

Bank of England

SoS! The overnight bilateral liquidity provision of non-bank financial institutions to banks

Staff Working Paper No. 1,195

July 2026

Elio Cucullo, Andrew Clare and Angela Gallo

Staff Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate. Any views expressed are solely those of the author(s) and so cannot be taken to represent those of the Bank of England or any of its committees, or to state Bank of England policy.



Bank of England

Staff Working Paper No. 1,195

SoS! The overnight bilateral liquidity provision of non-bank financial institutions to banks

Elio Cucullo,⁽¹⁾ Andrew Clare⁽²⁾ and Angela Gallo⁽³⁾

Abstract

We study the overnight bilateral gilt repo market to assess how global non-bank financial institutions (NBFIs) supply liquidity to large UK banks. Using proprietary transaction-level data from the Bank of England, we show that, in this segment, NBFIs provide substantially more liquidity than traditional interbank lenders, with volumes 6 to 12 times larger. We compute a relative pricing measure, the Spread-of-Spread (SoS), to capture the NBFIs premium over the interbank repo lending. We document that before 2022, NBFIs funding was cheaper than the interbank market, with the average SoS at -7 basis points, but became more expensive and volatile thereafter, averaging around 10 basis points. We document two mechanisms: an opportunity-cost channel where higher short-term rates lead NBFIs to pass higher liquidity cost onto banks, and a balance-sheet constraint channel, whereby monetary tightening heterogeneously compresses NBFIs balance-sheet capacity, increases the shadow cost of liquidity, and amplifies the persistence of volatility in the SoS.

Key words: Banks, non-bank financial institutions, repo market, liquidity.

JEL classification: C58, G01, G21, G23.

(1) Bank of England and Bayes Business School. Email: elio.cucullo@bankofengland.co.uk or elio.cucullo@bayes.city.ac.uk (corresponding author)

(2) Bayes Business School. Email: a.clare@citystgeorges.ac.uk

(3) Bayes Business School. Email: angela.gallo.1@citystgeorges.ac.uk

We thank the participants of the conferences held at the Board of Governors of the Federal Reserve System, European Central Bank, Bank of Japan, Federal Reserve Bank of Boston, and Bank of England for their valuable feedback and stimulating discussions. We are also grateful to Rebecca Maule, Marc Hinterschweiger, Francesc Rodriguez Tous, Giovanni Urga, and Guillaume Vuillemeys for their valuable comments. Any views expressed are solely those of the authors and cannot be taken to represent those of the Bank of England or to state Bank of England policy. This paper should therefore not be reported as representing the views of the Bank of England or its Committees.

The Bank's working paper series can be found at www.bankofengland.co.uk/working-paper/staff-working-papers

Bank of England, Threadneedle Street, London, EC2R 8AH

Email: enquiries@bankofengland.co.uk

©2026 Bank of England

ISSN 1749-9135 (on-line)

1. Introduction

Interbank markets have traditionally facilitated the redistribution of liquidity within the financial system. However, the global financial crisis (GFC) exposed vulnerabilities in these mechanisms and weakened the transmission of monetary policy (Afonso et al., 2010; Acharya et al., 2011; Gorton et al., 2020). Since then, the structure of liquidity provision has shifted substantially.

Non-bank financial institutions (NBFIs) now account for roughly half of the global financial assets (Financial Stability Board, 2025), while post-crisis regulatory reforms have raised banks' capital and liquidity requirements. These developments have altered the functioning of the traditional transmission mechanism: as liquidity provision has migrated toward NBFIs, opportunity-costs and balance-sheet constraints have the potential to introduce new frictions. These frictions may be amplified by the increasing interconnectedness between NBFIs and banks, which has created additional channels through which stress in liquidity provision can propagate (Financial Stability Board, 2024). This linkage operates through a range of exposures, including deposits, debt securities, repurchase agreements (repo) and derivatives (Bank for International Settlements, 2025).

In this paper, we study the role of NBFIs in providing liquidity to banks and identify the key channels driving variation in this activity. Doing so requires a setting in which bank–NBFI relationships are central to liquidity allocation, combined with granular data that track these relationships over time, across different economic regimes, and across heterogeneous NBFI types.

The UK gilt repo market provides such a setting. In this market, NBFIs play a central role: the bilateral dealer to client segment, which is also the primary segment in which NBFIs participate, accounted for roughly 65% of the total outstanding gilt repo stock in the first quarter of 2025, while the interdealer segment accounts for the remainder (Bank of England, 2025).¹ Interdealer activity, where the substantial share of the bank-to-bank trading occurs, is concentrated at short maturities and predominantly conducted through central counterparties.² This institutional structure provides a useful benchmark for

¹Across the overall market, 23% of gross outstanding positions are currently voluntarily centrally cleared at LCH Ltd. (Bank of England, 2025).

²Importantly, in the whole UK gilt repo market, dealer banks are large net providers of cash overall, as their repo and reverse repo positions do not fully offset, consistent with their role as intermediaries

assessing the role of NBFIs in the bilateral segment, which is one of the main channels through which banks source bilateral short-term secured funding, obtaining cash against high quality collateral via direct bilateral interactions, rather than through a central counterparty. Within this framework, banks draw on NBFIs funding particularly when the marginal cost of balance sheet usage rises at the dealer or treasury level, with repo desks intermediating client flows through matched book activities.

A large bilateral segment, the growing role of NBFIs, and the presence of meaningful counterparty risk in non centrally cleared transactions together make this segment particularly well suited to analysing how liquidity flows directly between banks and NBFIs. Accordingly, this analysis focuses on the overnight segment,³ where both dealer banks liquidity management and NBFIs liquidity provision is most pronounced. The aim of this analysis is therefore to study the role of NBFIs as one direct source of overnight cash for banks.

To examine this market, we make use of Sterling Money Market Data (SMMD), a unique and proprietary transaction-level repository collected by the Bank of England. This dataset provides comprehensive coverage of secured and unsecured money market transactions conducted by institutions representing approximately 95% of UK banking activity by volume. Data are collected daily on each business day from 2016 onwards under the Bank of England’s Sterling Money Market Framework. The sample spans from 1 July 2018 to 31 December 2024, covering 1,645 trading days and comprising 336,715 transactions.⁴ This granularity allows us to compare borrowing costs from NBFIs and banks under varying market conditions and to assess whether NBFIs substitute for, or complement traditional bank intermediation.

We supplement the SMMD with market-based measures of interest rate expectations from short-term interest rate swaps and long-term inflation expectations from long-tenor inflation linked swaps. This lets the study capture both front-end yield curve movements, which are most relevant for money market and investment funds, and long-duration real yield effects, which matter more for pension funds and insurers, thus providing a proxy

between cash-lending NBFIs and cash-borrowing clients.

³This also includes very short maturities such as tomorrow and next day.

⁴We choose this sample period to ensure consistent regulatory reporting following the introduction of the UK leverage ratio framework in 2018 (Bank of England, 2018), and to span a complete monetary policy cycle, from easing (2018-2022) to the peak of monetary tightening in 2024.

for changes in long-term real yields and the associated mark-to-market dynamics. For additional robustness, we augment the analysis with high-frequency monetary policy factors from the UK Monetary Policy Event-Study Database (Braun et al., 2024).

We document that, outside the centrally cleared segment, where the majority of interbank trading occurs, NBFIs account for most of the transaction volume and counterparty relationships. Between 2018 and 2024, average weekly transaction volumes involving NBFIs reached £18.7bn, six to twelve times higher than volumes observed in the bilateral interbank market.⁵ These differences should not be interpreted as evidence that aggregate repo borrowing by banks increased over time; rather, they highlight the central role of NBFIs as funding counterparties in the overnight uncleared segment. This is reflected in the structure of banks' funding relationships: the number of NBFI counterparties engaged by banks more than doubled over the sample period, rising from just over 200 in 2018 to more than 400 by 2024, while the number of bank counterparties remained stable at around 100. The average number of NBFI counterparties per bank increased from 11 to over 16, whereas the corresponding figure for bank counterparties declined from 8 to 5.

We construct a simple relative pricing measure, the Spread-of-Spread (SoS), to isolate the pricing differential between NBFI and interbank funding by netting out borrower-specific credit risk. We find that NBFI funding was cheaper than interbank funding prior to 2022 (-7 basis points on average) but became more expensive and volatile thereafter (averaging +10 basis points), particularly from investment funds, insurers, and pension funds.

To study the drivers of the SoS, we focus on both short and long-term market-based measures of interest rate expectations using swap rates. We document two mechanisms through which interest-rate expectations affect the linkage between banks and NBFIs. First, an *opportunity-cost* channel in which increases in short-term swap rates (one-year tenor) prompt investment funds, insurers, and pension funds to pass higher overnight liquidity costs on to banks, exceeding those transmitted through the traditional interbank channel. As short-term swap rates raise, these NBFI sectors demand a higher price to supply overnight repo liquidity. Second, we show that a balance-sheet constraint mechanism from the intermediary asset-pricing literature becomes economically relevant in overnight bank–NBFI repo when NBFIs act as the funding providers. Higher expected

⁵The comparison is based on bilateral repo transactions and therefore excludes centrally cleared interdealer activity.

long-term rates raise the shadow cost of balance sheets by inducing mark-to-market losses on long-duration assets, tightening leverage constraints, and amplifying margin-call pressures across NBFIs. When these constraints bind, NBFIs' capacity to supply liquidity to banks becomes less elastic, leading to higher volatility and persistence in the SoS, with heterogeneous effects across NBFIs sectors. In this setting, balance-sheet shocks propagate through volatility and directly affect the cost at which banks can obtain overnight funding from non-bank intermediaries.

This paper contributes to the literature on secured short-term lending and NBFIs intermediation by providing the first systematic analysis of bilateral repo funding from NBFIs to banks. Unlike prior studies that focus on central clearing counterparty (CCP) activity or portray NBFIs primarily as liquidity recipients (Copeland et al., 2014; Gorton and Metrick, 2012; Krishnamurthy et al., 2014), we examine the reverse channel: banks bilaterally borrowing from NBFIs as one of the funding options available to them, when balance-sheet usage at the dealer or treasury level becomes relatively costly at the margin, and where repo desks intermediate client flows through matched-book activities. This extends the intermediary asset-pricing literature linking dealer balance-sheet constraints to asset risk premia (He and Krishnamurthy, 2013; Du et al., 2022).

We show that NBFIs act as passive cash suppliers in normal times, but become price-sensitive and withdraw when dealer balance sheets tighten. These dynamics shape both the level and volatility of secured bank funding costs, with broader implications for market structure, resilience, and systemic risk. We do not study default risk or collateral quality (Boissel et al., 2017; Coen and Hüser, 2024); instead, we focus on how interest-rate expectations affect the willingness of NBFIs to supply overnight liquidity. By documenting these mechanisms, these findings also lay the groundwork for future studies on the complementarity and substitutability between NBFIs and banks in the provision of liquidity (Basel Committee on Banking Supervision, 2016).

The remainder of the paper is organised as follows. Section 2 reviews the related literature. Section 3 details the dataset we construct. Section 4 presents descriptive evidence on the market structure and participation. Section 5 examines funding cost differentials in repo markets through repo spreads and by introducing the SoS metric. Section 6 outlines the empirical strategy and presents the results. Section 7 concludes.

2. Related literature

Research focusing on short-term secured funding markets has traditionally focused on the functioning of repo markets for the interbank market and more recently on the evolving role of NBFIs in liquidity intermediation. A large body of work examines tri-party and centrally cleared repo segments, documenting how these markets transmit shocks and shape systemic resilience. During the GFC, U.S. tri-party repo proved relatively stable, though funding conditions tightened unevenly across collateral classes and heightened counterparty and valuation uncertainty amplified stress (Copeland et al., 2014; Gorton and Metrick, 2012; Krishnamurthy et al., 2014).

Subsequent studies extend these insights to the UK and euro area, showing that stress episodes, such as the COVID-19 shock, widened bilateral repo spreads for non-bank counterparties and shifted activity toward central clearing (Hüser et al., 2024). Collateral scarcity and demand pressures have been shown to impair market functioning (Coen and Hüser, 2024), while CCP-based segments generally remained resilient, with stable lending volumes during periods of turmoil (Mancini et al., 2016). Yet, crises such as the euro-area sovereign debt episode reveal that CCP-cleared markets can still exhibit stress-sensitive pricing, as investors demanded compensation for heightened sovereign and counterparty risk (Boissel et al., 2017).

A related strand studies how asset-purchase programmes and collateral scarcity shape repo pricing. Evidence from the ECB's Public Sector Purchase Programme (PSPP) shows that central bank purchases reduce repo rates, consistent with safe-asset scarcity effects and increased dispersion of rates below the policy floor (Arrata et al., 2020). These findings connect to broader work showing how quantitative easing, collateral segmentation, and specialness premia affect secured funding markets (Jank et al., 2022; Duffie, 1996; Ballensiefen et al., 2023). However, this literature largely focuses on tri-party or centrally cleared markets and primarily examines pricing levels rather than volatility. Evidence on bilateral repo remains comparatively limited, and little is known about lender-specific pricing differentials or state-dependent volatility dynamics.

A complementary literature emphasises how dealer balance-sheet constraints shape secured funding markets and broader asset pricing. Intermediary asset-pricing models link constraints on intermediary capital to variation in risk premia (He and Krishnamurthy,

2013; Du et al., 2022), while recent empirical work shows that tighter dealer balance sheets impair treasury and repo market functioning, raising spreads and increasing fragility (Duffie, 2023a; Duffie, 2023b; Chabot et al., 2024; Stein, 2024). Relatedly, constraints on the supply of safe and liquid balance-sheet capacity can also arise from the liability side of intermediaries. In particular, reserve scarcity has been associated with stress in U.S. money and repo markets, amplifying rate volatility and disrupting funding conditions (Copeland et al., 2021). Although these studies highlight the centrality of intermediary constraints, they focus primarily on dealer capacity rather than the behaviour of NBFIs as marginal liquidity providers.

Parallel contributions examine the expanding role of NBFIs in financial intermediation. Empirical work documents the sector’s rapid growth and its implications for market stability, monetary policy transmission, and the shifting boundary between regulated and less-regulated intermediation (Aramonte et al., 2021; Financial Stability Board, 2024). Regulatory reforms following the GFC reshaped banks’ balance-sheet capacity (Acharya et al., 2024; Acharya et al., 2013). As a consequence, NBFIs became more active in market-making and liquidity provision. (Duffie, 2023a; Metrick and Tarullo, 2022). Theoretical work models how regulation and backstops shape competition between banks and NBFIs (Harris et al., 2014) and highlights the systemic implications of shifting intermediation to less-regulated entities (Plantin, 2015). Yet, despite these advances, the literature provides little evidence on the conditions under which NBFIs act as liquidity suppliers to banks, particularly in bilateral repo markets where transactions are conducted without central clearing or tri-party intermediation and are, instead, negotiated directly between counterparties where their behaviour is most flexible.

Bringing these strands together, existing research has not yet examined the reverse channel in which banks bilaterally borrow from NBFIs. The intermediary asset-pricing literature shows that dealer balance-sheet constraints elevate risk premia, but it does not model how NBFIs respond when they are the marginal funding providers, nor how their supply elasticity varies across market states. This paper fills these gaps by providing the first systematic analysis of bilateral repo funding from NBFIs to banks.

3. Data

We leverage the Sterling Money Market Data (SMMD),⁶ a unique and proprietary transaction-level repository collected by the Bank of England. The SMMD provides comprehensive coverage of secured and unsecured money market transactions conducted by institutions representing approximately 95% of UK banking activity by volume. Data are collected daily on each business day from 2016 onwards under the Bank of England’s Sterling Money Market Framework, ensuring regulatory consistency and high reporting quality.

This analysis focuses on secured overnight bilateral gilt repo,⁷ the most informationally rich segment of the UK money market. These transactions are collateralised by UK government bonds (with currency denominated in pound sterling) and are conducted bilaterally, without central clearing.⁸ The sample spans from 1 July 2018 to 31 December 2024, covering 1,645 trading days and comprising 336,715 individual transactions with complete contract-level detail.⁹ The aggregate transaction volume over the sample period amounts to £35.34tn,¹⁰ covering transactions reported by UK banks with both global banks and global NBFIs, including money-market funds (MMFs), investment funds (IFs),¹¹ insurance corporations (ICs), and pension funds (PFs).¹² To examine the drivers of SoS, we also partition the sample into two sub-periods: a pre-tightening phase (July 2018–December 2021) and a post-tightening phase (January 2022–December 2024). This split allows us to assess how changes in the interest rate environment influence the pricing and volatility of liquidity provision across lender types. We supplement repo data with two additional sources of market information. First, we incorporate market-based measures

⁶Information on SMMD data collection is available at the following [link](#).

⁷See Appendix A.1 for the definition and scope.

⁸The dataset distinguishes between general collateral (GC) and gilt-specific (special) collateral. Consistent with UK Securities Financing Transactions Regulation (SFTR) data, we find that approximately 90% of trades are secured against special collateral. Accordingly, we focus the analysis on transactions backed by special collateral.

⁹The sample period (2018–2024) aligns with the post-leverage-ratio reporting regime (Bank of England, 2018) and captures a complete monetary policy cycle up to the peak of tightening.

¹⁰The regulatory oversight underpinning the SMMD ensures comprehensive market coverage and high data integrity. These features mitigate concerns related to selection or survivor bias and position the dataset as a reliable foundation for this study.

¹¹Investment funds category includes hedge funds.

¹²Although confidentiality requirements prevent disclosure of the exact number of reporting institutions, the sample encompasses a sufficiently large and representative set of counterparties to support robust empirical analysis. Appendix A.2 offers detailed descriptions of the business models associated with each NBFi category active in the repo market.

of interest rate expectations derived from short-term interest rate swaps (IRS_{1Y}) and long-term inflation expectations obtained from inflation-linked swaps (ILS_{30Y}). Second, we augment the dataset with high-frequency monetary policy factors from the UK Monetary Policy Event-Study Database (Braun et al., 2024). These factors, *Target* (current policy rate surprises), *Path* (revisions to the expected future policy path), and *QE* (asset-purchase announcements), capture the market reaction to policy decisions at different maturities. We align policy events with corresponding calendar weeks, averaging repo variables weekly while aggregating surprises over the 30-minute announcement window.¹³

4. Descriptive evidence

We begin this section with a descriptive analysis of bank and NBFIs transaction volume and counterparties. The UK bilateral overnight repo market exhibits a pronounced asymmetry in the composition and evolution of the transaction volume between banks and NBFIs (Figure 1). Bank-to-bank transactions remain relatively limited throughout the sample period, with weekly volumes ranging from £0.5bn to £3.9bn and a sample mean of £1.8bn.¹⁴ In contrast, NBFIs-bank activity is both larger in scale and more volatile, with weekly volumes spanning £10.4bn to £29.6bn and averaging £19.7bn.¹⁵

The time series of NBFIs-to-bank repo volumes reveals three distinct phases. First, from mid-2018 to early 2021, volumes exhibit a steady upward trajectory, rising from approximately £12bn to £20bn per week. Second, the period spanning 2021 to 2022 is characterised by persistently high volumes and episodic spikes, coinciding with the aftermath of the March 2020 Covid-19 market dislocation and the September 2022 liability-driven investment (LDI) episode. Third, from late 2022 through 2024, activity remains elevated and volatile, consistent with sustained balance sheet-driven demand for secured short-term funding from banks. This persists in an environment characterised by ample reserves and episodes of collateral scarcity, while dealers continue to fund primarily through centrally cleared interdealer markets, indicating that these dynamics are specific to the bilateral segment rather than reflective of aggregate bank funding conditions. For

¹³Non-event weeks are assigned zero values, and multiple announcements within a week are summed to create a balanced weekly impact study.

¹⁴Detail on bank-to-bank liquidity provision are documented in Appendix A.3, Figure 6.

¹⁵Summary statistics are reported in Appendix A.4, Table 5.

completeness, we also plot the reverse leg of this market¹⁶, where banks act as cash lenders. We find that NBF-to-bank reverse repo activity is limited, meaning a lack of material netting between borrowing and lending flows. This corroborates our finding that, in this market, banks are net recipients of liquidity from NBFIs.

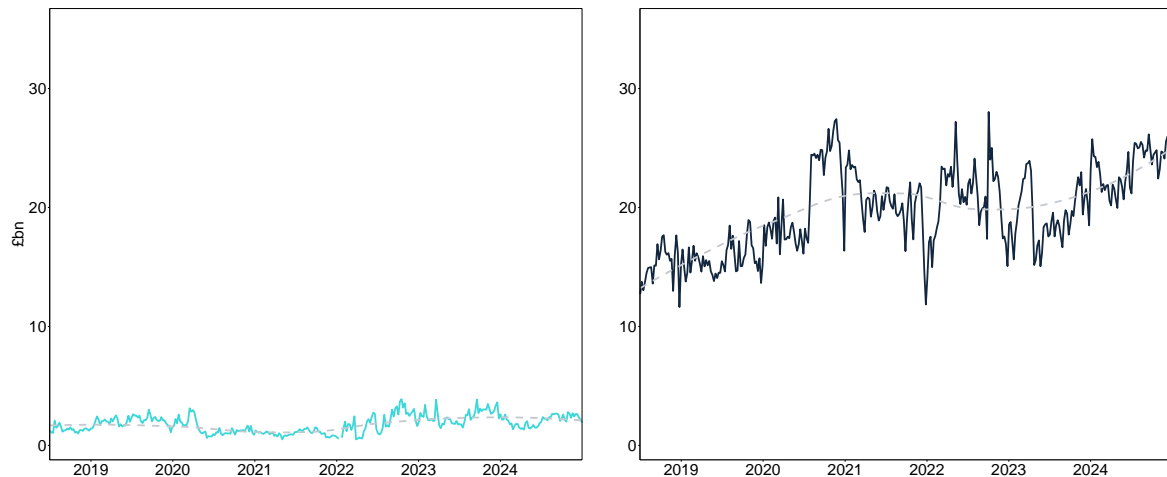


Figure 1. Weekly repo transaction volume (bank-to-bank vs NBF-to-bank)

Notes: This figure presents the transaction volume trends from July 2018 to December 2024. The left panel displays bank-to-bank transactions (cyan line), while the right panel shows NBFIs lending to banks (dark blue line). Volumes are expressed in billions of pounds sterling and averaged on a weekly basis.

Source: Bank of England Sterling Money Market Data.

To assess how bilateral relationships within the repo market have evolved over time, we analyse both the total number of individual counterparties and the average number of counterparties per bank, two measures that jointly capture the breadth and density of interaction networks across the system. These indicators allow us to track not only the expansion or contraction in the set of institutions with which banks engage, but also the intensity and diversification of these interactions, thereby offering a clearer view of how the structure of the market has changed (Figure 2).

Data reveal a marked and persistent divergence in connectivity patterns between banks and NBFIs. The number of NBF counterparty with which banks transact rises steadily throughout the sample period, increasing from just over 200 in 2018 to more than 400 by the end of 2024, a doubling in counterparties that points to a substantial broadening of banks’ engagement with NBFIs. In contrast, the number of bank-to-bank counterparties remains broadly unchanged, fluctuating around 100 and indicating a comparatively stable

¹⁶Appendix A.5, Figure 7.

interbank interaction structure. A similar divergence emerges when examining the average number of counterparties per bank: while the average number of NBFIs counterparties increases from 11 to more than 16, the corresponding figure for bank counterparties declines from 8 to 5 over the same period.

This pattern highlights an increasing connectivity with NBFIs as counterparties within the bilateral segment, and a corresponding reduction in the density of traditional interbank connections in this market. Importantly, this should be understood as a reconfiguration of relationships within bilateral trading, rather than as evidence of a broader reliance on NBFIs for bank funding.

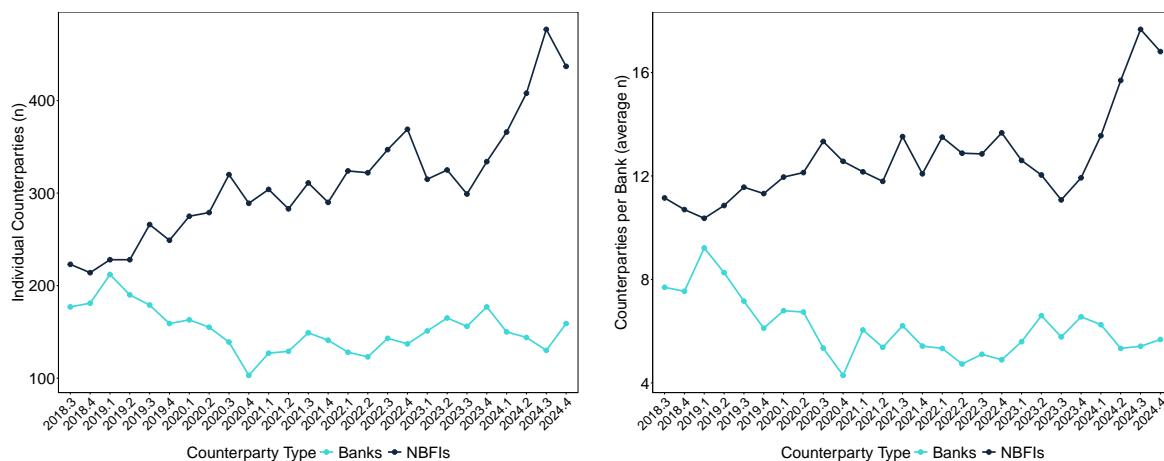


Figure 2. Bilateral interaction structure (bank-to-bank vs NBFIs-to-bank)

Notes: The left panel shows the number of individual counterparties (n) for banks (cyan) and NBFIs (dark blue) in the UK gilt repo market from July 2018 to December 2024. The right panel reports the average number of counterparties per bank, again distinguishing between banks and NBFIs. Data are averaged on a quarterly basis. Source: Bank of England Sterling Money Market Data.

NBFI participation remains stable over the sample, with no major shifts in the lending composition (Figure 3). MMFs expand from £3.1bn in early 2018 to £17.8bn in 2024, highlighting their importance as liquidity providers. IFs fluctuate between £4.3bn and £13.3bn, reflecting their mix of routine cash management and more active, sometimes leveraged, strategies. Insurers follow an inverted-U pattern, building up to a peak around 2021, while pension funds retreat from the market following the LDI-crisis episode.

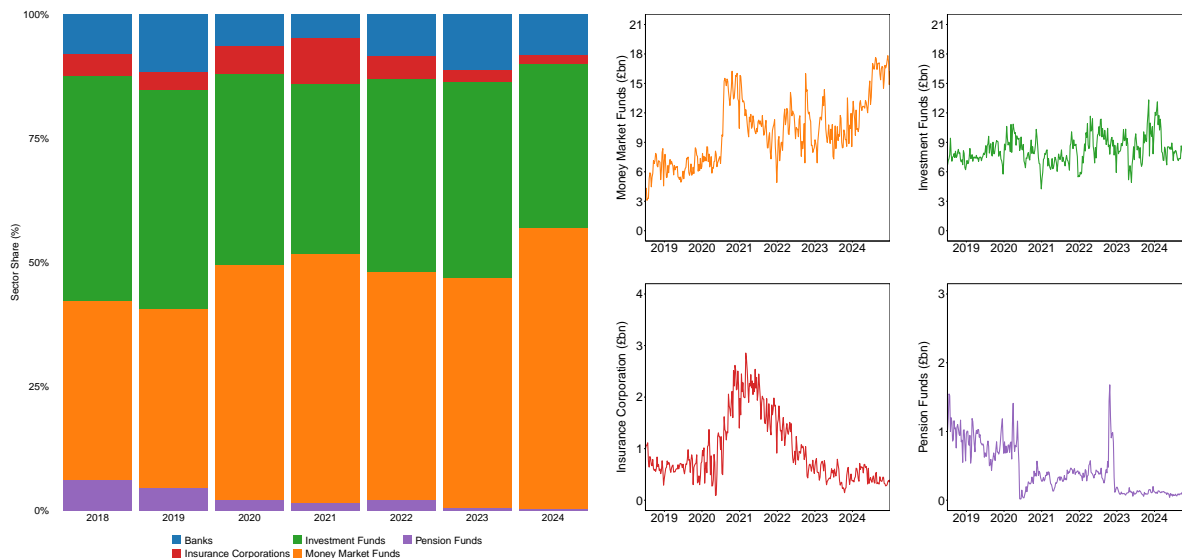


Figure 3. Sectors market share trend

Notes: The left panel shows the annual percentage composition of total repo volumes by NBF sector. The right panel shows the weekly trend of volumes by NBF sector. Source: Bank of England Sterling Money Market Data.

5. Funding cost differentials

This section focuses on repo spreads and subsequently introduces the SoS to analyse differences in funding costs between banks and NBFIs.

5.1. Repo spreads

Consistent with Hüser et al., 2024, we define the *repo spread* as the deviation between the volume-weighted average repo rate and the Bank of England policy rate (*Bank rate*), computed at both aggregate and sectoral levels. This helps us capture variations in market liquidity conditions and funding stress (Figure 4).

From 2018 to early 2020, the *repo spread* remained near zero, indicating ample liquidity and low funding stress. The *repo spread* rose during the March 2020 COVID-19 turmoil, reflecting increased demand for liquidity and risk aversion. Subsequently, it turned negative with troughs in late 2022 in the aftermath of the 2022 UK LDI crisis.¹⁷

¹⁷Appendix A.6, Table 6 provides details on the sectoral statistics.

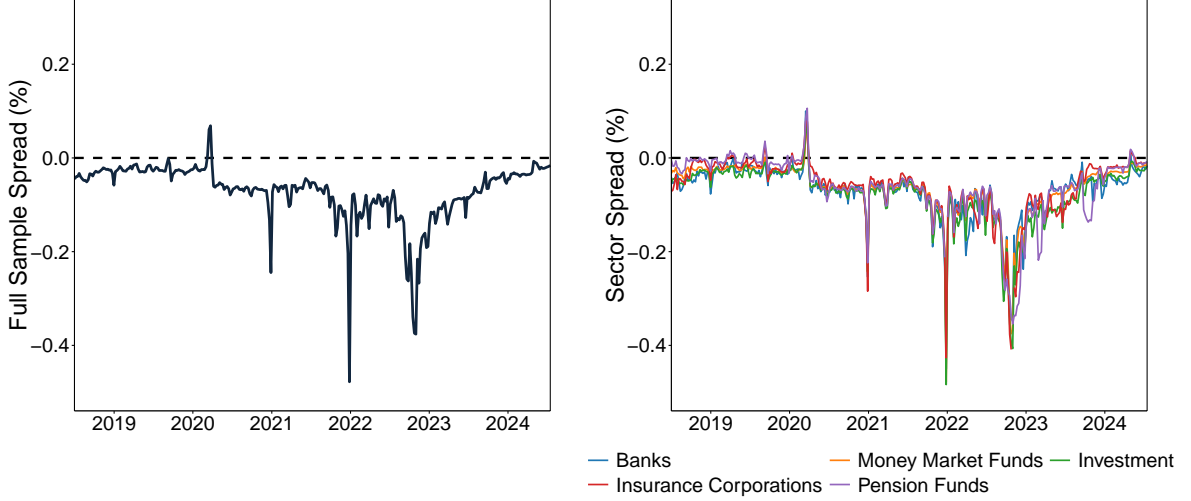


Figure 4. Weekly average repo spread

Notes: This figure displays the *repo spread* at aggregate level (left panel) and at NBFIs sectoral level (right panel) from July 2018 to December 2024. This represents the volume-weighted cost of repo transactions. In this study, the (volume-weighted) repo spread is the overnight (volume-weighted) repo rate minus the Bank Rate. Data are averaged on a weekly basis. Source: Bank of England Sterling Money Market Data.

5.2. Spread-of-Spread

We build on this literature by computing a simple metric that quantifies the relative cost of NBFIs liquidity provision versus traditional interbank lending.

This metric, which we refer to SoS calculates the sector-specific *premium* (or *discount*) banks pay when borrowing from NBFIs relative to other banks. Formally, we compute the SoS as the difference between NBFIs-to-bank and bank-to-bank repo spreads over the risk-free rate proxied by the Bank of England policy rate:

$$\text{SoS}_t^{(s)} = \underbrace{(R_t^{\text{NBFIs},(s)} - r_t^{\text{BoE}})}_{\text{NBFIs Repo Spread}} - \underbrace{(R_t^{\text{Bank}} - r_t^{\text{BoE}})}_{\text{Bank Repo Spread}}, \quad (1)$$

where $R_t^{\text{NBFIs},(s)}$ and r_t^{BoE} denote the volume-weighted average rates at which each NBFIs and bank, respectively, lend to banks, and r_t^{BoE} is the prevailing Bank of England policy rate. By simplifying the common term (r_t^{BoE}) present in both repo spread components, Equation (1) reduces to Equation (2), which expresses the $\text{SoS}_t^{(s)}$ as the differential between the repo rates of NBFIs and banks.

$$\text{SoS}_t^{(s)} = R_t^{\text{NBFIs},(s)} - R_t^{\text{Bank}} \quad (2)$$

This metric “nets out” the borrowing banking sector’s credit risk by comparing the spreads faced by the same borrower type when obtaining funding from two distinct lender types, NBFIs and bank lenders. A positive (*negative*) SoS indicates that banks pay a higher (*lower*) premium to source funds from a given NBFI than from other banks. An SoS value equal to or near zero indicates no cost difference for a bank to borrow from another bank versus NBFIs (Table 1).

Signal from $\text{SoS}_t^{(s)}$	Interpretation
$\text{SoS}_t^{(s)} > 0$	<i>Premium.</i> Banks pay a higher premium to borrow from NBFIs than from other banks.
$\text{SoS}_t^{(s)} < 0$	<i>Discount.</i> Banks pay a lower premium to borrow from NBFIs than from other banks.
$\text{SoS}_t^{(s)} \approx 0$	<i>Equilibrium.</i> No relative difference.

Table 1. Economic interpretation of the SoS.

To assess changes in the SoS metric over time, we plot its evolution across our sample period (Figure 5). Prior to 2022, the SoS is relatively stable and, on average, significantly negative (around -7 bps), indicating that banks were typically able to borrow from NBFIs at lower rates than in the interbank market. During 2022–23, however, the SoS becomes markedly more volatile and shifts sharply upwards, reaching an average of around 10 bps. This is consistent with a period of ample reserves and, heightened collateral scarcity, implying that the increase in the SoS might not be driven by aggregate liquidity shortages but by conditions specific to the bilateral repo market. By 2024, the SoS moves closer to its pre-2022 range, suggesting a partial normalisation following this period of stress. This descriptive evidence points to a pronounced but potentially transitory increase in the relative cost of NBFI-provided liquidity during 2022–23, consistent with heightened uncertainty, changing risk perceptions, and tighter funding conditions associated with the rapid tightening of monetary policy.¹⁸

¹⁸Following the heightened volatility observed after 2022, Appendix A.7 illustrates the widening of the SoS distribution across NBFI sectors, most notably among investment funds and insurance companies, highlighting increased heterogeneity in liquidity pricing relative to earlier years.

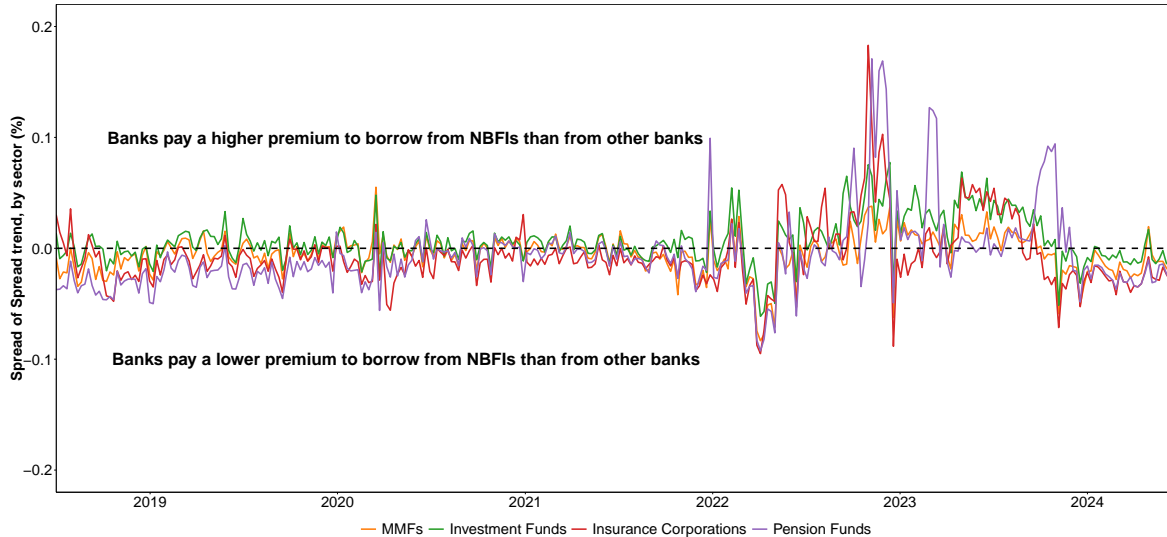


Figure 5. Weekly average Spread-of-Spread by NBF sector

Notes: This figure displays the evolution of SoS measures for each NBF sector relative to banks July 2018 to December 2024. An $\text{SoS}_t^{(s)} > 0$ indicates that banks pay more to borrow from NBFIs; negative values indicate the reverse. Data are averaged weekly. Source: Bank of England Sterling Money Market Data.

6. What drives changes to the SoS?

In this section we propose two distinct mechanisms to explain the dynamics of the SoS over time. First, an *opportunity-cost channel*, in which NBFIs adjust repo premia in line with changes in the returns on alternative safe, liquid assets. Second, a *balance-sheet constraint channel*, where rising swap rates might constrain NBF balance-sheet capacity in providing liquidity to banks.

6.1. Opportunity-cost channel

The *opportunity-cost* channel implies that NBFIs compare the return of their liquidity provision to banks versus the yield they would receive on alternative safe, liquid assets. When front-end rates rise, outside options become more attractive, and NBFIs have incentives to demand higher repo rates.

In a frictionless environment with flexible balance-sheets and smoothly clearing markets, the SoS should therefore increase short-term rates, with sectoral heterogeneity driven purely by liability horizons and asset duration. This mechanism relies on limited substitutability between non-banks and interbank funding. In practice, interbank markets are relatively

concentrated and relationship-based, so banks cannot seamlessly replace funding from a broad set of NBFIs with cheaper bank-to-bank borrowing. As a result, even when repo rates rise above interbank benchmarks, banks may accept higher funding costs, allowing the opportunity-cost channel to operate.

Notably, NBFIs will differ as a function of their liquidity needs, the maturity and risk profile of their portfolios, and their access to alternative safe assets. These differences determine the sensitivity of their funding supply to changes in front-end rates, and thus the extent to which they demand higher repo rates when outside yields rise. MMFs operate with near-zero duration assets and tight regulatory constraints; PFs and ICs hold large quantities of long-duration gilts; and IFs manage heterogeneous portfolios spanning cash buffers to riskier securities. These differences generate a natural laboratory to examine whether realised sensitivities across sectors match the frictionless predictions of the *opportunity-cost* channel.

6.1.1. Model specification

To proxy the *opportunity-cost* of supplying short-term liquidity, we use the one-year interest rate swap rate (IRS_{1Y}), which captures movements in the front end of the yield curve most relevant for short-horizon asset allocation. To capture long-duration real-yield effects particularly relevant for PFs and ICs, we use the thirty-year inflation-linked swap rate (ILS_{30Y}), which proxies changes in long-term real yields and associated mark-to-market dynamics. We use swap rates rather than nominal rates, as the latter do not reflect market expectations and move in a largely mechanical way.

To assess the relationship between swap rates and the SoS, we employ a series of Ordinary Least Squares (OLS) regression models estimated separately for each NBFIs sector (s). The model specification takes the following form:

$$\text{SoS}_{s,t} = \alpha_s + \beta_{1,s} IRS_{1y,t} + \beta_{2,s} ILS_{30y,t} + \varepsilon_{s,t}, \quad (3)$$

where $\text{SoS}_{s,t}$ denotes the SoS for each NBFIs sector s at time t as the dependent variable. The explanatory variables consist of two principal interest rate measures: $IRS_{1y,t}$, the one-year interest rate swap rate and the $ILS_{30y,t}$, the inflation linked swap rate with maturity

of thirty years. The coefficients $\beta_{1,s}$ and $\beta_{2,s}$ quantify the sensitivity of the SoS to each rate, while α_s accounts for sector-specific, time-invariant factors. The error term $\varepsilon_{s,t}$ is assumed to be zero mean and uncorrelated with the regressors. Identification relies on the fact that different NBFIs hold different asset durations and manage liquidity using different horizons: MMFs should load primarily on short-term rates; PFs and ICs should react to long real rates; IFs sit between these extremes.

To examine the pronounced break visible in Figure 5, we also estimate equation (3) separately for the pre-2022 and post-2022 periods:

$$\text{SoS}_{s,t}^{(k)} = \alpha_s^{(k)} + \beta_{1,s}^{(k)} \text{IRS}_{1Y,t} + \beta_{2,s}^{(k)} \text{ILS}_{30Y,t} + \varepsilon_{s,t}^{(k)}, \quad k \in \{\text{pre-2022, post-2022}\}, \quad (4)$$

6.1.2. Results

We find supportive evidence for the *opportunity-cost* channel, but also heterogeneity across NBFIs that aligns with balance-sheet structure (Table 2).¹⁹ Front-end swap rates IRS_{1Y} load positively for IFs, PFs, and ICs, with statistically significant coefficients at the 1% level in both univariate and joint specifications. Economically, a 1% increase in IRS_{1Y} raises SoS by roughly 0.3 bps for IFs, 0.5 bps for PFs, and 0.3 bps for ICs. MMFs display weaker sensitivity in the univariate specification, but become marginally sensitive when long-term rates are controlled for.

These patterns are consistent with the *opportunity-cost* mechanism: higher short-term yields increase outside options for supplying liquidity, and NBFIs pass through these opportunity-costs by demanding higher repo rates.²⁰

Responses to ILS_{30Y} show stronger heterogeneity. MMFs load significantly and negatively on long real rates. This correlation should not be interpreted as reflecting direct duration exposure, since MMFs predominantly hold short-maturity assets, but rather as capturing the broader monetary and financial conditions associated with increases in long real rates. Periods of rising long rates typically coincide with tighter monetary policy, higher

¹⁹The robustness checks of the baseline empirical results of this section are reported in Appendix A.8 and support the stability of our findings.

²⁰As a robustness check we estimate the baseline specification for the banking sector, where the dependent variable BankSpread_t , is the deviation between the volume-weighted average rate bank charges to banks and the ‘Bank rate’. The results (Appendix A.8, Table 11) support the *opportunity-cost* channel: banks do not pass higher costs through when lending to other banks.

opportunity costs of liquidity, and greater balance-sheet constraints for MMF sponsors, all of which can reduce MMFs’ willingness to provide liquidity to banks and compress the SoS. PFs also exhibit negative long-rate loadings, though smaller in magnitude. IFs and ICs show no meaningful sensitivity.

	MMFs			Investment Funds			Pension Funds			Insurance Corporations		
	IRS _{1y,t}	ILS _{30y,t}	All	IRS _{1y,t}	ILS _{30y,t}	All	IRS _{1y,t}	ILS _{30y,t}	All	IRS _{1y,t}	ILS _{30y,t}	All
Intercept	-0.006*** (0.001)	0.069*** (0.015)	0.070*** (0.015)	-0.001 (0.002)	0.007 (0.018)	0.011 (0.017)	-0.018*** (0.003)	0.045 (0.030)	0.050* (0.029)	-0.015*** (0.002)	-0.006 (0.026)	-0.003 (0.025)
IRS _{1y,t}	0.001 (0.000)		0.001* (0.000)	0.003*** (0.001)		0.003*** (0.001)	0.005*** (0.001)		0.005*** (0.001)	0.003*** (0.001)		0.003*** (0.001)
ILS _{30y,t}		-0.022*** (0.005)	-0.023*** (0.005)		-0.000 (0.005)	-0.004 (0.005)		-0.016 (0.009)	-0.021* (0.009)		-0.001 (0.008)	-0.004 (0.008)
R-squared	0.007	0.066	0.078	0.107	0.000	0.108	0.079	0.009	0.094	0.046	0.000	0.047
Adj. R-squared	0.004	0.063	0.073	0.104	-0.003	0.103	0.076	0.006	0.089	0.043	-0.003	0.041
Residual Std. Error	0.018	0.017	0.017	0.019	0.020	0.019	0.032	0.034	0.032	0.028	0.029	0.028
Observations	340	340	340	340	340	340	340	340	340	340	340	340

Table 2. Sectoral regression results

Notes: The dependent variable is the sectoral SoS. The column labelled “All” includes both IRS_{1y,t} and ILS_{30y,t} as independent variables. Standard errors are reported in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data.

The results from the pre- and post-monetary tightening phases indicate that the supply elasticity of NBFIs funding is state-dependent (Table 3). NBFIs act as passive liquidity providers during easing regimes but become highly price sensitive, and at times withdraw liquidity, during tightening regimes. Long real rate effects remain heterogeneous: MMFs exhibit stronger negative loadings post-2022, PFs lose significance, and IFs and ICs remain largely insensitive.

One potential concern is that movements in swap rates may partly reflect embedded monetary policy expectations rather than shifts in funding conditions. To address this issue, we augment the baseline specification with high-frequency monetary policy factors following Braun et al., 2024. The inclusion of these factors has no material effect: they are statistically insignificant across all NBFIs sectors (see Appendix A.9 for details). Our results confirm that the explanatory power of swap rates is not driven by omitted policy signalling.

Although the full-sample estimates are consistent with an opportunity-cost channel, the subsample evidence is more nuanced. In the pre-2022 period, the joint specifications produce negative coefficients for all sectors, with significant effects for MMFs, ICs, and PFs, whereas a positive short-rate pass-through is observed primarily after 2022.

These findings are difficult to reconcile with a simple opportunity-cost mechanism alone and are more consistent with a *balance-sheet constraint* channel, whereby monetary

tightening reduces the balance-sheet capacity of NBFIs and raises the shadow cost of supplying liquidity.

	MMFs (Pre-2022)			MMFs (Post-2022)		
	IRS _{1y,t}	ILS _{30y,t}	All	IRS _{1y,t}	ILS _{30y,t}	All
Intercept	0.002 (0.001)	0.056*** (0.013)	0.034* (0.015)	-0.035*** (0.006)	0.105** (0.036)	-0.005 (0.045)
IRS _{1Y,t}	-0.011*** (0.002)		-0.007* (0.003)	0.007*** (0.001)		0.007*** (0.002)
ILS _{30Y,t}		-0.018*** (0.004)	-0.011* (0.005)		-0.033** (0.011)	-0.008 (0.012)
R-squared	0.122	0.114	0.144	0.142	0.056	0.144
Adj. R-squared	0.117	0.109	0.135	0.136	0.050	0.133
Residual Std. Error	0.012	0.012	0.012	0.020	0.021	0.021
Observations	183	183	183	157	157	157
	Investment Funds (Pre-2022)			Investment Funds (Post-2022)		
	IRS _{1y,t}	ILS _{30y,t}	All	IRS _{1y,t}	ILS _{30y,t}	All
Intercept	0.003* (0.001)	0.007 (0.011)	-0.000 (0.014)	-0.020** (0.008)	0.042 (0.045)	-0.116* (0.055)
IRS _{1Y,t}	-0.002 (0.002)		-0.002 (0.003)	0.007*** (0.002)		0.009*** (0.002)
ILS _{30Y,t}		-0.002 (0.003)	0.001 (0.004)		-0.009 (0.014)	0.026 (0.015)
R-squared	0.006	0.001	0.006	0.106	0.003	0.124
Adj. R-squared	0.001	-0.004	-0.005	0.101	-0.003	0.113
Residual Std. Error	0.011	0.011	0.011	0.025	0.027	0.025
Observations	183	183	183	157	157	157
	Insurance Corporations (Pre-2022)			Insurance Corporations (Post-2022)		
	IRS _{1y,t}	ILS _{30y,t}	All	IRS _{1y,t}	ILS _{30y,t}	All
Intercept	-0.009*** (0.002)	-0.004 (0.014)	-0.025 (0.018)	-0.038** (0.012)	0.018 (0.067)	-0.155 (0.083)
IRS _{1Y,t}	-0.005* (0.003)		-0.007* (0.003)	0.008** (0.003)		0.010** (0.003)
ILS _{30Y,t}		-0.003 (0.004)	0.005 (0.006)		-0.007 (0.020)	0.032 (0.023)
R-squared	0.022	0.002	0.027	0.056	0.001	0.068
Adj. R-squared	0.017	-0.004	0.016	0.050	-0.006	0.056
Residual Std. Error	0.013	0.014	0.013	0.038	0.040	0.038
Observations	183	183	183	157	157	157
	Pension Funds (Pre-2022)			Pension Funds (Post-2022)		
	IRS _{1y,t}	ILS _{30y,t}	All	IRS _{1y,t}	ILS _{30y,t}	All
Intercept	-0.002 (0.002)	0.044* (0.018)	-0.038 (0.020)	-0.051*** (0.013)	0.102 (0.075)	-0.127 (0.092)
IRS _{1Y,t}	-0.023*** (0.003)		-0.028*** (0.004)	0.012*** (0.003)		0.014*** (0.003)
ILS _{30Y,t}		-0.018** (0.006)	0.012 (0.006)		-0.030 (0.022)	0.021 (0.025)
R-squared	0.255	0.053	0.269	0.099	0.012	0.103
Adj. R-squared	0.251	0.048	0.260	0.093	0.005	0.092
Residual Std. Error	0.015	0.017	0.015	0.042	0.044	0.043
Observations	183	183	183	157	157	157

Table 3. Regression results by NBFi sector (pre-2022 vs post-2022)

Notes: The dependent variable is the SoS for each NBFi. The column labelled “All” includes both IRS_{1y,t} and ILS_{30y,t} as independent variables. Standard errors are reported in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data.

6.2. Balance-sheet constraint channel

The OLS results show that short-term and long-term rates explain a meaningful share of variation in the SoS, with response heterogeneity across NBFIs and a sharp regime shift after 2022. However, these results primarily relate to *levels*. The *opportunity-cost* channel is fundamentally a frictionless mechanism: spreads adjust smoothly to relative yields, and volatility should not display large, persistent swings across market states.

In contrast, the descriptive evidence in Figure 5 shows substantial increases in volatility, clustering of large movements, and heightened persistence during the monetary tightening regime. Such features are more consistent with a *balance-sheet constraint* channel, in which rising rates generate mark-to-market losses on long-duration assets, tighten leverage constraints, amplify margin calls, and reduce the balance-sheet capacity of NBFIs to intermediate repo.

Under this mechanism, shocks propagate through volatility, not only through the conditional mean. Moreover, the extent of volatility persistence should differ across NBFIs according to their duration exposures, liquidity buffers, and balance-sheet flexibility. To evaluate these predictions, we estimate a GARCH model for each sector’s SoS, allowing us to examine whether NBFIs exhibit state-dependent volatility consistent with tightening balance-sheet constraints.

6.2.1. Model specification

To explore this channel, we employ a Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model, as introduced by Engle, 1982 and extended by Bollerslev, 1986. We decompose the SoS process for each sector $s \in \{\text{MMFs, IFs, PFs, ICs}\}$ into a conditional mean and a heteroskedastic innovation term.

The conditional mean is specified as an ARMA(1,1) process augmented with exogenous regressors:

$$\text{SoS}_t^{(s)} = \mu^{(s)} + \phi_1^{(s)} \text{SoS}_{t-1}^{(s)} + \theta_1^{(s)} \epsilon_{t-1}^{(s)} + \boldsymbol{\gamma}^{(s)'} \mathbf{X}_t + \epsilon_t^{(s)}, \quad t = 1, \dots, T, \quad (5)$$

where $\mu^{(s)}$ denotes the intercept (constant term) in the conditional mean equation, $\phi_1^{(s)}$

and $\theta_1^{(s)}$ are the autoregressive and moving average coefficients, respectively, X_t is the vector of exogenous interest-rate variables ($\text{IRS}_{1Y,t}, \text{ILS}_{30Y,t}$), and $\gamma^{(s)}$ is the corresponding vector of coefficients capturing their marginal effects.

Because the specification includes autoregressive dynamics and exogenous regressors, the unconditional mean of the process depends on these parameters as well as on the mean of \mathbf{X}_t . Finally, $\epsilon_t^{(s)}$ is an innovation term with time-varying conditional variance $\sigma_t^{2(s)}$. The innovation process is defined as:

$$\epsilon_t^{(s)} = \sigma_t^{(s)} z_t^{(s)}, \quad z_t^{(s)} \stackrel{iid}{\sim} t_{\nu^{(s)}}(0, 1), \quad (6)$$

The innovation term $z_t^{(s)}$ follows a standardized Student- t distribution with $\nu^{(s)}$ degrees of freedom, where $\nu^{(s)}$ governs tail thickness. Lower values of $\nu^{(s)}$ imply heavier tails, capturing the leptokurtic behaviour often observed in financial spreads. We estimate the model via quasi-maximum likelihood (QML), assuming a conditional Student- t distribution for the innovations.

This approach allows for consistent estimation under general forms of conditional heteroskedasticity and accommodates the excess kurtosis typically observed in financial spreads. The degrees-of-freedom parameter $\nu^{(s)}$ is estimated jointly with the other model parameters and governs the thickness of the conditional tails. The conditional variance follows a GARCH(1,1) process:

$$\sigma_t^{2(s)} = \omega^{(s)} + \alpha^{(s)} \epsilon_{t-1}^{2(s)} + \beta^{(s)} \sigma_{t-1}^{2(s)}, \quad (7)$$

The conditional variance $\sigma_t^{2(s)}$ corresponds to the one-step-ahead expected variance of the innovation:

$$\sigma_t^{2(s)} = \mathbb{E}[\epsilon_t^{2(s)} \mid \mathcal{F}_{t-1}], \quad (8)$$

where \mathcal{F}_{t-1} denotes the information set available at time $t - 1$. As such, the GARCH specification captures the time-varying second moment of the SoS process, allowing past shocks and past volatility to influence current risk conditions.

Subject to the usual parameter restrictions $\omega^{(s)} > 0$, $\alpha^{(s)} \geq 0$, $\beta^{(s)} \geq 0$, and $\alpha^{(s)} + \beta^{(s)} < 1$ we ensure positivity and covariance stationarity. The persistence of volatility shocks is

measured by $\alpha^{(s)} + \beta^{(s)}$, with values near unity indicating highly persistent volatility.

6.2.2. Results

Table 4 reports the full set of parameter estimates.²¹ The results provide strong evidence of a *balance-sheet constraint* channel and significant heterogeneity across NBFIs. Across all sectors, the AR(1) and MA(1) terms are large and highly significant, confirming substantial short-run persistence in the SoS and reinforcing the presence of mean-reverting behaviour.

MMFs and PFs exhibit the strongest autoregressive persistence, consistent with slow-moving balance-sheet adjustments and regulatory constraints that limit rapid changes in liquidity supply. IFs show a stronger MA component, indicating fast absorption of temporary shocks. Importantly, once autoregressive structure and volatility clustering are controlled for, the estimated effects of IRS_{1Y} and ILS_{30Y} in the mean equation become weaker and are generally statistically insignificant across sectors. An exception is the MMF sector, for which the coefficient on IRS_{1Y} remains statistically significant and of similar magnitude to the corresponding OLS estimate.

The parameters exhibit strong cross-sector heterogeneity aligned with liquidity management practices and duration exposure. MMFs and ICs' β is high (0.85–0.91) and α is modest. Volatility shocks decay slowly, which is consistent with slow adjustments in liquidity buffers and regulatory constraints that make MMF cash provision sensitive to market-wide liquidity conditions. PFs show large α (around 0.65) and low β (0.34), indicating that volatility responds sharply to new shocks, consistent with duration-induced losses from rising rates, and high persistence, reflecting slow rebalancing and LDI adjustments. IFs display intermediate values, with both α and β moderate, consistent with flexible portfolios but heterogeneous strategies.

These patterns are precisely what the *balance-sheet constraint* channel predicts: the impact of rate hikes operates not primarily through average spreads but through the persistence and amplification of volatility. All sectors exhibit heavy-tailed residuals, with degrees of freedom ν between 2.8 and 3.9. This indicates a high propensity for large shocks,

²¹The robustness checks of this section are reported in Appendix A.10 and support the stability of our findings.

consistent with sudden liquidity withdrawals, spikes in margin calls, or sharp adjustments in balance-sheet constraints under rising rates. PFs exhibit the heaviest tails, reflecting their exposure to duration-induced losses and the sudden deleveraging episodes observed during the gilt market turmoil.

The GARCH results indicates that NBFIs liquidity provision in overnight bank–NBFI repo is state-dependent. Increases in interest rates raise not only the level of the SoS but also its volatility and persistence, with stronger and more persistent responses among NBFIs sectors facing tighter balance-sheet or regulatory constraints.

These patterns are consistent with the balance-sheet constraint mechanism from the intermediary asset-pricing literature becoming economically relevant when NBFIs act as the marginal funding providers. Higher expected short- and long-term rates raise the shadow cost of balance sheets, tightening leverage constraints and amplifying margin-call pressures, which in turn reduces the elasticity of NBFIs' supply of liquidity to banks. As a result, balance-sheet shocks propagate through volatility and persistence in the SoS, helping to explain why the post-2022 period is characterised not only by higher spreads but also by more volatile and persistent movements.

Parameter	Sector	Estimate	Std. Error	t-stat	Robust SE	Robust t-stat
μ	MMFs	0.0587	0.0296	1.98	0.0288	2.04**
	IFs	0.0003	0.0026	0.12	0.0025	0.13
	ICs	0.0200	0.0407	0.49	0.0364	0.55
	PFs	0.0454	0.0424	1.07	0.0475	0.96
ω	MMFs	0.0000	0.0000	3.89	0.0000	2.58***
	IFs	0.0000	0.0000	1.54	0.0000	1.19
	ICs	0.0000	0.0000	0.68	0.0001	0.11
	PFs	0.0001	0.0000	2.62	0.0000	2.12**
α	MMFs	0.0526	0.0089	5.93	0.0094	5.58***
	IFs	0.2503	0.1359	1.84	0.1406	1.78*
	ICs	0.1185	0.1419	0.83	0.8986	0.13
	PFs	0.6560	0.2353	2.79	0.2340	2.80***
β	MMFs	0.9115	0.0219	41.68	0.0208	43.79***
	IFs	0.6268	0.1724	3.63	0.2218	2.83***
	ICs	0.8484	0.0236	35.88	0.1851	4.58***
	PFs	0.3430	0.1190	2.88	0.1513	2.27**
AR(1)	MMFs	0.9085	0.0386	23.55	0.0494	18.38***
	IFs	0.1795	0.0778	2.31	0.0892	2.01**
	ICs	0.8825	0.0355	24.84	0.1253	7.04***
	PFs	0.9343	0.0382	24.47	0.0784	11.92***
MA(1)	MMFs	-0.6082	0.0797	-7.63	0.1170	-5.20***
	IFs	-0.8141	0.0451	-18.04	0.0516	-15.77***
	ICs	-0.4267	0.0825	-5.17	0.0973	-4.38***
	PFs	-0.5072	0.0720	-7.05	0.0887	-5.72***
IRS _{1Y,t}	MMFs	0.0001	0.0012	0.12	0.0014	0.10
	IFs	-0.0001	0.0001	-1.11	0.0001	-1.15
	ICs	-0.0006	0.0005	-1.04	0.0101	-0.06
	PFs	0.0018	0.0024	0.77	0.0042	0.44
ILS _{30Y,t}	MMFs	-0.0194	0.0090	-2.16	0.0089	-2.18**
	IFs	-0.0001	0.0008	-0.09	0.0008	-0.09
	ICs	-0.0095	0.0120	-0.79	0.0117	-0.82
	PFs	-0.0203	0.0136	-1.50	0.0190	-1.07
$\nu^{(s)}$	MMFs	3.908	0.766	5.10	0.854	4.58***
	IFs	3.839	0.801	4.79	0.762	5.04***
	ICs	3.811	0.159	23.93	4.412	0.86
	PFs	2.899	0.427	6.78	0.588	4.93***

Table 4. GARCH(1,1) results with ARMA(1,1) mean and Student- t errors

Notes: Quasi-maximum likelihood (QML) estimates for ARMA(1,1)–GARCH(1,1) with Student- t innovations. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Parameters: μ (conditional mean); ω (baseline variance); α (shock sensitivity); β (volatility persistence); AR(1), MA(1) (mean dynamics); IRS_{1y,t} and ILS_{30y,t} (external regressors); $\nu^{(s)}$ (shape): Student- t degrees of freedom. Source: Bank of England Sterling Money Market Data.

7. Conclusion

This paper provides the first systematic analysis of overnight bilateral liquidity provision from NBFIs to large UK banks in the gilt repo market.

Using a unique transaction level dataset from the Bank of England (SMMD), we document that, within the bilateral segment, outside central clearing (where most bank-to-bank activity occurs), NBFIs account for most of the transaction volume and counterparty relationships. On average, they supply between six and twelve times more liquidity than the bilateral interbank market. To examine relative pricing, we introduce a simple, yet novel, metric, the spread-of-spread (SoS), which isolates the differential between bank to NBFi and bank to bank repo rates while holding borrower credit risk constant. We show that NBFi funding was, on average, cheaper than interbank alternatives prior to 2022, but became more expensive and volatile during the subsequent tightening cycle, before partially reverting in 2024.

We identify two mechanisms explaining this. First, an *opportunity cost* channel whereby increases in short term rates raise the return on alternative investments, leading NBFIs to demand higher compensation to supply overnight liquidity. Second, a *balance-sheet* constraint channel through which increases in expected long term rates tighten NBFIs' balance sheet capacity via mark to market losses on long duration assets, amplifying leverage constraints and margin pressures. When these constraints bind, NBFIs' supply of liquidity becomes less elastic, resulting in greater volatility and persistence in the SoS, with heterogeneous effects across sectors. In this environment, balance-sheet shocks transmit directly to banks' marginal cost of secured funding in the bilateral market.

The results highlight the growing importance of NBFIs as providers of bilateral bank funding and identify two channels driving variation in this activity. At the same time, these effects are specific to the bilateral market and should not be interpreted as reflecting the whole bank funding conditions, especially given the substantial role of centrally cleared interbank activity. These findings should therefore be interpreted within the institutional context of the UK bilateral gilt repo market and a period characterised by ample reserves and episodes of collateral scarcity. However, as NBFIs increasingly play a central role in bilateral funding markets, incorporating their behaviour into monitoring frameworks, stress testing exercises, and the design of liquidity backstops remains an important area for policy.

References

- Acharya, Nicola Cetorelli, and Bruce Tuckman (2024). *Where do banks end and NBFIs begin?* Tech. rep. National Bureau of Economic Research.
- Acharya, Schnabl, and Suarez (2013). “Securitization without risk transfer”. In: *Journal of Financial Economics* 107.3, pp. 515–536. ISSN: 0304-405X.
- Acharya, Hyun Song Shin, and Tanju Yorulmazer (2011). “Crisis resolution and bank liquidity”. In: *Review of Financial Studies* 24, pp. 2166–2205.
- Afonso, Gara, Anna Kovner, and Antoinette Schoar (Mar. 2010). *Stressed, Not Frozen: The Federal Funds Market in the Financial Crisis*. Staff Report 437. Revised May 2011. Federal Reserve Bank of New York.
- Aramonte, Sirio, Andreas Schrimpf, and Hyun Song Shin (2021). *Non-bank financial intermediaries and financial stability*. BIS Working Paper No. 972. Bank for International Settlements.
- Arrata, William et al. (2020). “The scarcity effect of QE on repo rates: Evidence from the euro area”. In: *Journal of Financial Economics* 137.3, pp. 837–856.
- Ballensiefen, Benedikt, Angelo Ranaldo, and Henning Winterberg (2023). “Money market disconnect”. In: *The Review of Financial Studies*, pp. 4158–4189.
- Bank for International Settlements (July 2025). *Banks’ Interconnections with Non-Bank Financial Intermediaries*. Horizon Scanning Report. Bank for International Settlements.
- Bank of England (2018). *The UK leverage ratio and its impact on repo market functioning*. Bank of England.
- (Sept. 2025). *Enhancing the resilience of the gilt repo market*. Discussion Paper.
- Basel Committee on Banking Supervision (Apr. 2016). *Interest Rate Risk in the Banking Book*. Tech. rep. BCBS 368. Bank for International Settlements.
- Boissel, Charles et al. (2017). “Systemic risk in clearing houses: Evidence from the European repo market”. In: *Journal of Financial Economics* 125.3, pp. 511–536.
- Bollerslev, Tim (1986). “Generalized autoregressive conditional heteroskedasticity”. In: *Journal of Econometrics* 31.3, pp. 307–327.
- Braun, Miranda-Agrippino, and Tuli (July 2024). *Measuring monetary policy in the UK: the UK Monetary Policy Event-Study Database*. Staff Working Paper 1050. Updated

- version of Staff Working Paper originally published 10 November 2023. Bank of England.
- Chabot, Laurent et al. (Sept. 2024). “Dealer Balance Sheet Constraints: Evidence from Dealer Level Data Across Repo Market Segments”. In: *FEDS Notes*.
- Coen, Patrick Coen and Anne-Caroline Hüser (2024). *Collateral demand in wholesale funding markets*. Staff Working Paper 1082. Bank of England.
- Copeland, Duffie, and Yang (2021). “Reserves Were Not So Ample After All”. In: *The Quarterly Journal of Economics* 140.1, pp. 239–281.
- Copeland, Antoine Martin, and Michael Walker (2014). “Repo runs: Evidence from the tri-party repo market”. In: *Journal of Finance* 69.6, pp. 2343–2380.
- Du, Wenxin, Alex Tepper, and Adrien Verdelhan (2022). “Are Intermediary Constraints Priced?” In: *Review of Financial Studies* 36.4, pp. 417–443.
- Duffie, Darrell (1996). “Special repo rates”. In: *The Journal of Finance* 51.2, pp. 493–526.
- (2023a). *Dealer Capacity and U.S. Treasury Market Functionality*. Tech. rep. SR 1070. Federal Reserve Bank of New York.
- (2023b). *Resilience Redux in the U.S. Treasury Market*. Tech. rep. Jackson Hole Conference Paper. Federal Reserve Bank of Kansas City.
- Engle, Robert F. (1982). “Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation”. In: *Econometrica* 50.4, pp. 987–1007.
- Financial Stability Board (2024). *Global Monitoring Report on Non-Bank Financial Intermediation 2024*. Financial Stability Board.
- (2025). *Global Monitoring Report on Non-Bank Financial Intermediation 2025*. Financial Stability Board.
- Gorton, Gary, Toomas Laarits, and Andrew Metrick (2020). “The run on repo and the Fed’s response”. In: *Journal of Financial Stability* 48, p. 100744.
- Gorton, Gary and Andrew Metrick (2012). “Securitized banking and the run on repo”. In: *Journal of Financial Economics* 104.3, pp. 425–451.
- Harris, Michael, Christian Opp, and Markus Opp (2014). “Macroprudential bank capital regulation in a competitive financial system”. SSRN Electronic Journal.
- He, Zhiguo and Arvind Krishnamurthy (2013). “Intermediary Asset Pricing”. In: *American Economic Review* 103.2, pp. 732–770.

- Hüser, Anne-Caroline, Caterina Lepore, and Luitgard Anna Maria Veraart (2024). “How does the repo market behave under stress? Evidence from the COVID-19 crisis”. In: *Journal of Financial Stability* 70, p. 101193. ISSN: 1572-3089.
- Jank, Stephan, Emanuel Moench, and Martin Schneider (2022). “Safe asset shortage and collateral reuse”. In: *SAFE Working Paper No. 355*.
- Krishnamurthy, Arvind, Stefan Nagel, and Dmitry Orlov (2014). “Sizing up repo”. In: *The Journal of Finance* 69.6, pp. 2381–2417.
- Mancini, Lorian, Angelo Ranaldo, and Jan Wrampelmeyer (2016). “The Euro interbank repo market”. In: *Review of Financial Studies* 29.7, pp. 1747–1779.
- Metrick, Andrew and Daniel Tarullo (Jan. 2022). “Congruent Financial Regulation”. In: *Brookings Papers on Economic Activity*.
- Plantin, Guillaume (2015). “Shadow Banking and Bank Capital Regulation”. In: *Review of Financial Studies* 28.1, pp. 146–175.
- Stein, Jeremy C. (2024). *The Effect of Primary Dealer Constraints on Intermediation in the Treasury Market*. Research Department Working Paper 24-15. Federal Reserve Bank of Boston.

A. Appendix

A.1. Definition and scope of the UK bilateral overnight repo market

The overnight bilateral repo market constitutes a core segment of the secured sterling money market, facilitating short-term liquidity redistribution among financial institutions. Transactions are collateralised by UK government bonds (gilts) denominated in sterling and are conducted bilaterally, without the intermediation of a central counterparty. In this setting, the *cash borrower* provides to the *cash lender* in exchange for cash. The transaction is contractually structured as a simultaneous sale and forward repurchase of the same security at a predetermined price and date. At time t , the borrower delivers a gilt with market value g_t to the lender in exchange for a cash amount $V_t \leq g_t$. The transaction matures at $t + 1$ (overnight), at which point the borrower repurchases the gilt by paying:

$$V_{t+1} = V_t(1 + R_t),$$

where R_t denotes the agreed overnight repo rate, assumed to satisfy $R_t \geq 0$. The repo rate is typically benchmarked against the Bank of England's policy rate r_t^{BoE} , and the difference between the two, referred to as the *repo spread*, is given by:

$$\text{repo spread}_t = R_t - r_t^{\text{BoE}}.$$

This spread serves as a market-based indicator of short-term funding conditions and liquidity premia. The bilateral nature of these transactions implies that counterparty credit risk is not mitigated by a central counterparty, rendering the repo spread particularly sensitive to shifts in perceived creditworthiness and market stress. As such, the bilateral segment provides a valuable lens through which to examine the pricing and volatility of secured short-term funding.

A.2. Insitutional setting

Money Market Funds (MMFs). MMFs are key providers of overnight liquidity in the gilt repo market. Their investment mandates prioritise capital preservation and daily liquidity, making overnight repos an attractive instrument for managing cash balances

while minimising credit and duration risk. MMFs typically invest on behalf of a broad client base, including corporates and institutional investors, and are not materially leveraged. During periods of market stress, such as the March 2020 ‘dash for cash’, MMFs’ efforts to maintain liquidity buffers contributed to elevated repo rates and reduced market depth, as they withdrew funding to meet redemption pressures. Their participation is highly sensitive to repo pricing, particularly when risk-adjusted returns on alternative instruments shift.

Investment Funds (IFs). IFs engage in repo transactions both to manage liquidity and to implement investment strategies. While some IFs use repos to finance longer-dated asset holdings, others, particularly hedge funds (HFs), employ repos to obtain leverage and execute arbitrage strategies. These include micro relative value trades (exploiting pricing discrepancies across similar gilts), swap-spread trades (involving offsetting positions in gilts and interest rate swaps), and, to a lesser extent, cash-futures basis trades. Macro strategies based on economic forecasts are also prevalent.

Insurance Corporations and Pension Funds (IC and PFs). ICs and PFs are long-horizon investors that use LDI strategies to hedge interest rate and inflation risks. These rely on long-dated, inflation-linked gilts and derivatives to manage duration mismatches, with repo markets supporting margin calls and capital efficiency. While ICs and PFs are typically less sensitive to short-term repo price moves, their structural demand for leverage and collateral can strain markets under stress. Though their repo activity is usually low-frequency, their collective adjustments can significantly affect pricing and liquidity.

A.3. Bank-to-bank repo activity

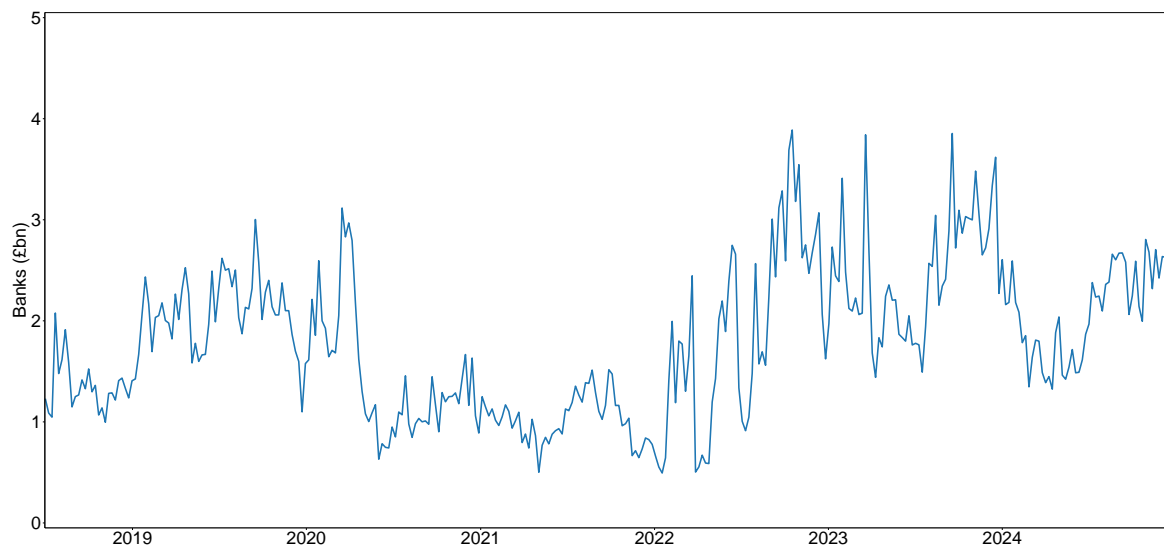


Figure 6. Bank-to-bank weekly transaction volumes

Notes: This figure zooms into bank-to-bank liquidity provision via overnight repo July 2018 to December 2024. Transaction volumes oscillate between £1bn and £4bn per week, with periods of relative stability interspersed by episodes of heightened volatility. Notably, volumes remained subdued during 2020 and early 2022, before exhibiting a marked increase in both level and volatility from mid-2022 onward. Data are averaged on a weekly basis. Source: Bank of England Sterling Money Market Data.

A.4. Summary statistics bank-to-bank and bank-to-NBFI repo activity

Sector	Mean	Median	St. Dev.	Min	Max
Banks	1.80	1.75	0.73	0.50	3.89
NBFIs (total)	19.71	19.57	3.63	10.41	29.59
<i>of which:</i>					
MMFs	10.09	9.84	3.35	3.09	17.83
IFs	8.19	7.96	1.40	4.25	13.32
ICs	0.95	0.70	0.62	0.09	2.86
PFs	0.43	0.35	0.35	0.02	1.68

Table 5. Summary statistics of repo transaction volumes (£bn)

Notes: Bank-to-bank repo activity is relatively modest, with a mean weekly volume of £1.80bn, a median of £1.75bn, and a standard deviation of £725.7mn. Volumes range from a minimum of £494mn to a maximum of £3.89bn. In contrast, bank-to-NBFI transactions are substantially larger and more volatile, with a mean weekly volume of £19.71 bn, a median of £19.57bn, and a standard deviation of £3.63bn. The minimum and maximum weekly volumes in this segment are £10.41bn and £29.59bn, respectively. Source: Bank of England Sterling Money Market Data.

A.5. Reverse repo

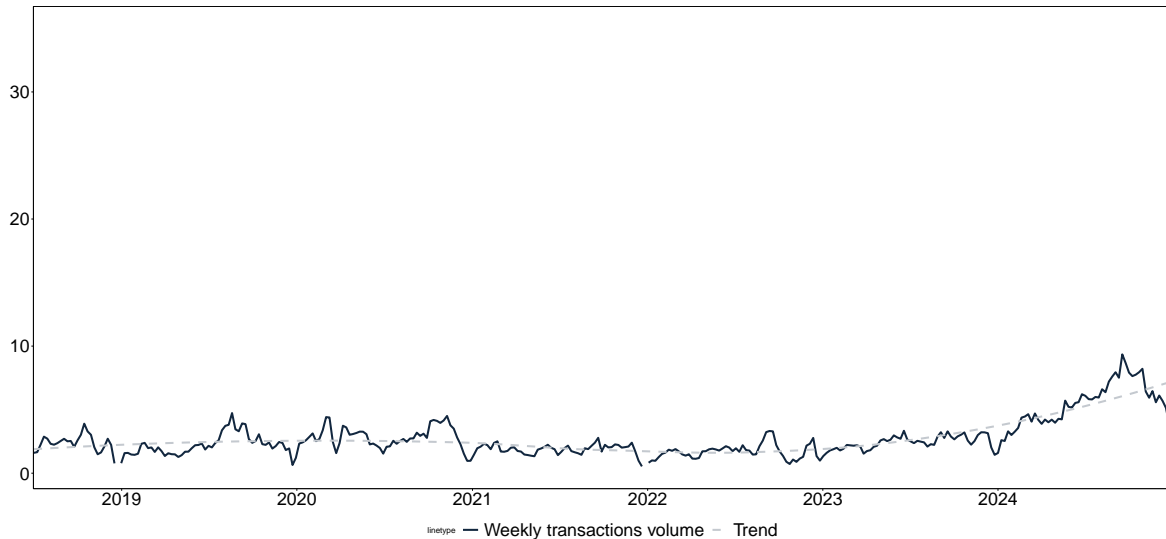


Figure 7. Reverse repo transaction volume (bank-to-NBFI)

Notes: This figure presents the NBFI reverse repo transaction volume (i.e., banks lending to NBFIs) trend from July 2018 to December 2024. Volumes are expressed in billions of pounds sterling and averaged on a weekly basis. This figure highlights both the scale and the shifting composition of reverse repo flows over time, corroborating Figure 1 descriptive findings that banks are net repo borrower in the overnight bilateral segment. Source: Bank of England Sterling Money Market Data.

A.6. Summary statistics of overnight bilateral repo spread

Sector	Mean	Median	St. Dev.	Min	Max
Banks	-7.0	-6.0	6.0	-8.0	3.8
MMFs	-6.0	-6.0	6.0	-7.3	1.6
IFs	-7.0	-6.0	7.0	-7.5	1.6
ICs	-6.0	-5.0	7.0	-8.6	1.9
PFs	-6.0	-5.0	8.0	-9.0	2.4

Table 6. Summary statistics of weekly average repo spread, by sector (basis points)

Notes: Average spreads are broadly similar across sectors, clustering around -6 to -7 basis points, implying that repo transactions are typically priced slightly below the policy rate benchmark. The dispersion of spreads is relatively contained, with standard deviations ranging between 6 and 8 basis points, though PFs and ICs exhibit the highest variability, consistent with more episodic market participation. The range of observations is narrowest for MMFs and widest for PFs, whose spreads span from -90 to $+24$ basis points, indicating occasional episodes of heightened funding cost differentials.

Source: Bank of England Sterling Money Market Data.

A.7. Spread-of-Spread volatility mapping

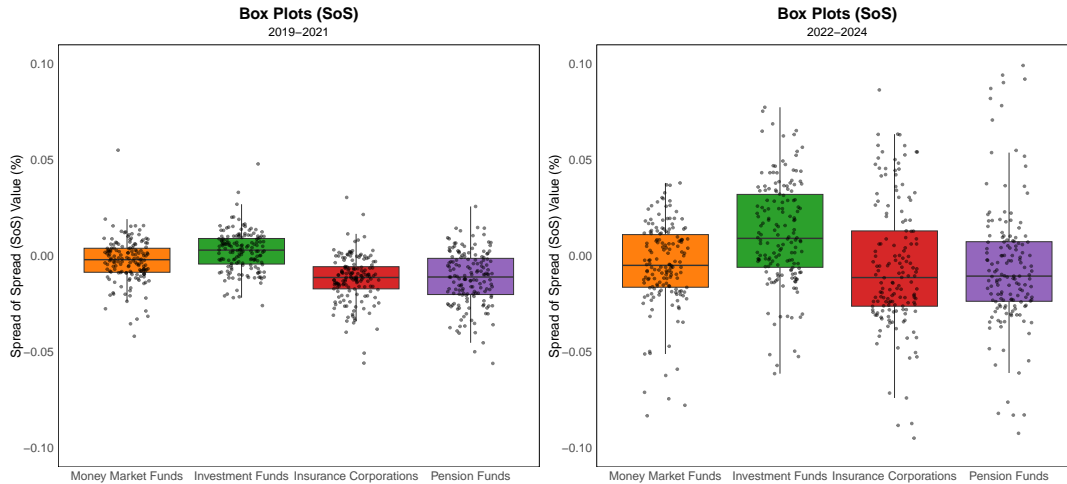


Figure 8. Spread-of-Spread volatility analysis

Notes: This figure documents the aggregate changes in the SoS distribution (by NBFBI sector) for two sub-periods. During 2019–2021, SoS across all sectors cluster closely around zero, indicating stable and uniform liquidity pricing, with narrow interquartile ranges and few outliers reflecting low volatility. In contrast, the 2022–2024 period exhibits significantly greater dispersion and volatility, especially for IFs and ICs. Wider interquartile ranges and more frequent extreme values demonstrate increased volatility for the SoS metric. IFs show a clear upward shift in both median and upper spread values, indicating periods of higher liquidity costs for banks borrowing from NBFIs. ICs and PFs also experience increased SoS volatility, with medians tending lower, highlighting ongoing sectoral differences in liquidity pricing.

Source: Bank of England Sterling Money Market Data.

A.8. Diagnostic and robustness tests of the baseline OLS regression

Model	IRS _{1y,t}	ILS _{30y,t}
VIF Results	1.009	1.009

Table 7. Variance Inflation Factors (VIF)

Notes: Variance Inflation Factors (VIFs) were computed for all sectoral models to assess multicollinearity among the independent variables. All VIF values are close to unity, indicating no evidence of multicollinearity. Source: Bank of England Sterling Money Market Data.

Model	BP Statistic	p-value
MMFs	21.473	< 0.001
IFs	38.335	< 0.001
ICs	21.563	< 0.001
PFs	20.448	< 0.001

Table 8. Breusch-Pagan Test for Heteroskedasticity

Notes: The Breusch-Pagan test was applied to detect the presence of heteroskedasticity. The null hypothesis of homoskedastic residuals was rejected in all models at the 1% significance level. This suggests that the variance of the residuals is not constant across observations. Source: Bank of England Sterling Money Market Data.

Model	DW Statistic	p-value
MMFs	1.057	< 0.001
IFs	0.953	< 0.001
ICs	0.619	< 0.001
PFs	0.694	< 0.001

Table 9. Durbin-Watson test for autocorrelation

Notes: The Durbin-Watson test was used to assess autocorrelation in the residuals. All models exhibit strong positive autocorrelation, with Durbin-Watson statistics well below the benchmark value of 2 and p-values below 0.001. Source: Bank of England Sterling Money Market Data.

Sector	Variable	OLS Estimate	p-value
MMFs	IRS _{1y,t}	0.00096	0.441
	ILS _{30y,t}	-0.02324**	0.010
IFs	IRS _{1y,t}	0.00329**	0.009
	ILS _{30y,t}	-0.00355	0.691
ICs	IRS _{1y,t}	0.00307**	0.014
	ILS _{30y,t}	-0.00357	0.689
PFs	IRS _{1y,t}	0.00484***	0.000
	ILS _{30y,t}	-0.02052**	0.022

Table 10. OLS coefficient estimates with Newey–West inference

Notes: This table reports OLS coefficient estimates together with p-values computed using Newey–West heteroskedasticity- and autocorrelation-consistent standard errors. Newey–West adjustments affect inference (standard errors, test statistics, and p-values) but do not alter the underlying OLS coefficient estimates. The results indicate that the main findings are broadly robust to accounting for serial correlation and heteroskedasticity. However, the coefficient on IRS_{1y,t} for MMFs is no longer statistically significant under Newey–West inference ($p = 0.441$), suggesting that evidence for this relationship is sensitive to the treatment of serial dependence. The dependent variable is the NBFIs SoS. Source: Bank of England Sterling Money Market Data.

	IRS _{1Y}	ILS _{30Y}	All
Intercept	0.0956 (0.0592)	-4.2066* (1.8411)	-5.1615*** (0.5916)
IRS _{1Y}	-0.9416*** (0.0195)		-0.9568*** (0.0177)
ILS _{30Y}		0.6565 (0.5528)	1.5917*** (0.1784)
Adj. R^2	0.8730	0.0012	0.8970
Observations	340	340	340

Table 11. Regression results for Banks

Notes: This alternative specification model shows that short-term nominal rates (IRS1Y, t) enter with large, negative, and highly significant coefficients, indicating that higher front-end rates compress the interbank spread. By contrast, long-term real rates (ILS30Y, t) behave differently from NBFIs: the univariate estimate is positive and insignificant, but in the joint model it becomes strongly positive and significant, implying that higher long-term real rates widen interbank spreads once short-term conditions are controlled for. Overall, banks exhibit asymmetric pass-through along the yield curve, front-end rate increases narrow spreads, while long-end real rate rises push them wider. Dependent variable is the Bank spread. Standard errors are reported in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data.

A.9. Augmenting the baseline regression with UK monetary policy factors

We supplement our repo dataset with the UK monetary policy factors constructed in the UK Monetary Policy Event-Study Database (Braun et al., 2024). These factors, Target, Path, and QE, respectively capture unexpected changes in the current policy rate, revisions to the expected future path of policy, and the effects of asset purchase (quantitative easing) announcements. They thus summarise distinct dimensions of monetary policy surprises, corresponding broadly to short-, medium-, and long-maturity segments of the yield curve.

To merge the two datasets, we align each monetary policy event with the corresponding calendar week in the repo dataset. Repo variables are averaged at the weekly frequency, while monetary policy surprises are aggregated over the thirty-minute window before and after each policy announcement or press conference. For weeks without monetary policy events, the factors are set to zero, ensuring a balanced weekly panel. When multiple announcements occur within the same week, we sum the factor values to capture the cumulative weekly impact of monetary policy surprises. Thus, we estimate the following linear OLS regression model:

$$\text{SoS}_{i,t} = \alpha + \beta_1 \text{IRS}_{1y,t} + \beta_2 \text{ILS}_{30y,t} + \gamma_1 \text{Target}_t + \gamma_2 \text{Path}_t + \gamma_3 \text{QE}_t + \varepsilon_{i,t}, \quad (9)$$

where $\text{SoS}_{i,t}$ is the Spread-of-Spread for sector i at time t . The variables Target_t , Path_t , and QE_t are the short-rate, path, and quantitative easing factors constructed from high-frequency UK monetary policy surprises. Including these factors allows us to test whether policy signalling and unconventional measures exert incremental influence on sectoral SoS beyond what is explained by market-implied swap rates.

Across all NBFIs sectors, the coefficients on Target_t , Path_t , and QE_t are statistically insignificant and economically small, with wide confidence intervals, and the adjusted R^2 remains unchanged relative to the baseline IRS/ILS specification (Table 12, Table 13, Table 14 and Table 15).

By contrast, the estimates on $\text{IRS}_{1Y,t}$ and $\text{ILS}_{30Y,t}$ remain stable in magnitude and significance, closely matching the baseline sectoral regressions. These results support the conclusion that monetary policy transmits to sectoral SoS primarily through realised

market rates, rather than through independent effects of policy communication or QE announcements.

Money Market Funds							
	IRS _{1Y,t}	ILS _{30Y,t}	Baseline	+Target	+Path	+QE	Full
Intercept	0.0703*** (0.0151)	0.0703*** (0.0151)	0.0703*** (0.0151)	0.0688*** (0.0151)	0.0703*** (0.0152)	0.0699*** (0.0151)	0.0684*** (0.0152)
IRS _{1Y,t}	0.000963** (0.00045)		0.000963** (0.00045)	0.000977** (0.00045)	0.000964** (0.00045)	0.000953** (0.00045)	0.000970** (0.00045)
ILS _{30Y,t}		-0.02324*** (0.00456)	-0.02324*** (0.00456)	-0.02279*** (0.00457)	-0.02322*** (0.00457)	-0.02312*** (0.00457)	-0.02265*** (0.00458)
Target				0.0638 (0.0469)			0.0609 (0.0478)
Path					0.00892 (0.0469)		0.0224 (0.0485)
QE						-0.0340 (0.0464)	-0.0291 (0.0486)
Adj. R^2	0.0730	0.0729	0.0731	0.0753	0.0703	0.0717	0.0710
Observations	340	340	340	340	340	340	340

Table 12. Money-Market Funds baseline and monetary policy factors

Notes: Dependent variable is the Money-Market Funds Spread-of-Spread. Standard errors are reported in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data and UK Monetary Policy Event-Study Database.

Investment Funds							
	IRS _{1y,t}	ILS _{30y,t}	Baseline	+Target	+Path	+QE	Full
Intercept	0.01063 (0.01727)	0.01063 (0.01727)	0.01063 (0.01727)	0.01001 (0.01734)	0.01049 (0.01730)	0.01051 (0.01731)	0.00968 (0.01740)
IRS _{1Y,t}	0.00329*** (0.00052)		0.00329*** (0.00052)	0.00330*** (0.00052)	0.00329*** (0.00052)	0.00329*** (0.00052)	0.00329*** (0.00052)
ILS _{30Y,t}		-0.00355 (0.00521)	-0.00355 (0.00521)	-0.00337 (0.00523)	-0.00351 (0.00522)	-0.00352 (0.00522)	-0.00326 (0.00525)
Target				0.0264 (0.0537)			0.0267 (0.0547)
Path					0.0187 (0.0535)		0.0244 (0.0556)
QE						-0.0104 (0.0530)	-0.0119 (0.0556)
Adj. R^2	0.1025	0.1027	0.1024	0.1006	0.1002	0.1000	0.0957
Observations	340	340	340	340	340	340	340

Table 13. Investment Funds baseline and monetary policy factors

Notes: Dependent variable is the Investment Funds Spread-of-Spread. Standard errors are reported in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data and UK Monetary Policy Event-Study Database.

Insurance Corporations							
	IRS _{1y,t}	ILS _{30y,t}	Baseline	+Target	+Path	+QE	Full
Intercept	-0.00327 (0.0253)	-0.00327 (0.0253)	-0.00327 (0.0253)	-0.00598 (0.0253)	-0.00260 (0.0253)	-0.00432 (0.0253)	-0.00577 (0.0254)
IRS _{1Y,t}	0.00307*** (0.00075)		0.00307*** (0.00075)	0.00310*** (0.00075)	0.00306*** (0.00075)	0.00305*** (0.00075)	0.00307*** (0.00075)
ILS _{30Y,t}		-0.00357 (0.00763)	-0.00357 (0.00763)	-0.00275 (0.00764)	-0.00380 (0.00763)	-0.00327 (0.00763)	-0.00284 (0.00765)
Target				0.1156 (0.0784)			0.0993 (0.0798)
Path					-0.0883 (0.0783)		-0.0642 (0.0810)
QE						-0.0889 (0.0775)	-0.0556 (0.0811)
Adj. R^2	0.0412	0.0412	0.0411	0.0446	0.0420	0.0421	0.0430
Observations	340	340	340	340	340	340	340

Table 14. Insurance Corporations baseline and monetary policy factors

Notes: Dependent variable is the Insurance Corporations Spread-of-Spread. Standard errors are reported in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data and UK Monetary Policy Event-Study Database.

Pension Funds							
	IRS _{1y,t}	ILS _{30y,t}	Baseline	+Target	+Path	+QE	Full
Intercept	0.0497* (0.0289)	0.0497* (0.0289)	0.0497* (0.0289)	0.0492* (0.0290)	0.0494* (0.0289)	0.0502* (0.0289)	0.0492* (0.0291)
IRS _{1Y,t}	0.00484*** (0.00086)		0.00484*** (0.00086)	0.00485*** (0.00086)	0.00485*** (0.00086)	0.00485*** (0.00086)	0.00486*** (0.00086)
ILS _{30Y,t}		-0.0205** (0.00870)	-0.0205** (0.00870)	-0.0204** (0.00874)	-0.0204** (0.00871)	-0.0206** (0.00872)	-0.0203** (0.00877)
Target				0.0207 (0.0896)			0.0300 (0.0914)
Path					0.0377 (0.0894)		0.0321 (0.0928)
QE						0.0367 (0.0885)	0.0339 (0.0929)
Adj. R^2	0.0887	0.0887	0.0888	0.0861	0.0865	0.0864	0.0816
Observations	340	340	340	340	340	340	340

Table 15. Pension Funds baseline and monetary policy factors

Notes: Dependent variable is the Pension Funds Spread-of-Spread. Standard errors are reported in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data and UK Monetary Policy Event-Study Database.

We run the same specification for the banking sector spread as the dependent variable. Specifically, we estimate the following model:

$$BankSpread_t = \alpha + \beta_1 IRS_{1y,t} + \beta_2 ILS_{30y,t} + \gamma_1 Target_t + \gamma_2 Path_t + \gamma_3 QE_t + \varepsilon_t. \quad (10)$$

Consistent with the NBFIs results, all three high-frequency monetary policy factor variables remain statistically insignificant, economically small, and leave the adjusted R^2 unchanged (Table 16).

	Banks						
	IRS _{1Y,t}	ILS _{30Y,t}	Baseline	+Target	+Path	+QE	Full
Intercept	0.09561 (0.05923)	-4.2066* (1.8411)	-5.16154*** (0.59157)	-5.12212*** (0.59328)	-5.16194*** (0.59262)	-5.17594*** (0.59244)	-5.13730*** (0.5950)
IRS _{1Y,t}	-0.94159*** (0.01950)		-0.95681*** (0.01765)	-0.95719*** (0.01766)	-0.95681*** (0.01767)	-0.95717*** (0.01767)	-0.95766*** (0.0177)
ILS _{30Y,t}		0.6565 (0.5528)	1.59166*** (0.17838)	1.57971*** (0.17890)	1.59180*** (0.17870)	1.59582*** (0.17863)	1.58406*** (0.1794)
Target				-1.68063 (1.83562)			-1.94201 (1.8711)
Path					0.05309 (1.83306)		0.27624 (1.8991)
QE						-1.22332 (1.81470)	-1.62894 (1.9014)
Adj. R^2	0.8730	0.0012	0.8969	0.8970	0.8967	0.8968	0.8965
Observations	340	340	340	340	340	340	340

Table 16. Banks baseline and monetary policy factors

Notes: Dependent variable is the Bank Spread. Standard errors in parentheses. Significance codes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Bank of England Sterling Money Market Data and UK Monetary Policy Event-Study Database.

A.10. Diagnostic and robustness checks of the GARCH

Spread	AIC	BIC	Shibata	Hannan-Quinn
MMFs	-5.8558	-5.7544	-5.8572	-5.8154
IFs	-5.7043	-5.6027	-5.7056	-5.6638
ICs	-5.4179	-5.3166	-5.4193	-5.3776
PFs	-5.3365	-5.2351	-5.3378	-5.2961

Table 17. Model selection criteria for each spread

Notes: Information criteria confirm the adequacy of the chosen specification for each spread. All models exhibit strongly negative AIC and BIC values, indicating good fit. Source: Bank of England Sterling Money Market Data.

Sector	Box-Ljung (Res)	Box-Ljung (Sq Res)	ARCH LM (Lag 3)	ARCH LM (Lag 5)
MMFs	2.321	3.557	1.017	1.399
IFs	0.407	3.804	2.389	3.419
ICs	2.443	0.388	0.049	0.055
PFs	1.512	0.982	0.019	0.020

Table 18. Residual diagnostic tests

Notes: Ljung-Box tests on residuals and squared residuals show no evidence of serial correlation or remaining ARCH effects across all spreads. The ARCH LM tests also confirm the absence of conditional heteroskedasticity. These results validate the adequacy of the conditional variance specification. Source: Bank of England Sterling Money Market Data.

Sector	Sign Bias	Neg Bias	Pos Bias	Joint Effect
MMFs	0.208	0.905	0.500	1.072
IFs	0.920	0.366	0.881	1.102
ICs	1.326	0.529	0.887	1.877
PFs	1.258	0.012	0.606	1.982

Table 19. Sign bias test results

Notes: The Sign Bias Test results show no evidence of asymmetry in the volatility response for any of the spreads. Source: Bank of England Sterling Money Market Data.

Sector	Group 20	Group 30	Group 40	Group 50
MMFs	12.24 (0.8753)	18.76 (0.9272)	24.47 (0.9665)	48.82 (0.4802)
IFs	13.86 (0.7917)	34.19 (0.2325)	34.45 (0.6773)	46.69 (0.5671)
ICs	19.88 (0.4017)	22.12 (0.8153)	30.82 (0.8219)	37.35 (0.8881)
PFs	24.47 (0.1787)	28.65 (0.4836)	38.59 (0.4885)	50.88 (0.3994)

Table 20. Adjusted Pearson goodness-of-fit

Notes: Adjusted Pearson goodness-of-fit tests across multiple group sizes (20–50) yield p-values well above conventional thresholds for all spreads. This confirms no evidence of model misspecification and supports the robustness of the fitted GARCH models. Source: Bank of England Sterling Money Market Data.