹⁹

Our baseline empirical specification is estimated as follows:

$$Haircut_{i,j,c,t} = \beta Reach_{c,t} + \gamma' \mathbf{X}_{i,j,c,t} + \mu_{i,t} + \eta_c + \lambda_{j,q} + \varepsilon_{i,j,c,t} \quad (14)$$

where $Haircut_{i,j,c,t}$ is the percentage haircut on a repo for security i between dealer j and client c on day t ; the primary variable of interest, $Reach_{c,t}$, counts the number of unique dealers the client has transacted with over a rolling 12-months look-back window. The vector of controls, $\mathbf{X}_{i,j,c,t}$, includes the natural logarithm of the transaction volume and fixed effects for maturity buckets. To isolate the impact of client outside options from collateral-specific shocks and macroeconomic conditions, we incorporate different fixed effect specifications. Specifically, $\mu_{i,t}$ denotes security-by-day (ISIN $\times$ day) fixed effects, fully absorbing unobserved daily variation in collateral quality and liquidity. Unobserved, time-invariant client characteristics are captured by client fixed effects, η_c , which are replaced by dealer-by-client fixed effects in our within-relationship specifications. Finally, $\lambda_{j,q}$ represents dealer leverage tercile fixed effects, absorbing time-varying balance sheet constraints at the dealer level. Standard errors are again clustered at the dealer-client level across all specifications as in Tables 3 and 4.

Table 6 reports the results of these panel regressions. Economically, clients in the collateral-driven repo market segment are incentivised to negotiate repo haircuts upwards (i.e., lending less cash for a given amount of highly sought-after securities), whereas clients in the funding-driven segment have the opposite incentive to negotiate haircuts downwards (i.e., borrowing more cash for a given amount of securities posted as collateral). The regression results confirm this dual dynamic. In the collateral-driven segment (Columns 1–4), the coefficient is positive and statistically significant, consistent with clients whose broader outside options

¹⁹This measure could, in principle, also capture client sophistication or trading intensity; our dealer $\times$ client fixed effect specification absorbs any time-invariant component of both, so the identified variation reflects changes in the client's active dealer network rather than fixed client type.

Table 6: Client outside options

	Collateral-driven				Funding-driven			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Reach	0.052*** (0.016)	0.038** (0.015)	0.042** (0.017)	0.097*** (0.021)	-0.112*** (0.040)	-0.094*** (0.036)	-0.094*** (0.034)	-0.184*** (0.051)
Reach $\times$ Post				-0.072*** (0.014)				0.178*** (0.051)
ISIN $\times$ day FE	✓	✓	✓	✓	✓	✓	✓	✓
Client FE	✓			✓	✓			✓
Dealer $\times$ client FE		✓	✓			✓	✓	
Leverage tercile FE	✓	✓	✓	✓	✓	✓	✓	✓
Balanced relationships			✓				✓	
<i>N</i>	1,803,840	1,803,840	1,374,947	1,803,840	1,359,609	1,359,609	1,124,741	1,359,609
<i>R</i> ²	0.86	0.90	0.91	0.86	0.90	0.91	0.92	0.90

Note: Transaction-level regressions of repo haircuts (%) on client outside options, proxied by *Reach*, the number of distinct dealers a client transacted with over a rolling 12-month look-back window. The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024. Columns (1)–(4) use the collateral-driven sample; columns (5)–(8) use the funding-driven sample. Columns (3) and (7) restrict each sample to dealer–client pairs active both pre- and post-June 2021, as indicated by the *Balanced relationships* row. *Post* equals one after June 28, 2021, when the binding 3% leverage-ratio requirement took effect. Controls: log volume, maturity-bucket dummies. Standard errors clustered at the dealer-client level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

allow them to secure higher haircuts terms when posting collateral. In the funding-driven segment (Columns 5–8), the coefficient on *Reach* is negative and highly significant, indicating that clients with a broader network of active dealer relationships successfully negotiate lower haircuts. This outside-options effect complements [Bittner and Jank \(2025\)](#) who document that competition among lenders weakens risk-based haircut pricing in bank-to-hedge-fund lending. Overall, the results are in line with Corollary 3.

The interaction terms between our outside-options proxy and the Post-June 2021 indicator (*Reach* $\times$ *Post*) in Columns (4) and (8) reveal a significant attenuation of the outside-options effect in both segments once the leverage ratio becomes binding. The mechanism follows directly from Section 5.1: once the leverage-ratio shadow cost enters the dealer’s optimization, the constraint seems to take precedence over client bargaining leverage. Dealers can no longer accommodate the pricing preferences of even well-connected clients when doing so consumes scarce leverage capacity, and the outside-options premium is compressed across both segments.

5.4. Robustness

We provide a range of robustness checks that confirm our baseline results across alternative empirical specifications.

First, the haircut data is centered around zero so that stickiness within client-dealer pairs or contractual agreements unobserved from the data could be the reason for our empirical results. To address this concern, we are repeating our main regression specifications on the basis of transactions with non-zero haircuts (hence considering only about 30% of the sample) in Appendix C.1. The directions of the estimates as well as their significance are widely unchanged.

Second, different counterparties may have different contracting terms and trading conditions. As we are mostly interested in the NBFI-sector, we repeat the exercise only considering the sectors S124 (non-money market investment funds) and S125 (non-bank financial intermediaries) and thus mirroring the sample in Bittner and Jank (2025). Again, the significance as well as the direction of the estimates remains stable (see Appendix C.1).

Lastly, we ask whether our results are driven by the leverage ratio specifically, or by more general capital constraints. If our leverage-constrained dealers also face tight risk-weighted capital constraints, our estimates might reflect risk-weighted capital costs rather than the non-risk-weighted leverage penalty. To test this, we re-estimate our baseline specification (Table 3) replacing leverage-ratio terciles with total-capital-ratio terciles; the interaction coefficients are mostly statistically insignificant (see Appendix C.2). This result is itself consistent with the regulatory asymmetry at the heart of our mechanism. Under the risk-based framework, sovereign collateral attracts a zero or near-zero risk weight, so collateral-driven repos are inexpensive in risk-weighted capital terms. The leverage ratio, by contrast, is non-risk-weighted and penalizes collateral-driven repos from the dealer's perspective regardless of the collateral's risk profile.

5.5. Takeaways

Taken together, our results show that all three frictions operate asymmetrically across collateral- and funding-driven trades. In collateral-driven trades, dealer balance-sheet constraints raise haircuts, higher convenience yields lower them through the replacement-risk

channel, and clients with broader outside options negotiate higher haircuts. As a result, high-convenience-yield government bonds can nonetheless carry relatively higher haircuts when the balance-sheet channel dominates the convenience-yield channel and dealers have less market power. In funding-driven transactions, by contrast, the leverage-ratio constraint does not bind: the reverse-repo leg does not expand the dealer's exposure measure. Convenience yields and outside options both matter, but with signs opposite to those in the collateral-driven segment. Convenience yields raise haircuts, as dealers accumulate more of a valuable rehypothecable bond per euro of cash lent. Broader outside options compress haircuts, as clients successfully negotiate more cash per euro of collateral posted. The three frictions, therefore, push haircuts in opposite directions across the two segments, reflecting the fundamentally different impact across collateral- and funding-driven repo market segments.

6. Implications for market outcomes and monetary policy

Section 3 developed a bargaining model with three frictions that shape haircuts in the bilateral repo market, and Section 5 tested the corresponding predictions in transaction-level haircut data. Proposition 3 extended the model to two further implications for repo rates: constrained dealers should display higher rate volatility and weaker pass-through of policy-rate changes, both in the collateral-driven segment, with funding-driven placebos in each case. This section tests both in turn.

Testing them cleanly requires exogenous variation in the tightness of the dealer's constraint. In principle, variation from any of the three frictions we identified (balance-sheet cost, convenience yield, market power) could serve as an identification device. In practice, only the leverage-ratio channel provides a sharp exogenous shock: the June 2021 introduction of the binding 3% leverage-ratio requirement was legislated in 2019 under CRR II, well before any of the market outcomes we test, and its effective date was not chosen in response to contemporaneous repo-market conditions. Convenience yields and dealer market power, by contrast, co-move endogenously with repo-market activity and would raise reverse-causality concerns. We, therefore, use variation in dealer leverage-ratio headroom around the June 2021 shock as the identification strategy for constrained haircuts, and interpret our estimates as the effect operating through the balance-sheet friction rather than through all three channels jointly.

6.1. Market outcomes

Proposition 3(i) states that in the collateral-driven segment, repo-rate volatility is higher in trades intermediated by constrained dealers than in trades intermediated by unconstrained dealers, holding fixed the collateral and the client.

To test this empirically, we aggregate transactions to the dealer–collateral country–month level and compute the standard deviation of DFR-adjusted repo rates within each cell, $\sigma_{r,d,j,t}$. Monthly aggregation provides enough transactions per cell to compute a meaningful within-cell standard deviation, while preserving sufficient time-series variation to identify the effect of the June 2021 leverage-ratio shock in a difference-in-differences design.²⁰ Our treatment exploits the cross-sectional variation in leverage constraints; for this, we sort dealers into terciles of the leverage-ratio distribution each quarter and estimate:

$$\sigma_{r,d,j,t} = \sum_{k=1}^2 \beta_k \mathbb{I}_{\{\text{Tercile}_{d,t}=k\}} \times \text{Post}_t + \mathbf{X}'_{d,j,t} \gamma + \alpha_j + \delta_t + \omega_d + \eta_k + \varepsilon_{d,j,t}, \quad (15)$$

where Tercile_1 denotes the most constrained dealers (lowest leverage-ratio headroom) and Post_t equals one after June 2021. The vector $\mathbf{X}_{d,j,t}$ collects three controls: the average log transaction volume; the average maturity; and $\log N_{\text{tx},d,j,t}$, where $N_{\text{tx},d,j,t}$ is the number of transactions in cell (d, j, t) . We include collateral country, month and dealer fixed effects. As an alternative, we replace the leverage tercile interactions with a continuous measure, $(\text{LR}_{d,t} - 3\%) \times \text{Post}_t$, where $\text{LR}_{d,t} - 3\%$ is the dealer's leverage-ratio headroom above the regulatory minimum, in percentage points.

Table 7 reports the results. Columns (1) and (2), estimated on collateral-driven repos, show that the most constrained dealers exhibit a statistically significant increase in rate volatility after the June 2021 shock: the coefficient on $\text{Tercile}_1 \times \text{Post}$ is 0.046, significant at the 1% level, and the middle tercile shows a positive effect of 0.028 (significant at 5%). The monotone ordering of the two tercile coefficients is consistent with the pattern being driven by the tightness of the balance-sheet constraint. Column (3) confirms this using the continuous leverage-ratio headroom: a one percentage point reduction in headroom raises σ_r by approximately 1.2 basis points post-treatment ($p < 0.05$). Column (4) reports the corresponding tercile specifica-

²⁰We retain cells with at least three transactions, so that $\sigma_{r,d,j,t}$ is well-defined and not driven by too few observations.

tion on funding-driven repos. The Tercile 1 coefficient is both quantitatively smaller than the collateral-driven estimate (0.035 versus 0.046) and statistically weaker, significant only at the 10% level, while the Tercile 2 coefficient is close to zero. Because the balance-sheet channel operates specifically in the collateral-driven segment, we do not interpret column (4) as identifying a haircut-driven volatility effect. Rather, it suggests that leverage-constrained dealers may generate more volatile pricing also through broader intermediation channels, although the effect there is markedly weaker.

Table 7: Leverage constraints and repo rate volatility

	Collateral-driven			Funding-driven
	(1)	(2)	(3)	(4)
Tercile 1 $\times$ Post	0.046*** (0.010)	0.046*** (0.011)		0.035* (0.018)
Tercile 2 $\times$ Post	0.028** (0.010)	0.028** (0.011)		−0.008 (0.017)
LR headroom $\times$ Post			−0.012** (0.005)	
Country FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓
Dealer FE	✓	✓	✓	✓
Cluster: Dealer	✓			
Cluster: Dealer $\times$ Country		✓	✓	✓
N	9,025	9,025	9,025	10,123
R^2	0.32	0.32	0.32	0.26

Note: Cell-level regressions of the within-cell standard deviation of DFR-adjusted repo rates (σ_r) on dealer leverage-ratio constraints. The unit of observation is dealer $\times$ collateral country $\times$ month. The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024. Cells with fewer than three transactions are dropped. Dealers are sorted into leverage-ratio terciles within each quarter; Tercile 1 denotes the most constrained, Tercile 3 (omitted) the least. *Post* = 1 after June 28, 2021. Columns (1)–(2) use the tercile indicators on the collateral-driven sample under alternative clustering choices; column (3) uses the continuous leverage-ratio headroom (dealer’s leverage ratio minus the 3% minimum, in percentage points); column (4) re-estimates the tercile specification on the funding-driven sample as a placebo. Controls: average log volume, average maturity, $\log(N_{tx})$. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Taken together, the results point in the same direction: when leverage constraints prevent dealers from pricing haircuts optimally, the resulting risk shows up in rate volatility, most sharply in the collateral-driven segment where the balance sheet mechanism is cleanest.

6.2. Monetary policy transmission

Our results also have suggestive implications for the first steps of transmission of monetary policy. Focusing on the first stage, “in an idealized money market, any change in the main monetary policy rate should pass through perfectly to all money market rates” (Corradin, Eisenschmidt, Hoerova, Linzert, Schepens, and Sigaux, 2020, p. 13). Recent evidence shows that repo-market frictions impair this pass-through. Ballensiefen et al. (2023) document that money markets are segmented; Eisenschmidt et al. (2024) show that dealer market power in OTC repo reduces pass-through of the ECB’s policy rate to non-dealer counterparties by 20 to 30 percentage points relative to the inter-dealer benchmark. Nguyen, Tomio, and Vari (2023) show that the scarcity of safe assets and the limited participation of investors in the repo market affected the pass-through of ECB rate hikes in 2022.

Our analysis complements this work by identifying a distinct, within-dealer channel: Proposition 3(ii) predicts that under framework commitment, the trade-date rate response to a policy rate change scales inversely with the commitment haircut $\bar{h}_{CD,j}$. Because Corollary 1 implies constrained dealers set higher $\bar{h}_{CD,j}$ in the collateral-driven segment, they pass policy rate changes through less completely to their clients.

To measure pass-through, we exploit the eleven changes in the ECB’s deposit facility rate (DFR) between July 2022 and June 2024: ten hikes through September 2023 and the June 2024 cut. For each decision, we construct a transaction-level panel by stacking a symmetric ± 7 business-day window around the announcement. The dependent variable is the DFR-adjusted repo rate, defined as the transaction-level repo rate minus the prevailing DFR. Let $\text{PostHike}_t = 1$ for transactions on or after the implementation date. The estimating equation pools collateral-driven and funding-driven trades within dealer–client pairs:

$$\begin{aligned} r_{d,c,i,t}^{\text{adj}} = & \beta_1 \text{PostHike}_t \times \text{LR}_d^{\text{std}} \times \text{Coll}_i + \beta_2 \text{PostHike}_t \times \text{LR}_d^{\text{std}} \\ & + \beta_3 \text{PostHike}_t \times \text{Coll}_i + \beta_4 \text{PostHike}_t + \gamma \mathbf{X}_{d,c,i,t} + \alpha_{d,c} + \delta_{e,i} + \varepsilon_{d,c,i,t}, \end{aligned} \quad (16)$$

where LR_d^{std} is the dealer’s leverage ratio standardised to mean zero and unit standard deviation, Coll_i is an indicator equal to one for collateral-driven trades, $\alpha_{d,c}$ are dealer–client fixed effects, and $\delta_{e,i}$ are Event–ISIN fixed effects. Controls $\mathbf{X}$ include log volume and maturity-

bucket dummies. The triple interaction β_1 identifies the differential effect of dealer leverage on rate adjustments in collateral-driven trades, netting out any common leverage effect in funding-driven trades.

Table 8: Pass-through of monetary policy

	All events			Hikes only
	(1)	(2)	(3)	(4)
PostHike $\times$ LR ^{std}	−0.013 (0.024)	−0.013 (0.023)	−0.012 (0.038)	−0.019 (0.023)
PostHike $\times$ LR ^{std} $\times$ Coll	0.074*** (0.022)	0.074*** (0.020)	0.081** (0.030)	0.083*** (0.024)
Event $\times$ ISIN FE	✓	✓		✓
Event $\times$ Country FE			✓	
Dealer $\times$ client FE	✓	✓	✓	✓
Cluster: Dealer	✓		✓	✓
Cluster: Dealer $\times$ Client		✓		
<i>N</i>	199,095	199,095	199,095	185,450
<i>R</i> ²	0.84	0.84	0.70	0.85

Note: Transaction-level pass-through regressions using ± 7 business-day windows stacked around each ECB deposit facility rate (DFR) decision, pooling collateral-driven and funding-driven repos. The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024. The dependent variable is the DFR-adjusted repo rate. $\text{PostHike}_t = 1$ on or after the rate decision date. LR_d^{std} is the dealer's leverage ratio, standardised to mean zero and unit standard deviation. *Coll* equals one for collateral-driven trades. The triple interaction identifies the differential rate adjustment of constrained dealers in collateral-driven trades relative to funding-driven trades; the double interaction $\text{PostHike} \times \text{LR}^{\text{std}}$ captures the leverage effect in funding-driven trades and serves as a placebo. Columns (1)–(3) pool all eleven DFR decisions between July 2022 and June 2024 under alternative fixed-effect and clustering specifications; column (4) restricts to the ten hikes, excluding the June 2024 cut. Controls: log volume, maturity-bucket dummies. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Column (1) reports the pooled specification. The triple interaction $\text{PostHike} \times \text{LR}^{\text{std}} \times \text{Coll}$ is 0.074 ($p < 0.01$): a one-standard-deviation increase in the dealer's leverage ratio raises the post-decision DFR-adjusted rate by 7.4 basis points in collateral-driven trades, relative to funding-driven trades. A positive coefficient means that less-constrained dealers keep the repo rate closer to the new DFR, while more-constrained dealers let it lag behind by more. Higher leverage headroom, therefore, corresponds to *more complete* pass-through in the collateral-driven segment. The double interaction $\text{PostHike} \times \text{LR}^{\text{std}}$ is −0.013 and insignificant, hence, there is no comparable effect in funding-driven trades. Column (4) restricts to the ten hikes and delivers consistent results. The 7.4 basis-point differential is modest in absolute terms but non-trivial as a share of a typical policy step of 25 or 50 basis-point moves. Balance-

sheet constraints act *within* the dealer sector: more constrained dealers exhibit significantly weaker rate pass-through in collateral-driven trades.

7. Conclusion

This paper studies how haircuts are set in the euro-area bilateral repo market, a segment that sits at the intersection of monetary policy transmission and sovereign debt liquidity. Using transaction-level data, we show that three channels jointly account for haircut setting: dealer balance-sheet costs, collateral convenience yields, and client outside options. Each channel is quantitatively meaningful, and their effects differ systematically across the collateral-driven and funding-driven segments, with the same underlying friction often generating opposite haircut movements. Two rate-level implications follow: rate volatility is systematically higher and pass-through of ECB policy rate changes systematically weaker in trades intermediated by leverage-constrained dealers. These findings have implications for the calibration of balance-sheet regulation as it applies to secured funding, for the interpretation of policy-rate pass-through in the money market, and for the design of central-bank facilities that ease specific frictions in the collateral chain.

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Online Appendix to
“Stop Believing in Haircuts”

Appendix A. Equilibrium computations and proofs

This appendix derives the equilibrium haircuts (6), the surplus values, and the closed-form rates (7). It then proves the comparative statics of Corollaries 1–3 and the commitment predictions of Proposition 3. Throughout, a starred surplus S_j^{seg} denotes joint surplus evaluated at the equilibrium haircut of that segment.

Appendix A.1. The Nash program and transferable utility

Fix a segment and a haircut h . Both payoffs are affine in the rate with a common slope of opposite sign: writing the rate-stripped payoffs $\tilde{\pi}(h) \equiv \pi + (\text{rate term})$ and $\tilde{U}_c(h) \equiv U_c - (\text{rate term})$, in the collateral-driven segment

$$\pi^{CD} = \tilde{\pi}^{CD}(h) - (1-p)r, \quad U_c^{CD} = \tilde{U}_c^{CD}(h) + (1-p)r,$$

and the reverse signs in the funding-driven segment, where the dealer receives the rate. In either case $\pi + U_c = \tilde{\pi}(h) + \tilde{U}_c(h) \equiv S(h)$ is independent of r : utility is transferable, and the rate is a pure transfer of size $(1-p)r$ between the parties.

The generalised Nash product is $P = \pi^{\theta_j} U_c^{1-\theta_j}$ with disagreement payoffs zero. For fixed h , maximising $\ln P$ over r gives the first-order condition

$$\theta_j \frac{\partial \pi / \partial r}{\pi} + (1 - \theta_j) \frac{\partial U_c / \partial r}{U_c} = 0 \implies \frac{\theta_j}{\pi} = \frac{1 - \theta_j}{U_c},$$

because $\partial \pi / \partial r$ and $\partial U_c / \partial r$ are equal in magnitude and opposite in sign. Combined with $\pi + U_c = S(h)$ this yields the Nash split

$$\pi = \theta_j S(h), \quad U_c = (1 - \theta_j) S(h). \quad (\text{A.1})$$

Substituting back, $P = \theta_j^{\theta_j} (1 - \theta_j)^{1-\theta_j} S(h)$, so the haircut that maximises the Nash product is the one that maximises joint surplus, $h^* = \arg \max_h S(h)$, independently of θ_j . The rate then follows from (A.1): solving $U_c(h^*, r) = (1 - \theta_j) S(h^*)$ for r gives the transfer. This establishes the separation used in the main text: the bargaining share θ_j affects only the rate.

Appendix A.2. Collateral-driven segment

Joint surplus is $S^{CD}(h) = \pi^{CD} + U_c^{CD}$ with the rate cancelling:

$$S^{CD}(h) = v - y_j + r^{DFR}(1 - h) + \lambda h - \frac{\varphi}{2}h^2 - \frac{pm}{2}(h + s(y_j))^2 - \frac{\Gamma_j}{2}(1 - h)^2.$$

Collecting terms in h ,

$$S^{CD}(h) = A_j^{CD} + B_j^{CD}h - \frac{1}{2}(\Phi + \Gamma_j)h^2, \quad \begin{aligned} A_j^{CD} &= v - y_j + r^{DFR} - \frac{pm}{2}s(y_j)^2 - \frac{\Gamma_j}{2}, \\ B_j^{CD} &= \lambda + \Gamma_j - r^{DFR} - pm s(y_j), \end{aligned} \quad (\text{A.2})$$

where $\Phi = \varphi + pm$ and $(S^{CD})'' = -(\Phi + \Gamma_j) < 0$, so the problem is strictly concave. The first-order condition $B_j^{CD} = (\Phi + \Gamma_j)h$ equates joint marginal benefit and cost of the haircut in both segments,

$$\begin{aligned} \lambda + \Gamma_j(1 - h_{CD,j}^*) &= r^{DFR} + \varphi h_{CD,j}^* + pm(h_{CD,j}^* + s(y_j)), \\ \omega y_j + p q (1 - \ell(y_j)) [\ell(y_j)(1 + h_{FD,j}^*) - h_{FD,j}^*] &= \lambda_c + \varphi_c h_{FD,j}^*, \end{aligned} \quad (\text{A.3})$$

where the second line is derived below in Appendix A.3. The collateral-driven condition gives

$$h_{CD,j}^* = \frac{B_j^{CD}}{\Phi + \Gamma_j} = \frac{\lambda + \Gamma_j - r^{DFR} - pm s(y_j)}{\Phi + \Gamma_j}.$$

For a concave quadratic $A + Bh - \frac{1}{2}Ch^2$ the optimised value is $A + B^2/(2C) = A + \frac{1}{2}C(h^*)^2$; hence

$$S_j^{CD} = A_j^{CD} + \frac{(B_j^{CD})^2}{2(\Phi + \Gamma_j)} = A_j^{CD} + \frac{1}{2}(\Phi + \Gamma_j)(h_{CD,j}^*)^2.$$

Imposing the split (A.1) through the client's payoff,

$$U_c^{CD} = v + (1 - p)r + \lambda h_{CD,j}^* - \frac{\varphi}{2}(h_{CD,j}^*)^2 = (1 - \theta_j) S_j^{CD},$$

and solving for r delivers

$$r_{CD,j}^* = \frac{1}{1 - p} \left[(1 - \theta_j) S_j^{CD} - v - \lambda h_{CD,j}^* + \frac{\varphi}{2}(h_{CD,j}^*)^2 \right],$$

the first line of (7). Solving instead through the dealer-side split $\pi^{CD} = \theta_j S_j^{CD}$ gives the algebraically identical expression.

Appendix A.3. Funding-driven segment

Joint surplus is $S^{FD}(h) = \pi^{FD} + U_c^{FD}$ with the rate cancelling; in exact form,

$$S^{FD}(h) = v_c - r^{DFR} + \omega y_j \frac{1}{1-h} - \frac{pq}{2} \left(1 - \frac{1-\ell(y_j)}{1-h}\right)^2 - \lambda_c \left(\frac{1}{1-h} - 1\right) - \frac{\varphi_c}{2} \left(\frac{1}{1-h} - 1\right)^2.$$

Imposing the linearisation $1/(1-h) = 1+h$, so that $\frac{1}{1-h} - 1 = h$ and $1 - \frac{1-\ell(y_j)}{1-h} = \ell(y_j) - (1 - \ell(y_j))h$, and collecting terms,

$$\begin{aligned} A_j^{FD} &= v_c - r^{DFR} + \omega y_j - \frac{pq}{2} \ell(y_j)^2, \\ S^{FD}(h) &= A_j^{FD} + N_j h - \frac{1}{2} D_j h^2, \quad N_j = \omega y_j + pq \ell(y_j)(1 - \ell(y_j)) - \lambda_c, \\ D_j &= \varphi_c + pq(1 - \ell(y_j))^2, \end{aligned} \tag{A.4}$$

with $(S^{FD})'' = -D_j < 0$. The first-order condition $N_j = D_j h$ is the funding-driven tangency condition, the second line of (A.3), and gives

$$h_{FD,j}^* = \frac{N_j}{D_j} = \frac{\omega y_j + pq \ell(y_j)(1 - \ell(y_j)) - \lambda_c}{\varphi_c + pq(1 - \ell(y_j))^2}.$$

The optimised surplus is, as in the collateral-driven segment,

$$S_j^{FD} = A_j^{FD} + \frac{N_j^2}{2D_j} = A_j^{FD} + \frac{1}{2} D_j (h_{FD,j}^*)^2.$$

Imposing the split through the client's payoff,

$$U_c^{FD} = v_c - (1-p)r - \lambda_c h_{FD,j}^* - \frac{\varphi_c}{2} (h_{FD,j}^*)^2 = (1 - \theta_j) S_j^{FD},$$

and solving for r gives

$$r_{FD,j}^* = \frac{1}{1-p} \left[v_c - \lambda_c h_{FD,j}^* - \frac{\varphi_c}{2} (h_{FD,j}^*)^2 - (1 - \theta_j) S_j^{FD} \right],$$

the second line of (7). Because r enters π and U_c with opposite signs and the common weight $(1 - p)$, it is a pure transfer, completing the proof of Propositions 1 and 2. ■

Appendix A.4. Comparative statics: proofs of Corollaries 1–3

Both equilibrium haircuts in (6) are explicit ratios of the fundamentals, so we differentiate directly.

Proof of Corollary 1 (balance-sheet constraints). From $h_{CD,j}^* = B_j^{CD} / (\Phi + \Gamma_j)$ with $\partial B_j^{CD} / \partial \Gamma_j = 1$, the quotient rule gives

$$\frac{\partial h_{CD,j}^*}{\partial \Gamma_j} = \frac{(\Phi + \Gamma_j) - B_j^{CD}}{(\Phi + \Gamma_j)^2} = \frac{1 - h_{CD,j}^*}{\Phi + \Gamma_j},$$

which is strictly positive whenever the cash leg $1 - h_{CD,j}^* > 0$. Because Γ_j enters neither N_j nor D_j in the funding-driven segment, $\partial h_{FD,j}^* / \partial \Gamma_j = 0$. ■

Proof of Corollary 2 (convenience yields). The collateral-driven derivative is immediate from $\partial B_j^{CD} / \partial y_j = -pm s'(y_j)$ with $s'(y_j) > 0$:

$$\frac{\partial h_{CD,j}^*}{\partial y_j} = -\frac{pm s'(y_j)}{\Phi + \Gamma_j} < 0.$$

For the funding-driven segment, write $h_{FD,j}^* = N_j / D_j$ with derivatives in y_j (denoting $\ell \equiv \ell(y_j)$):

$$N_j' = \omega + pq(1 - 2\ell)\ell', \quad D_j' = -2pq(1 - \ell)\ell'.$$

By the quotient rule,

$$\text{sign}\left(\frac{\partial h_{FD,j}^*}{\partial y_j}\right) = \text{sign}(N_j' D_j - N_j D_j').$$

Using $N_j = D_j h_{FD,j}^*$ and $\ell' \leq 0$,

$$\begin{aligned} N_j' D_j - N_j D_j' &= D_j [\omega + pq(1 - 2\ell)\ell'] - D_j h_{FD,j}^* [-2pq(1 - \ell)\ell'] \\ &= D_j \left\{ \omega + pq \ell' [1 - 2\ell + 2(1 - \ell)h_{FD,j}^*] \right\}. \end{aligned}$$

Since $D_j > 0$ and $\ell' = -|\ell'|$,

$$\text{sign}\left(\frac{\partial h_{FD,j}^*}{\partial y_j}\right) = \text{sign}\left(\omega - pq|\ell'|[1 - 2\ell + 2(1 - \ell)h_{FD,j}^*]\right).$$

The sufficient condition $\omega > pq|\ell'|$ holds whenever $1 - 2\ell + 2(1 - \ell)h_{FD,j}^* \leq 1$, i.e. whenever $h_{FD,j}^* \leq \ell/(1 - \ell)$: the empirically relevant region in which frictions compress the funding-driven haircut below its risk-management benchmark. ■

Proof of Corollary 3 (market power and outside options). By Appendix A.1, θ_j enters only the rate, so $\partial h_{\cdot,j}^*/\partial \theta_j = 0$ in both segments. The preference derivatives are direct: from $h_{CD,j}^* = B_j^{CD}/(\Phi + \Gamma_j)$ with $\partial B_j^{CD}/\partial \lambda = 1$,

$$\frac{\partial h_{CD,j}^*}{\partial \lambda} = \frac{1}{\Phi + \Gamma_j} > 0.$$

From $h_{FD,j}^* = N_j/D_j$ with $\partial N_j/\partial \lambda_c = -1$ and λ_c not entering D_j ,

$$\frac{\partial h_{FD,j}^*}{\partial \lambda_c} = -\frac{1}{D_j} < 0.$$

The rate derivatives in Proposition 2 follow from differentiating (7) with respect to θ_j and noting that h^* , hence S_j^{seg} , is independent of θ_j :

$$\frac{\partial r_{CD,j}^*}{\partial \theta_j} = -\frac{S_j^{CD}}{1 - p} < 0, \quad \frac{\partial r_{FD,j}^*}{\partial \theta_j} = +\frac{S_j^{FD}}{1 - p} > 0. \quad \blacksquare$$

Appendix A.5. Proof of Proposition 3 (commitment structure)

The trade-date rate under commitment is (9). Fix $\bar{h}$ and treat $S_j^{CD}(\bar{h}; \Gamma^t, y^t, \lambda^t)$ as a function of the current fundamentals. The partial derivatives, read off the collected form (A.2) evaluated at $\bar{h}$, are

$$\frac{\partial S_j^{CD}}{\partial r^{DFR}} = 1 - \bar{h}, \quad \frac{\partial S_j^{CD}}{\partial \Gamma^t} = -\frac{1}{2}(1 - \bar{h})^2, \quad \frac{\partial S_j^{CD}}{\partial \lambda^t} = \bar{h}, \quad \frac{\partial S_j^{CD}}{\partial y^t} = -1 - p m s'(y^t)(\bar{h} + s(y^t)).$$

Part (i). Differentiating (9) with respect to r^{DFR} gives

$$\frac{\partial r_{CD,j}^{*,t}}{\partial r^{DFR}} = \frac{1}{1-p} \cdot (1-\theta_j) \cdot (1-\bar{h}) = \frac{(1-\theta_j)(1-\bar{h}_{CD,j})}{1-p},$$

which is (11). On $\bar{h}_{CD,j} < 1$, which holds whenever the cash leg is positive, the derivative is strictly decreasing in $\bar{h}_{CD,j}$.

Part (ii). Assembling the four derivatives of $r_{CD,j}^{*,t}$ with regard to the fundamental parameters from (9),

$$\begin{aligned} \frac{\partial r_{CD,j}^{*,t}}{\partial r^{DFR}} &= \frac{(1-\theta_j)(1-\bar{h})}{1-p}, & \frac{\partial r_{CD,j}^{*,t}}{\partial \Gamma^t} &= -\frac{(1-\theta_j)(1-\bar{h})^2}{2(1-p)}, \\ \frac{\partial r_{CD,j}^{*,t}}{\partial \lambda^t} &= \frac{(1-\theta_j)\bar{h}-\bar{h}}{1-p} = -\frac{\theta_j\bar{h}}{1-p}, & \frac{\partial r_{CD,j}^{*,t}}{\partial y^t} &= -\frac{(1-\theta_j)[1+pm s'(y^t)(\bar{h}+s(y^t))]}{1-p}. \end{aligned}$$

The λ^t derivative combines the $(1-\theta_j)\partial S/\partial \lambda$ contribution from (9) with the direct $-\lambda^t \bar{h}$ term in the bracket, yielding $-\theta_j \bar{h}/(1-p)$. Under independent shocks to the parameters with variances σ_x^2 , the variance of the trade-date rate is the sum of squared derivatives times variances,

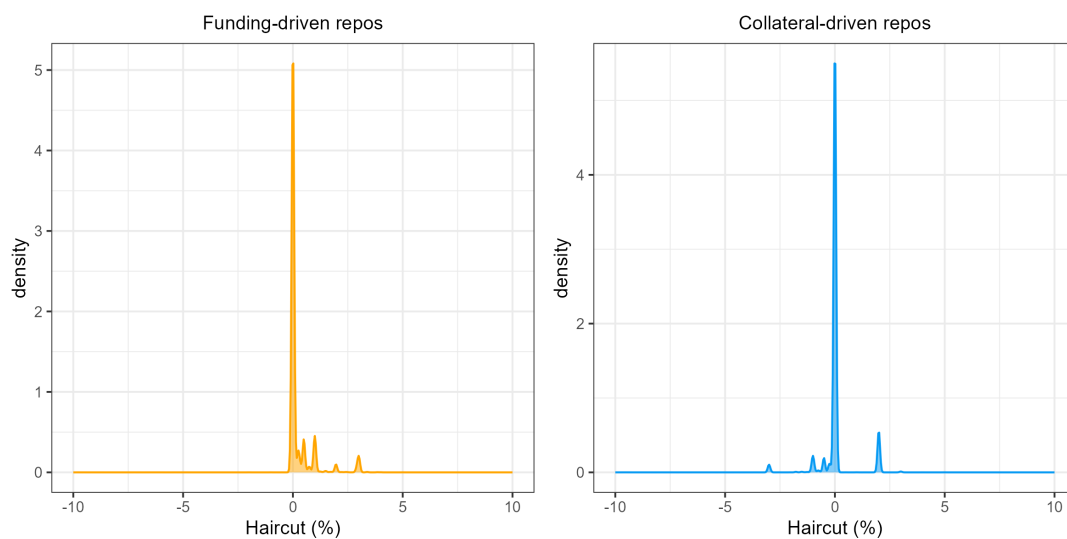
$$\text{Var}(r_{CD,j}^{*,t}) = \left(\frac{1-\theta_j}{1-p}\right)^2 \left[(1-\bar{h})^2 \sigma_{r^{DFR}}^2 + \frac{1}{4}(1-\bar{h})^4 \sigma_{\Gamma}^2 + \Psi(\bar{h}; y) \sigma_y^2 \right] + \left(\frac{\theta_j \bar{h}}{1-p}\right)^2 \sigma_{\lambda}^2,$$

with $\Psi(\bar{h}; y) \equiv [1+pm s'(y)(\bar{h}+s(y))]^2$. This is (10). ■

Appendix B. Summary statistics

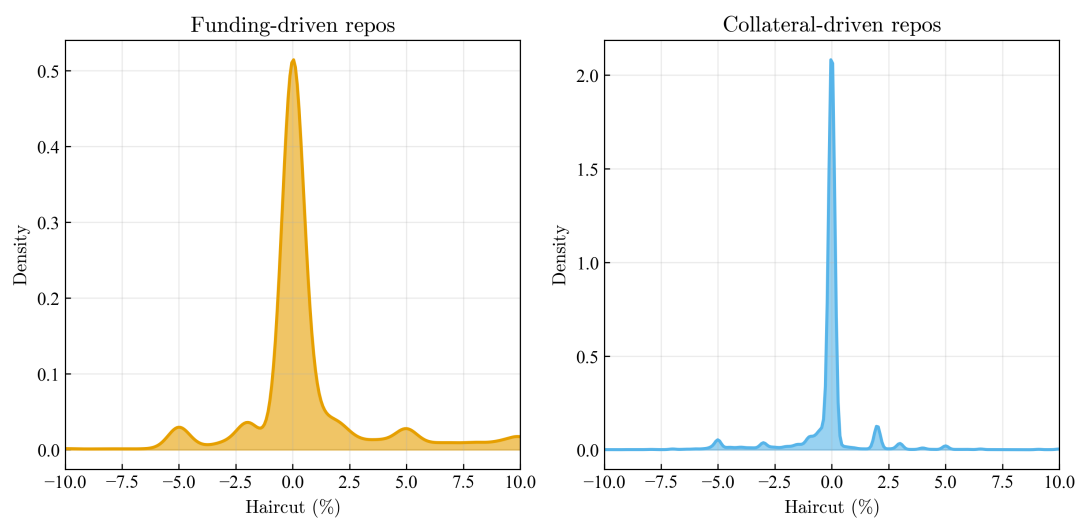
Appendix B.1. Haircut distribution

Figure B.1: What is the distribution of haircuts?



Note: This histogram displays the distribution of reported haircuts in SFTDS in funding-driven and collateral-driven repo transactions between dealer banks and non-dealer clients from January 2021 to December 2024 at the transaction level. The estimation used a Gaussian kernel.

Figure B.2: What is the distribution of haircuts?



Note: This histogram displays the estimated distribution of haircuts in funding-driven and collateral-driven repo transactions between dealer banks and non-dealer clients from January 2019 to June 2024 on a *dealer-client-day* level (the SFTDS coverage is 2021–2024, differing from the MMSR sample used elsewhere). The estimation used a Gaussian kernel.

Appendix B.2. Dealer and client characteristics

Table B.1: Dealer summary statistics

	Tercile 1 <i>most constrained</i>	Tercile 2	Tercile 3 <i>least constrained</i>	All
Mean leverage ratio (%)	3.87	4.70	5.82	4.80
<i>Panel A: Collateral-driven</i>				
Number of clients (rolling 12m)	265.9	125.3	129.8	203.5
Volume per transaction (EUR mn)	28.81	27.12	17.41	26.49
<i>Panel B: Funding-driven</i>				
Number of clients (rolling 12m)	198.4	111.5	30.2	152.8
Volume per transaction (EUR mn)	21.87	27.55	12.70	22.06
<i>Panel C: Mean leverage ratio by dealer's majority collateral country (%)</i>				
Majority German collateral (DE)				4.75
Majority French collateral (FR)				3.44
Majority Italian collateral (IT)				5.00
Majority Spanish collateral (ES)				5.59

Note: Dealer-level summary statistics by leverage-ratio tercile. Dealers are sorted into terciles within each quarter using their reported leverage ratio (Tier 1 capital divided by non-risk-weighted exposure). Tercile 1 denotes the most constrained (lowest) leverage ratio; Tercile 3 the least. Panel A restricts to collateral-driven repos (dealer lends securities, receives cash); Panel B restricts to funding-driven repos (dealer lends cash, receives securities). Panel C assigns each dealer to a single collateral country based on the largest share of their trading volume across the combined collateral-driven and funding-driven sample, and reports the mean leverage ratio within each group. The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024.

Table B.2: Client summary statistics

	Q1	Q2	Q3	Q4	Q5	All
<i>Panel A: Collateral-driven</i>						
Number of dealers (rolling 12m)	1.1	3.2	3.2	3.4	3.6	1.5
<i>Panel B: Funding-driven</i>						
Number of dealers (rolling 12m)	1.1	3.7	3.9	4.2	4.3	1.6

Note: Client-level summary statistics. Q1–Q5 report the mean within each quintile of the client distribution; the “All” column reports the unconditional mean across all clients. The number of dealers is the count of distinct dealer counterparties with which a client transacted over a rolling 12-month window. The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024, across all counterparty sectors. Rates and haircuts are winsorised at the 0.5th/99.5th percentiles.

Appendix C. Robustness

Appendix C.1. Robustness: non-zero haircuts

Table C.1: Balance sheet space and haircuts

	Collateral-driven			
	Non-zero haircuts		S124/S125 counterparties	
	(1)	(2)	(3)	(4)
Tercile 1 $\times$ Post	0.623*** (0.215)	0.617*** (0.217)	0.462* (0.252)	0.462* (0.252)
Tercile 2 $\times$ Post	0.878*** (0.222)	0.870*** (0.224)	0.445* (0.252)	0.445* (0.252)
Tercile 1 $\times$ Post $\times$ QE		0.204 (0.234)		−0.006 (0.062)
Tercile 2 $\times$ Post $\times$ QE		0.283 (0.225)		−0.004 (0.059)
ISIN $\times$ day FE	✓	✓	✓	✓
Client FE	✓	✓	✓	✓
N	387,392	387,392	787,353	787,353
R^2	0.93	0.93	0.87	0.87

Note: Robustness of the balance-sheet regressions in Table 3 to two sample restrictions. Columns (1)–(2) exclude transactions with a zero haircut. Columns (3)–(4) restrict the counterparty universe to sectors S124 (investment funds excluding money market funds) and S125 (other financial intermediaries). Within each panel, the odd column reports the baseline tercile specification and the even column adds the quarter-end interaction ($QE = 1$ on the last two business days of each quarter). Dealers are sorted into leverage-ratio terciles within each quarter; Tercile 1 denotes the most constrained, Tercile 3 (omitted) the least. $Post = 1$ after June 28, 2021. All specifications include tercile and $Post$ main effects, with the latter absorbed by the ISIN $\times$ day fixed effects. Controls: log volume, maturity-bucket dummies. Standard errors clustered at the dealer $\times$ client level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.2: Convenience yields and haircuts

	Non-zero haircuts				S124/S125 counterparties			
	Collateral-driven		Funding-driven		Collateral-driven		Funding-driven	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Convenience yield	-0.291*** (0.102)	-0.314*** (0.108)	0.690*** (0.121)	0.712*** (0.122)	-0.156** (0.073)	-0.164** (0.078)	0.396*** (0.125)	0.420*** (0.135)
Month FE	✓		✓		✓		✓	
Country FE	✓		✓		✓		✓	
Country × month FE		✓		✓		✓		✓
Dealer × client FE	✓	✓	✓	✓	✓	✓	✓	✓
<i>N</i>	407,128	407,121	375,178	375,177	959,363	959,363	400,648	400,640
<i>R</i> ²	0.87	0.87	0.74	0.77	0.69	0.70	0.64	0.65

Note: Robustness of the convenience-yield regressions in Table 5 to two sample restrictions. Columns (1)–(4) exclude transactions with a zero haircut. Columns (5)–(8) restrict the counterparty universe to sectors S124 (investment funds excluding money market funds) and S125 (other financial intermediaries). Within each panel, the odd column uses month, country, and dealer × client fixed effects; the even column replaces month and country with the interacted country × month effect. The convenience yield is defined as the spread between the sovereign benchmark yield (interpolated via a Nelson–Siegel curve at the bond’s remaining maturity) and the corresponding OIS rate. Controls: log volume, maturity-bucket dummies. Standard errors clustered at the dealer × client level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.3: Client outside options and haircuts

	Non-zero haircuts				S124/S125 counterparties			
	Collateral-driven		Funding-driven		Collateral-driven		Funding-driven	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Reach	0.014 (0.010)	0.005 (0.008)	−0.155 (0.094)	−0.154* (0.073)	0.052*** (0.015)	0.144*** (0.029)	−0.080** (0.032)	−0.131** (0.046)
Reach × Post		0.018 (0.015)		−0.004 (0.104)		−0.113*** (0.026)		0.113** (0.044)
ISIN × day FE	✓	✓	✓	✓	✓	✓	✓	✓
Client FE	✓	✓	✓	✓	✓	✓	✓	✓
Leverage tercile FE	✓	✓	✓	✓	✓	✓	✓	✓
<i>N</i>	387,392	387,392	413,879	413,879	1,002,234	1,002,234	477,994	477,994
<i>R</i> ²	0.93	0.93	0.93	0.93	0.85	0.85	0.92	0.92

Note: Robustness of the client-outside-options regressions in Table 6 to two sample restrictions. Columns (1)–(4) exclude transactions with a zero haircut. Columns (5)–(8) restrict the counterparty universe to sectors S124 (investment funds excluding money market funds) and S125 (other financial intermediaries). Within each panel, the odd column reports the baseline *Reach* specification and the even column adds the *Reach* × *Post* interaction. *Reach* is the number of distinct dealers each client transacts with over a rolling 12-month window. *Post* = 1 after June 28, 2021. Controls: log volume, maturity-bucket dummies. Standard errors clustered at the dealer level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix C.2. Robustness: capital ratio and risk-weighted-assets (RWA)

Table C.4: Capital ratio and haircuts (various specifications)

	Collateral-driven				
	(1)	(2)	(3)	(4)	(5)
Tercile 1 $\times$ Post	−0.026 (0.023)	−0.015 (0.057)		−0.002 (0.059)	−0.027 (0.023)
Tercile 2 $\times$ Post	−0.140** (0.063)	−0.081* (0.039)		−0.058 (0.035)	−0.140** (0.063)
CR headroom $\times$ Post			0.007 (0.012)		
T1 $\times$ Post $\times$ QE					0.052** (0.022)
T2 $\times$ Post $\times$ QE					0.016 (0.027)
ISIN $\times$ day FE	✓	✓	✓	✓	✓
Client FE	✓		✓		✓
Dealer $\times$ client FE		✓		✓	
Dealer FE			✓		
Balanced relationships				✓	
<i>N</i>	1,556,748	1,556,533	1,556,748	1,141,552	1,556,748
<i>R</i> ²	0.83	0.88	0.83	0.88	0.83

Note: Robustness of the balance-sheet regressions in Table 3 using total capital ratios in place of leverage ratios. The dependent variable is the transaction-level repo haircut (%). The sample covers bilateral dealer-to-client repos collateralised by euro-area government bonds, January 2019 to June 2024. Dealers are sorted into total-capital-ratio terciles within each quarter; Tercile 1 denotes the most constrained, Tercile 3 (omitted) the least. *CR headroom* is the dealer's total capital ratio minus the 8% minimum, in percentage points. *Post* = 1 after June 28, 2021. *QE* = 1 on the last two business days of each quarter. *Balanced relationships* restricts to dealer–client pairs active both pre- and post-June 2021. All specifications include tercile and *Post* main effects, with the latter absorbed by the ISIN $\times$ day fixed effects. Controls: log volume, maturity-bucket dummies. Standard errors clustered at the dealer level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Acknowledgements

Comments are welcome. We are especially grateful to Jeremy Bejarano, Jean-Edouard Colliard, Stefano Corradin, Falko Fecht, Stefan Greppmair (discussant), Andy Hill, Felix Hermes, Stephan Jank, Seung Joo Lee, Edouard Mattille, Andrea Poinelli, Patrick Schaffner, Martin Scheicher, Andreas Schrimpf, Nuria Suárez Suárez (discussant), Dimitrios Tsomocos, Jonathan Wallen, Hannah Winterberg, and ECB colleagues as well as conference participants at the 21st Central Bank Conference on the Microstructure of Financial Markets and the German Finance Association Annual Meeting and seminar participants at the ECB for their helpful comments and suggestions. All views, findings, and errors are our own.

The views expressed are those of the authors and do not necessarily reflect those of the ECB, the Eurosystem, or the Banque de France.

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ISBN 978-92-899-8068-5

ISSN 1725-2806

doi:10.2866/3158501

QB-01-26-245-EN-N