Bank to Non-Bank Lending and the Reallocation of Credit*

Jian Li[†] Yiming Ma[‡] Caterina Mendicino[§] Dominik Supera[¶]

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Abstract

We analyze how bank lending to non-bank financial institutions (NBFIs) affects credit supply to the real economy. Using granular supervisory and loan-level data, we document rapid growth in bank lending to NBFIs relative to lending to non-financial firms. This growth is driven primarily by reverse repos to NBFIs that invest in securities, e.g., investment funds, rather than by loans to NBFIs that extend credit to firms, e.g., private credit funds. We show that the expansion in bank–NBFI lending primarily reflects rising NBFI borrowing demand to fund government securities, which stems from the tapering of QE and the expansion of government bond supply in the Euro area and US. Importantly, loans to NBFIs disproportionately crowd out loans to non-financial firms rather than securities on bank balance sheets, which ultimately contracts credit supply to the real economy. A model rationalizes our empirical findings and quantifies the aggregate crowding-out effect. Taken together, our results imply that the rise of bank lending to NBFIs represents a narrowing of bank business models and a contraction in bank credit intermediation.

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†Columbia Business School. Email: jl5964@columbia.edu

‡Columbia Business School and NBER. Email: ym2701@columbia.edu

§European Central Bank and CEPR. Email: caterina.mendicino@ecb.int

¶Columbia Business School. Email: ds3791@columbia.edu

1 Introduction

An essential function of the financial system is to extend credit to firms in the real economy. Traditionally, deposit-taking banks directly lend to non-financial firms. More recently, banks are increasingly lending to non-bank financial institutions (NBFIs). For instance, banks lend to private debt funds (Chernenko et al., 2025) and extend credit lines to real estate investment funds (REITS) (Acharya et al., 2024a). In the U.S., term loans and credit line commitments to NBFIs have exceeded $0.3 trillion and $1.5 trillion in 2022 (Acharya et al., 2024b). A similar trend is evident in the Euro area, where bank lending to NBFIs has expanded to more than EUR 3.1 trillion—equivalent to 63% of total bank lending to firms. Between 2019 and 2024, bank lending to NBFIs grew by nearly 60%, while lending to non-financial firms rose by only about 20%. The divergence has become especially pronounced since 2022, as bank loans to firms have stagnated while lending to NBFIs has continued to expand steadily.

As bank-to-NBFI lending takes up an increasing share of bank balance sheets, an important question is how aggregate credit supply to firms is affected. On the one hand, banks' increased lending to NBFIs may, in turn, allow NBFIs to supply more loans. For example, bank lending to private debt funds enables them to lend more to non-financial firms. In this sense, NBFIs may simply pass through or even expand banks' lending capacity. On the other hand, NBFIs' increased borrowing from banks may not be for lending purposes but to fund other assets, such as government securities. If constrained banks cut direct lending to firms in order to lend to NBFIs, the aggregate credit supply to firms may contract.

To address this question, we first document that the rapid growth in bank lending to NBFIs is primarily comprised of reverse repos to NBFIs that invest in securities, e.g., investment funds, rather than by loans to NBFIs that extend credit to firms, e.g., private credit funds. We then examine the forces behind this trend and show that it is predominantly driven by rising NBFI borrowing demand to finance government securities, consistent with the tapering of quantitative easing and the expansion of government bond supply in the Euro area and the US. This trend is further amplified by loan supply factors, including the reduction in central bank reserves and banks' incentive to hold liquid and safe assets.

At the same time, we find that bank lending to NBFIs disproportionately crowds out bank lending to non-financial firms rather than other liquid assets on bank balance sheets. Our empirical analysis and model show that the reduction in bank lending to non-financial firms is not offset by NBFI's increased lending to non-financial firms, which is why, ultimately, aggregate credit to the real economy contracts.

Taken together, our findings imply that bank lending to NBFIs is not merely the pass-through of lending through intermediaries with lower balance sheet costs. Rather, when borrowing demand originates from NBFIs that do not extend credit to firms, banks effectively become "narrower" and contract credit supply to the real economy while expanding the indirect financing to government bonds. Our findings also imply that the presence of bank-to-NBFI lending exacerbates the crowding out of credit provision to the real economy as major central banks continue shrinking the size of their balance sheets, leaving an ever-increasing supply of government bonds in search of funding.

We begin by examining bank-to-NBFI lending using credit registry data from Anacredit that covers all loans extended by banks in the Euro area from 2019 to 2025. Our first key finding is that a significant share of bank lending to NBFIs is comprised of reverse repos. Reverse repos make up 45% of all loans at the end of our sample, while term loans and credit lines account for 35% and 23%, respectively.[1] The prevalence of reverse repos is significant because reverse repos fund their underlying collateral, i.e., government bonds, and are therefore not directly facilitating lending to the real economy.

We also find that the growth of bank-to-NBFI loans was primarily taken up by NBFIs that do not focus on lending to the real economy. To understand which NBFIs borrow from banks, we manually classify NBFI borrowers into granular institution types. Our classification reveals that NBFIs can be roughly grouped into those that focus on lending to firms and those that do not. The former includes, for example, private debt funds, lending companies, leasing companies, and factoring companies. The latter includes, for example, hedge funds and mutual funds. We find that the former primarily takes up credit lines and term loans, while the latter borrows a disproportionate amount of reverse repos. Hedge funds, in particular, are playing an increasingly important role in this market and account for the rapid growth in reverse repos since 2023. We confirm that our results are not driven by loans within banking groups and matched-book repos.

What explains the rapid growth in bank-to-NBFI lending? We show that the predominant driver is a rise in borrowing demand by NBFIs that invest in securities, especially government bonds. That is why loan growth is concentrated in reverse repos and disproportionately taken up

[1] The use of term loans and credit lines is consistent with bank lending to NBFIs in the U.S. setting, as documented by Acharya et al. (2024b). Given the focus on term loans and credit lines in the literature, the outsized share of reverse repos may seem surprising. One possible reason is that the FR Y-14Q data in the U.S. does not require the reporting of reverse repo positions.

by investment funds like hedge funds, even after conditioning on the same lending bank and loan type at the same time. Further, loan spreads increase with loan volumes, especially for loans to hedge funds and backed by government securities, which is consistent with a dominant rise in loan demand rather than loan supply.

We further find that the rise in NBFI borrowing demand stems from the unwinding of QE and the rise in government bond issuance in major economies, which leaves an increasing supply of government bonds in search of financing. We show that the timing of QT in the euro area and the US mirrors the surge in bank-to-NBFI lending in our sample. The volume of bank-to-NBFI lending also moves in tandem with the amount of government bonds held outside of of central bank balance sheets. Finally, we show that when the ECB reduces its holding of a particular government bond, the volumes and spreads of reverse repos backed by that bond increase, consistent with a rise in the demand for repo funding for that bond. These results holds even when comparing bonds issued by the same country and of the same maturity bucket at the same time, which rules out potential confounding factors like conventional monetary policy and time-varying macroeconomic conditions.

The rise in bank-to-NBFI lending is further amplied bank banks' incentive to hold liquid and safe assets. Loans to NBFIs are safer, carry lower risk weights, and are more liquid than other forms of lending in part due to NBFIs' equity cushion, making them more attractive when regulatory capital becomes binding or liquidity tightens. That is why banks with lower capital ratios and larger deposit outflows expand their lending to NBFIs more. At the same time, the reduction in central bank reserves associated with QT frees up bank balance sheet capacity especiallly for low-duration and low-risk assets like reverse repos that are closer substitutes for reserves.

Finally, we empirically show that expansion of bank lending to NBFIs has significant consequences for aggregate credit supply. We find that the extension of bank-to-NBFI loans has come largely at the expense of loans to non-financial firms. Quantitatively, a one–percentage-point increase in NBFI lending is associated with a 0.56 percentage point decline in lending to firms on bank balance sheets, while substitution across other balance sheet items, such as government bonds, reserves, and interbank claims, is substantially weaker or insignificant. This reallocation from firm to NBFI loans coupled with the rise of NBFI loan demand to fund securities over lending implies a net reduction in loan supply to non-financial firms. This result is robust to controlling for corporate credit demand using loan-level data. We also find that the loss in bank loan supply is not offset by other forms of credit extended by NBFIs, and firms more reliant on banks with higher NBFI loan growth are especially exposed. In other words, the reallocation of bank balance sheets toward NBFI lending is not a neutral reshuffling of credit. Rather, it represents a narrowing of bank business models and ultimately results in a contraction of credit supply.

We develop a model to rationalize the empirical findings and to quantify the aggregate effect of increasing privately-held government bond supply, such as through increased issuance or QT, on firm credit provision and the government bond market. In our model, a representative bank issues retail and institutional deposits and allocates its balance sheet across reserves, government bonds, corporate loans, loans to NBFIs, and equities subject to a risk-weighted capital constraint and a leverage constraint. We let institutional depositors be risk averse and demand higher deposit rates when the bank is riskier. Corporate loans are riskier than securities so the risk weight for corporate loans exceeds that of securities. We let loans to NBFIs be collateralized to varying degrees, capturing differences in the mix of reverse repos and other loans.[2] As collateral reduces default, the risk weight of NBFI loans declines with the degree of collateralization.

NBFIs choose their portfolio allocation to maximize equity value, taking into account that the demand for their claims increases with expected return and decreases with risk. NBFIs differ in the sensitivity of their claims to risk and return, which may arise from differences in investor bases. For example, investors in money market funds are more sensitive to risk than those in private debt funds and lending companies. Given investors' preferences, each NBFI chooses how much to borrow from the bank, its degree of collateralization, and the allocation across corporate loans, government bonds, and equities. Finally, all markets clear in equilibrium.

One contribution of our model is to capture the heterogeneity of NBFIs in a coherent framework. We show that differences in risk sensitivity yield cross-sectional patterns in NBFIs' asset and liability choices that are consistent with our empirical results. NBFIs with more risk-sensitive investor bases choose to hold more securities and take on less leverage. The higher portfolio share of securities in turn allows them to borrow from banks using more collateralized instruments, e.g., reverse repos. In contrast, NBFIs with less risk-sensitive investors choose to hold more corporate loans, take on more leverage, and borrow from banks using less collateralized instruments, e.g., term loans and credit lines. These predictions are borne out in the data. Our analysis suggests the composition of the NBFI sector matters for the aggregate effect on the real economy.

[2]Effectively, we denote loans secured with securities as collateralized. More broadly, we can interpret the share of secured loans as the share of loans that is fully collateralized against losses in the case of default. In practice, term loans and credit lines may also be secured to some extent, but these assets tend to be less safe and offer less protection against loan default for the same haircut.

We then calibrate the model to the aggregate banking and NBFI sector using a combination of granular and aggregate data from the euro area and conduct counterfactual analysis. We are interested in how an increased supply of government bonds affects credits extended to firms, loans to NBFs, and government bond markets. We first consider a 5% shift in the residual government bond supply facing the bank and the NBFI sector, which could happen through QT or increased issuance. In this scenario, the equilibrium yield on bonds rises, prompting both banks and NBFIs to shift their holdings towards the higher-yielding bonds and away from firm loans. Further, on the margin, the bank's cost of holding securities outright—through its own risk aversion and its depositors' preference—is higher than that of the NBFI sector, whose more risk-tolerant investors make it the better marginal holder of the additional bonds. That is why banks prefer to extend short-term, collateralized reverse repos to NBFIs over holding government securities on their own balance sheets. Access to reverse repos from banks allow NBFIs to lever up and fund more securities. At the same time, the bank reallocates away from direct lending to firms toward lending to NBFIs. As a result, bank-to-NBFI lending rises and total lending to non-financial firms contracts. In our calibrated model, lending to non-financial firms contracts by about 6%, while bank lending to NBFIs rises by 3.6%.

Finally, to highlight the effect of bank-to-NBFI lending, we vary the cost of bank-to-NBFI lending with the same shift in the residual government bond supply facing the bank and the NBFI sector. When bank-to-NBFI lending is cheaper, the crowding out of firm credit is amplified because the bank is now more incentivized to reallocate away from direct firm lending toward NBFI lending in response to the increased government bond supply, which then increases the capacity of the NBFI—the better marginal holder—to fund more governmen bonds. Relative to the bank, the NBFI is more sensitive to changes in bond yields because its investors are more risk tolerant. As a result, the aggregate intermediary sector is more willing and able to absorb the additional bonds, hence reducing the impact on government bonds yields. At the same time, however, the intermediary sector also contracts credit supply to firms by more. We confirm both effects in our calibrated model: when bank-to-NBFI becomes costlier or more restrictive, the bank retains more corporate loans and the contraction in firm credit is dampened, though at the cost of a larger increase in government-bond yields.

Taken together, our results show the rise in government bonds outside of cental banks' balance sheets as an important driver behind the expansion of bank lending to NBFIs. Because much of this lending flows to NBFIs that do not extend loans to firms, this demand-driven expansion of bank-to-NBFI lending coincides with a contraction in credit to the real economy. Our model highlights that the size of the spillover effects depends on the link between banks and NBFIs. The ease of lending to NBFIs amplifies the contraction in firm credit, while making the government bond market more elastic. This tradeoff is important to keep in mind going forward as the unwinding of central bank balance sheets, government bond issuance, and the importance of the NBFI sector all continue to grow.

2 Literature Review

We contribute to the growing literature on bank lending to NBFIs. Acharya et al. (2024b) provides the first comprehensive documentation of bank lending to NBFIs in the U.S. They show that banks and NBFIs have become highly interconnected and that banks remain exposed to credit and funding risk from their NBFI loans. Several papers have focused on bank lending to private credit. Chernenko, Ialenti and Scharfstein (2025) argue that banks lend to private credit funds because of their favourable capital treatment, while Haque, Jang and Wang (2025) study the effect of bank lending to private credit on monetary policy transmission. Others zoom in on credit lines. Jiang (2023) analyzes how banks' credit lines to mortgage borrowers affect their competition in mortgage markets. Acharya, Gopal, Jager and Steffen (2024a) examine banks' credit lines to REITs and show that banks may decide against extending credit lines to firms that are dependent on nonbank financing. Xu (2025) also studies banks' credit lines to NBFIs using a macroeconomic model. Closely related to us is Buchak, Matvos, Piskorski and Seru (2024), who document the decline of financial intermediation on bank balance sheets and rationalize this trend using a model where banks hold securities issued by originate-to-distribute intermediaries. Our contribution is twofold. First, while prior work has mostly focused on banks' regulatory constraints in explaining the rise of bank-to-NBFI lending, we show that NBFIs' demand for bank funding, driven by QT and government bond issuance in advanced economies, played an even more important role. Second, we show that bank lending to NBFIs is not limited to credit lines and term loans—a significant share of loans is in the form of reverse repos borrowed by NBFIs like hedge funds and security dealers. Given this heterogeneity, the composition of NBFIs is consequential for aggregate loan supply to the real economy.

Our findings also contribute to the literature on leveraged holdings of government bonds. In the US setting, Barth and Kahn (2021) first point out that a large amount of Treasuries are financed by the Treasury-basis trade, where hedge funds buy Treasury securities, use the Treasuries as collateral to borrow in repo, and short the corresponding Treasury futures that are demanded by non-banks like mutual funds. Kashyap et al. (2025) develop a model to show how the central bank can best address fragilities arising from the Treasury-basis trade. We document the rise in reverse repos for funding government bonds in the Euro area and shed light on how it impacts dealers banks' other balance sheet activities, including the spillover effects on their lending to the real economy. We also identify the shrinking size of central bank balance sheets in the US and Euro area as an important driver behind the growth in leveraged sovereign bond holdings by non-banks. This finding adds to a growing literature on the implications of QT, e.g., Acharya et al. (2023), Lopez-Salido and Vissing-Jorgensen (2023), Du et al. (2024) and d'Avernas et al. (2025). In particular, our findings are consistent with Du et al. (2024), who point out that the reduction in central bank asset holdings are primarily absorbed by NBFIs.

More broadly, we relate to the literature on bank and non-bank financial intermediation. This literature has largely studied different NBFIs separately. One exception is Cetorelli, Cisternas and Sarkar (2025), who classify NBFI sectors by their economic functions. Traditionally, bank deposits have been shown to be the safe and liquid asset for investors Gorton and Pennacchi (1990), Dang, Gorton, Holmström and Ordonez (2017), Diamond (2020). More recently, NBFIs like money market funds and mutual funds have also been shown to provide investors with some degree of liquidity and safety (Sunderam, 2015, Chernenko and Sunderam, 2016, Ma et al., 2025). We develop a framework in which banks and different NBFIs are heterogeneous in the sensitivity of their claims to risk and returns, which in turn determines portfolio choices and the interaction between bank and NBFIs. For example, investment funds have more sensitive claims and choose to hold more securities, while private debt funds have less sensitive claims and hold more loans. At the same time, NBFI investors are, on average, more risk-tolerant and return-chasing than bank depositors, which explains why NBFIs are more responsive to an increase in government bond supply while banks prefer to lend to NBFIs using short-term collateralized loans.

Finally, we add to the banking literature that has explored the changing business model of banks over time. One strand of work has focused on how higher capital requirements lead banks to reduce lending to firms (Elenev et al., 2021, Mendicino et al., 2019, Gropp et al., 2019, Fraisse et al., 2020) and to increase their holdings of safe and liquid securities (Stulz et al., 2022). The long-term decline in bank lending has also been associated with falling interest rates (Wang, 2025, Supera, 2021), the rise in intangible assets (Dell'Ariccia et al., 2021), and regulatory and technological changes (Buchak et al., 2024). We show that the "narrowing" of bank business models is also reflected in compositional changes of bank lending, where banks increasingly substitute from loans to non-financial firms to shorter-term, safer loans to NBFIs. These NBFIs primarily invest in securities like government bonds, implying that the reallocation of bank credit toward NBFIs contracts credit supply to firms while expanding the financial sector's capacity to fund government debt.

3 Data

We construct a novel granular dataset combining several regulatory sources from the ECB to analyze banks' lending to both NBFIs and non-financial firms.

Bank-level data. We use the Individual Balance Sheet Items (IBSI) database maintained by the ECB, which provides monthly information on granular asset and liability categories for approximately 2000 banks operating in the euro area. To obtain a more detailed view of balance sheet composition, we complement these data with supervisory information from Financial Reporting (FINREP), which contains harmonized accounting data on the structure of banks' assets, liabilities, and income statements. We also use regulatory data from Common Reporting (COREP) to capture banks' capital positions and risk exposures. Finally, we use Bankscope and the Register of Institutions and Affiliates Database (RIAD) to construct the ownership and group structure of banks.

Loan-level data. We use loan-level information from AnaCredit, a credit registry jointly maintained by the ECB and the national central banks of the Eurosystem. AnaCredit contains transaction-level data on all credit exposures of euro area banks, providing a detailed and consistent view of bank-borrower relationships, including bank lending to both NBFIs and non-financial corporations. The dataset covers a comprehensive range of credit instruments, including revolving credit, credit lines, reverse repurchase agreements, and term loans. For a subset of our repo market analysis, we further supplement AnaCredit with two transaction-level datasets in the repo market. First, we use the Money Market Statistical Reporting (MMSR) dataset, a confidential ECB dataset that records all euro-denominated borrowing and lending transactions conducted by a representative sample of major euro area banks across both the secured and unsecured segments of the money market. Second, we complement the analysis using the Securities and Financing Transactions Datastore (SFTDS), which covers all securities and financing transactions of euro area entities not only in euro but also in other foreign currencies, such as US dollar.

Securities holdings data. We use data on securities holdings by euro area banks (SHSG), NBFI sectors (SHSS), and the European Central Bank (SHSE). We observe holdings at the individual security (ISIN) level. For banks, the data are collected at the individual banking-group level, while for NBFIs they are aggregated at the sector–country level, such as mutual funds in a given country. SHSE allows us to track securities holdings by the ECB during its quantitative easing and tightening programs.

4 Stylized Facts

4.1 Bank Lending to Non-Banks by Instrument and Sector

Fact 1. A significant share of bank lending to NBFIs is comprised of reverse repos to NBFIs that primarily invest in securities.

We begin by examining the breakdown of bank lending to NBFIs using different instruments. In Figure 1, we plot the outstanding volume of credit lines, term loans, revolving credit, reverse repos, and other loans lent by banks to all NBFIs using AnaCredit data. We note that reverse repos are the largest category, accounting for 45% of all loans at the end of the sample period. Term loans and credit lines also make up a sizeable share of total loans at 35% and 23%, respectively. The prevalence of term loans and credit lines is consistent with bank lending to NBFIs in the U.S. setting, as documented by Acharya et al. (2024b). Given the focus on term loans and credit lines in the literature, the outsized share of reverse repos may seem surprising. One possible reason is that the FR Y-14Q data in the U.S. does not require the reporting of reverse repo positions. The prevalence of reverse repos is important because reverse repos fund their underlying collateral, i.e., government bonds, and are therefore not directly facilitating lending to the real economy.

Which NBFIs borrow from banks? In Figure 2, panel (a) shows the volume of loans lent to investment funds, insurances, and pensions. Observe that investment funds, including hedge funds, mutual funds, real estate funds, and private equity funds, are the largest borrowers and their loan volume is growing rapidly especially from 2023 onwards. Panel (b) shows the volume of loans lent to other financial institutions (OFIs), financial auxiliaries (FAs), and captive financial institutions (Captives), where the loan volume of OFIs is particularly pronounced. OFIs, FAs, and Captives correspond to codes S125, S126, and S127 in the ECB's official institutional sector classification, respectively. The official classification, though comprehensive, does not fully capture the economic function of the underlying institutions. That is why we further classify NBFIs into more granular institution types using a combination of manual methods and large language models.

Panels (c), (d), and (e) of Figure 2 show loan volumes to the granular NBFI sectors classified by our algorithm. Panel (c) shows that among investment funds, hedge funds are the largest borrowers and also display the rapid growth observed in Panel (a) starting in 2023. Mutual funds also have a growth spurt toward the end of the sample, but their overall borrowing is below that of hedge funds. In addition to hedge funds and mutual funds, which predominantly invest in securities, there are also other funds and real estate funds. The former includes private debt funds and funds invested in alternative assets, while the latter predominantly invests in real estate assets and are similar to REITs in the US. These are the second- and third-largest borrowers among investment funds, and their borrowing volume has been steadily increasing. The volume of loans to private equity funds is relatively limited.

In panel (d) of Figure 2, the largest borrowers are the dealer and the market infrastructure provider sectors. The dealer sector includes dealers and brokers, i.e., firms that trade securities, derivatives and structured products for their own account or as market-makers; the market infrastructure sector is comprised of entities that facilitate the functioning of financial markets, including clearing houses, exchanges, payment and settlement providers. The amount borrowed by insurance companies and pensions is relatively smaller. Overall, the institutions in this panel serve important functions but are generally not focused on lending to the real economy.

Panel (e) of Figure 2 plots the loan volume to all other NBFI sectors in our classification. Broadly speaking, these are all NBFIs that are more directly engaged in lending to the real economy. Lending companies are specialized lenders focused on commercial loans, consumer credit, and auto finance; leasing companies are financial firms that provide asset leasing for vehicles, equipment, and real estate; factoring companies lend to businesses against receivables. Finally, SPVs are entities created to isolate loans or mortgages and to repackage them into securities, while holding companies are financial subsidiaries that provide captive financing to firms.[3]

The composition of NBFI borrowers is closely linked to the composition of loan instruments. To explore which type of NBFIs take up which kind of loans, we estimate

$$LoanGrowth_{kt} = \sum_{s} \beta_{ks} \mathbb{1}_s LoanGrowth_{kst} + \epsilon_{kst}, \tag{4.1}$$

where $LoanGrowth_{kt}$ is the log difference in loan volumes for instrument k in month t, $\mathbb{1}_s$ is an indicator variable for sector s, and $LoanGrowth_{kst}$ is the log difference in loan volumes for

[3]Appendix Table B.5 shows the composition of collateral used by NBFIs to borrow from banks across all instruments. The collateral structure is informative about the asset composition of NBFIs' balance sheets and is consistent with our classification of NBFIs into subsectors. In particular, institutions that primarily invest in securities, such as mutual funds, hedge funds, have a larger fraction of securities within assets used as collateral. By contrast, NBFIs more directly engaged in credit intermediation, such as lending companies, private funds, have a broader mix of assets, including loans, that are pledged to secure their borrowing. The composition of collateral thus provides indirect evidence on the heterogeneity of NBFI asset holdings and their underlying business models.

instrument k and sector s in month t. The more positive the coefficient β_{ks}, the more loan growth for sector s comoves with the overall loan growth for instrument k, consistent with sector s taking up more of those loans and driving more of the aggregate growth of those loans. For the ease of presentation, we group NBFIs with similar economic functions together into the same sector.

Table 1 shows the results. From columns (1), (2), and (3), we see that the growth in credit lines, term loans, and revolving credit most corresponds to the growth in credit lines, term loans, and credit lines extended to other investment funds, companies engaged in lending, factoring, and leasing, as well as holding companies and SPVs. At the same time, credit lines, term loans, and revolving credit are taken up less by dealers, market infrastructure providers, hedge funds, and mutual funds.

For reverse repos, however, column (4) paints the opposite picture. The growth of reverse repos to dealers, market infrastructure providers, hedge funds, and mutual funds closely accounts for the overall growth in reverse repos, whereas reverse repo uptake by companies engaged in lending, factoring, and leasing as well, as holding companies and SPVs, is much more limited. These results are corroborated by Appendix Figures A.2 to A.3, where we plot each sector's loan volume for each instrument over time. One interpretation consistent with these results is that NBFIs more directly focused on lending to the real economy tend to borrow from banks in the form of credit lines, term loans, and revolving credit, while NBFIs less focused on lending tend to borrow more in the form of reverse repos. The next subsection will delve further into the relationship between NBFIs' asset composition and liability composition.

So far, we have shown that banks lend to various NBFI sectors using a variety of loan instrument, where reverse repos make up a significant share. This result is significant because reverse repos tend to fund government bonds rather than lending to the real economy.

Our analysis focuses on bank lending to NBFIs and its implications for lending to the real economy. We acknowledge that there are other exposures between banks and NBFIs. For example, some NBFIs may hold deposits at banks or other securities issued by banks. While these liability-side linkages are interesting, we focus on the gross exposures on the asset side given our research question and following a large literature on bank lending to firms. One specific concern may arise with reverse repos, where some dealers may simply be matching borrowers and lenders. To this end, we confirm that the majority of banks in our sample are not simply engaged in match-making. In Appendix Figure A.4, we use bank balance sheet data to show that the reverse repos on the asset side of our sample of banks do not mirror the liability side of our sample of banks. The reason is that our sample includes deposit-taking banks engaged in lending. Indeed, if we only zoom in on the dealer banks that report in the MMSR data, which is required for the largest dealers in the repo market, then the reverse repo and repo positions are much more aligned, consistent with large dealers acting as match-makers in the repo market.

Another concern is that our results may be driven by banks lending to non-bank subsidiaries belonging to the same holding company. To this end, we create a mapping key for all subsidiaries of bank holding companies and check which loans are extended within group. From Appendix Figure A.5, we observe that the majority of loans are extended to NBFIs outside of the lending bank's holding company. Only term loans have a relatively larger share of within-group loans. From Appendix Figures A.7 and A.6, we see that only OFIs, which include SPVs, leasing companies, lending companies, and factoring companies, have a relatively larger proportion of in-group loans. These NBFIs tend to use more term loans, consistent with the larger share of in-group term loans.

4.2 Credit Demand by Non-Bank Financial Intermediaries

Fact 2. The expansion of bank lending to NBFIs predominantly reflects increased credit demand from NBFIs, particularly investment funds that seek to fund government bonds using reverse repos. This increase in demand stems from quantitative tightening by central banks and a surge in sovereign debt issuance.

So far, we have documented that the expansion in lending to NBFIs has been concentrated in reverse repo loans to investment funds. In this section, we show that the rapid growth in bank-to-NFBI lending predominantly arises from NBFIs' increased demand to fund government bonds, which are in search of funding following QT by central banks and increased issuance. We first examine the aggregate time series. Panels (a) and (b) of Figure 3 show that in the euro area and the United States, the rise in reverse repo lending by euro area banks to NBFIs intensifies precisely when central banks reduced their government bond holdings in the transition from QE to QT, while total government bond supply steadily increases.[4] The timing is consistent with QT increasing the amount of government debt in need of private financing, thereby increasing NBFI loan demand, especially through reverse repos. To see this even more clearly, panels (c) and (d) of Figure 3 plot reverse repo lending volumes against government bonds that are privately held. We observe that in both the euro area and the United States, reverse repo lending to NBFIs

[4]The reduction in central bank balance sheets in this time period occured across several advanced economies. In addition to the euro area and the US, Appendix Figure A.8 shows similar patterns for the United Kingdom and Japan.

increases in tandem with private holdings of government bonds. This pattern suggests that the demand for bank-to-NBFI loans is not only determined by the total supply of government bonds, but by government bond supply that must be financed outside of central bank balance sheets.[5]

If our conjectured channel is correct, we would observe an increase in government bond holdings held by investment funds at the same time as the rise in reverse repos. Indeed, panel (a) of Appendix Figure A.11 shows that, as ECB bond holdings declined, euro-area securities were absorbed primarily by foreign investors and euro-area investment funds. The role of foreign investors is also mirrored in the loan data. Appendix Figure A.12 breaks down reverse repo lending by borrower location and shows that the growth in reverse repo lending is concentrated among NBFIs outside the euro area. This suggests that the rise in government bond holdings is largely financed by foreign-domiciled investment funds borrowing from euro-area banks in repo markets.

Our proposed channel is consistent with the rise in leveraged government bond holdings, including the Treasury basis trade that has been documented in the US. As Barth and Kahn (2021) show, hedge funds hold cash Treasuries financed using reverse repos, while selling Treasury futures to asset managers who want to obtain leveraged duration exposure but face constraints on direct repo borrowing. We abstract away from the interesting interactions between different investment funds that Barth and Kahn (2021) and Kashyap et al. (2025) analyze in detail, but our finding that reverse repos are predominantly taken up by hedge funds is aligned with the mechanism of the Treasury-basis trade eventhough the ultimate holders of duration exposure tend to be other investment funds like mutual funds. Our findings show that the rise in leveraged financing of government bonds is a global phenomenon that is also sizable for European government bonds. We further find that around one-fifth of reverse repos given out by euro area banks are backed by US Treasuries (see Panel (b) of Appendix Table A.1). In subsequent sections, we further connect the rise in leveraged government bond holdings to its implications on bank balance sheets and the real economy.

Relatedly, the close connection between QT, reverse repos, and leveraged government bond holdings that we point out for the euro area is also evident in the US. Appendix Figure A.9 shows

[5]One caveat of the Anacredit data is that we do not observe the specific collateral backing each reverse repo loan. To this end, we use transaction-level reverse repo data from both the SFTDS and the MMSR to confirm that the majority of reverse repos extended by banks to NBFIs are indeed secured by government bonds. Panel (a) of Appendix Table A.1 shows that 83% of reverse repos in the MMSR and 92% of reverse repos in the SFTDs are backed by government bonds for euro area issuers. These findings provide further support that the growth in reverse repo loans stems from the rising supply of government bonds in search of private funding.

that hedge fund repo borrowing rises closely with changes in private holdings of Treasuries and MBS, especially around QE and QT episodes. At the same time, panel (b) of Figure A.11 shows that the decline in Federal Reserve holdings was matched by large increases in the holdings of households and nonprofits (a category that includes hedge funds), money market funds, the rest of the world, investment funds, and dealers.

One concern could be that the observed patterns are driven by conventional monetary policy rather than unconventional monetary policy. Figure 4 overlays reverse repo lending, privately held euro-area government bonds, and the ECB deposit facility rate. ECB rate hikes begin before the large increase in reverse repo lending, and reverse repo lending keeps rising even after policy rates start to decline. This timing is, therefore, difficult to rationalize with interest rate policy and instead points to QT and the associated increase in privately held government bonds as a central driver.

Another important concern is that our results may be driven by variations in banks' loan supply, especially as unconventional monetary policy is endogenously determined based on economic conditions that also affect banks. In the next subsection, we examine the role of specific supply factors in detail. In the remainder of this section, we use granular loan-level data to confirm that NBFI loan demand was the main driver behind the growth in bank-to-NBFI lending during our sample period. We provide three sets of supporting evidence in this regard. First, our key empirical specification relates bank lending to the privately held stock of government bonds:

$$\log(\text{Lending}_{b,n,i,t}) = \alpha_{b,x,t} + \alpha_{b,n,i} + \beta \log(\text{Priv. Gov. Bonds}_{t-1}) \times C_{b,n,i} + \gamma X_{b,n,i,t} + \epsilon_{b,n,i,t}, \quad (4.2)$$

where the outcome variable is the log level of lending by bank b to borrower n through instrument type i at time t. $\log(\text{Priv. Gov. Bonds}_{t-1})$ denotes the log stock of privately held government bonds, lagged by one month. The variable $C_{b,n,i}$ captures borrower and loan characteristics, such as whether the borrower is a hedge fund, whether the borrower is another NBFI, or whether the loan is a repo. The fixed effect $\alpha_{b,n,i}$ absorbs persistent bank–borrower–instrument relationships. To formally assess the role of credit demand, we follow Amiti and Weinstein (2018) and control for credit supply forces by incorporating a granular bank $\times$ loan-bucket $\times$ time fixed effect, $\alpha_{b,x,t}$, where loan buckets are defined by probability of default and maturity, each discretized into five buckets. These fixed effects absorb bank-level and loan-type-specific changes in credit supply over time.

Table 2 reports the results. Columns (1)–(3) use all loans to firms and NBFIs and compare lending to hedge funds and other NBFIs relative to lending to non-financial firms. As privately held government bonds rise, lending increases disproportionately to hedge funds. In economic terms, the estimates imply that a 1% increase in private holdings of government bonds is associated with roughly 2.5% higher lending to hedge funds relative to non-financial firms. Importantly, the hedge-fund coefficient declines only modestly, by around 7%, after absorbing bank × loan-bucket × time fixed effects in column (3). In other words, variations in bank loan supply, even if they involve changes in preferences for the riskiness and maturity of loans, can only explain a relatively small amount of the variation in bank-to-NBFI lending. This implies that the increase in lending primarily reflects stronger borrower demand, while credit supply factors play a smaller role.

Columns (4)–(7) zoom in on NBFI borrowers. Within NBFIs, lending again rises disproportionately to hedge funds. Similarly, the coefficient only declines by around 20% when the model is saturated with the most stringent bank–loan bucket–time fixed effects. This reinforces the interpretation that the pattern is driven primarily by stronger credit demand from hedge funds, with bank supply conditions also contributing, but to a lesser extent. The estimates imply that a 1% increase in private holdings of government bonds is associated with a roughly 1.3% higher lending to hedge funds relative to other NBFIs. Column (7) further confirms that the increase in borrowing by hedge funds is concentrated in reverse repo loans.

Our results are robust to alternative empirical specifications. In particular, Appendix Table A.2 shows that our findings remain unchanged if instead of using the aggregate stock of privately held government bonds, we measure government bond holdings at the sector–country level computed using granular ISIN-level SHSS data.[6]

Second, we show that as loan quantities grew, loan spreads increased rather than decreased, which is consistent with a larger increase in loan demand. In the aggregate, Appendix Figure A.10 shows that as the ECB begins QT and reduces its securities holdings, secured lending spreads move up toward the deposit facility rate. Quantities and spreads rise together, consistent with stronger NBFI demand for repo funding dominating any potential increase in supply, which would have lowered repo spreads. At the loan-level, Table 3 shows that loan quantities

[6]The results show that bank lending rises disproportionately to hedge funds when government bond holdings increase in the corresponding NBFI sector and country. This pattern holds after controlling for bank–time fixed effects, bank–loan-bucket–time fixed effects, and country–time fixed effects, further supporting the interpretation that the expansion of bank-to-NBFI lending reflects securities-financing demand by investment funds. Our results also further generalize to other countries and currencies. [7] Appendix Table A.3 shows that higher country-specific private holdings of government bonds are associated with more lending to hedge funds and more repo lending to NBFIs in all four major currencies. The relationship is therefore not only a euro-area phenomenon: the USD, GBP, and JPY coefficients point to global securities-financing demand during QT.

and spreads both increase disproportionately for hedge funds as privately held government bonds increase, consistent with a dominant borrowing demand channel.[8]

Finally, we provide direct evidence for our proposed channel by showing that when the ECB reduces its holding of a particular government bond, the volumes and spreads of repos backed by that bond increase, consistent with a rise in the demand for repo borrowing to finance that bond. To this end, we calculate the volume of reverse repos backed by bond j of maturity m and issuer-country n in month t, $\text{Lending}_{j,m,n,t}$, and estimate how its log differences are related to changes in the amount of bond j held by the ECB as a proportion of the total outstanding supply, Δ ECB $\text{Holding}_{j,m,n,t}$:

$$\Delta \log(\text{Lending}_{j,m,n,t}) = \alpha_{m,t} + \alpha_{n,t} + \alpha_j + \alpha_{m,n,t} + \beta \text{ECB Holding}_{j,m,n,t} + \epsilon_{j,m,n,t}. \quad (4.4)$$

Although ECB holdings decisions are meant to be market neutral, one may worry about correlated fundamentals that affect both ECB holdings and repo volumes. That is why we only explore variation within specific buckets of repos. In the most stringent specification, we include ISIN fixed effects to rule out bond-specific factors and maturity-country-time fixed effects to only compare bonds issed by the same country and in the same maturity bucket in the same month. We repeat the estimation for repo rates by replacing $\Delta \log(\text{Lending}_{j,m,n,t})$ with changes in repo rates for bond j in month t.

Table 4 reports the results. The coefficients for repo lending and repo rates are both negative and statistically significant across specifications, which indicates that as the ECB reduces its holdings of a given bond, repos backed by that bond increase in volume and trade at a higher rate. These patterns provide direct evidence for an increase in demand for funding bonds in private markets that the ECB retreats from, which increases the demand for reverse repos backed by those bonds. Our fixed effects ensure that these results cannot be explained by changes in conventional monetary policy, reserve supply, or country-level macroeconomic conditions. The increase in repo rates also points to demand increases dominating over any remaining supply factors that exist for reverse repos in the same maturity-country-time bucket.

4.3 Capital and Liquidity Constraints in Bank Lending to Non-Banks

Fact 3. The rise in bank-to-NBFI lending is amplified by bank capital and liquidity constraints.

[8]Moreover, this increase is particularly pronounced for reverse repo loans denominated in non-euro currencies and for transactions backed by low-haircut collateral. These patterns are consistent with hedge funds increasing borrowing from banks to finance Treasury basis trades.

Although the previous section points to a larger effect of NBFI loan demand during our sample period, we proceed to explore potential drivers of bank loan supply because they also play a role in the determination of loan quantities and spreads in equilibrium. Our model in section 5 also features both loan demand and supply factors in evaluating counterfactuals.

First, we examine the effect of central bank reserves. As the ECB reduces its asset portfolio, the quantity of central bank reserves declines at the same time. The decline in reserves has several potential effects on bank balance sheets. Reserves, although risk-free, are counted in the leverage ratio so the reduction in reserves could free up bank balance sheet capacity for other types of lending (Diamond et al., 2024a). At the same time, reserves are highly liquid with zero duration, so lower reserve balances may induce banks to rebalance toward other liquid and low-duration assets, such as short-term collateralized loans to NBFIs (Christensen and Krogstrup, 2019). This rebalancing may be amplified if QE irreversibly increased banks' demand for liquidity (Acharya et al., 2023, Acharya and Rajan, 2024).

Consistent with both channels in the literature, we find that banks with larger reserve reductions also experienced a larger increase in NBFI lending as a proportion of their total assets during the QT period (Appendix Figure A.13). At the same time, banks with lower ex-ante reserve buffers are more exposed to duration and liquidity risk from further reserve reductions and may have stronger incentives to rebalance toward NBFI loans. We test this mechanism by interacting privately held government bond supply with banks' excess reserves measured before the QT period and estimating

$$log(\text{Lending to NBFI}_{b,n,t}) = \alpha_{n,t} + \alpha_{n,b} + \beta \log(\text{Priv. Gov. Bonds}_{t-1}) \times C_b + \epsilon_{b,n,t}, \quad (4.5)$$

where the outcome variable is the log level of bank b's loans to NBFI n at time t and bank characteristic C_b is banks' excess reserves pre QT. We saturate the regression with NBFI-time fixed effects, which control for time-varying credit demand by NBFIs (Khwaja and Mian, 2008), and bank-NBFI fixed effects. Table 5, Column (2) confirms that banks with lower excess reserves indeed increase their lending to NBFIs by more as reserves are drained with QT, consistent with the rebalancing channel.

Nevertheless, we note that the economic effect of reserve supply is relatively modest in our setting. In Appendix Figure A.13, a 1 percentage point decline in reserves relative to total assets is associated with a 4.6 basis point increase in NBFI lending relative to total assets. In Table, 5, a 1% increase in privately held government bonds is associated with about 0.033% higher NBFI lending for a bank with excess reserves one standard deviation lower (about 7 percentage points), relative to a bank with average excess reserves.

Another possibility is that banks are incentivized to increase lending to NBFIs because of capital requirements. Bank capital requirements have steadily increased across developed economies since the Global Financial Crisis and several euro area countries further tightened capital regulation in 2022 by raising countercyclical capital buffers. As capital requirements rise, banks operating closer to regulatory constraints—i.e., those with lower capital ratios—may respond by shifting away from assets that require more equity capital. Indeed, NBFI loans tend to have lower default probabilities and, hence, risk weights than non-financial firm loans (See Appendix Table A.4). This effect is especially pronounced for reverse repos backed by euro area government bond collateral, which have a risk weight of zero. To examine this mechanism, we re-estimate equation 4.8 with banks' ex-ante total capital ratios as explanatory variable. Column (1) of Table 5 shows that banks with lower ex-ante total capital ratios increased their lending to the NBFI sector by more. This result is consistent with prior findings in the literature (Acharya et al., 2024b, Buchak et al., 2024, Chernenko et al., 2025, Xu, 2025).

Finally, we analyze the effect of deposit outflows. Beginning in July 2022, the ECB's rate hikes triggered deposit outflows from bank balance sheets, consistent with the standard deposit channel of monetary policy (Drechsler et al., 2017). Table 5, Column (3), shows that banks losing a greater share of core deposits expanded their NBFI lending by more after the tightening of monetary policy, consistent with loans to NBFIs having shorter maturities and being more liquid than term loans and credit lines to non-finanacial firms, especially reverse repos to NBFIs.

4.4 The Effect of Bank Lending to Non-Bank Financial Intermediaries on Credit Supply

Fact 3. Bank lending to non-bank financial intermediaries primarily crowds out bank credit to non-financial firms on bank balance sheets and leads to a contraction in aggregate credit supply.

What are the implications of bank lending to NBFIs? We have shown that much of the growth in lending goes to NBFIs that do not focus on lending to firms, but the net effect on credit supply further depends on how banks adjust their balance sheets to lend to NBFIs. Do banks substitute away from the same securities that are now held by NBFIs or do they contract actual lending to non-financial firms? At the same time, to what extent can non-financial firms replace the loss in bank loans with loans and credit extended by NBFIs?

Figure 5 shows the evolution of aggregate bank loans to firms and NBFIs with both series normalized to one in January 2019. Over the period from 2019 to 2025, bank lending to NBFIs grew by 80%, whereas lending to firms increased by only about 30%. The divergence became especially pronounced after 2023, when corporate lending stagnated while NBFI credit continued to expand steadily. To assess whether this divergence reflects active substitution on banks' balance sheets rather than coincidental trends, we formally test whether increases in lending to NBFIs are associated with reductions in lending to firms. We proceed in three steps.

First, we use supervisory balance sheet data to examine the relationship between changes in corporate and NBFI lending, each expressed as a share of total loans and securities, at the bank level. Figure 6 presents a binscatter of the change between 2019m12 and 2025m12, showing a strong negative relationship: banks that expanded credit to NBFIs tended to simultaneously reduce lending to firms.

Second, we test these substitution patterns formally by estimating the following regression:

$$\Delta \frac{y_{b,t}}{\text{All Loans \& Securities}_{b,t}} = \alpha_b + \alpha_t + \beta\, \Delta \frac{\text{NBFI Loans}_{b,t}}{\text{All Loans \& Securities}_{b,t}} + \varepsilon_{b,t}, \tag{4.6}$$

where $\Delta y_{b,t}/\text{All Loans \& Securities}_{b,t}$ is the change in the holdings of asset type y (e.g., loans to firms, etc.) by bank b in month t, normalized by total loans and securities. $\Delta\text{NBFI loans}_{b,t}/\text{All Loans \& Securities}_{b,t}$ is the change in bank lending to NBFIs relative to total loans and securities. We saturate the model with time (α_t) and bank fixed effects (α_b).

Table 6 presents the results. We find that the main source of growth in NBFI lending is the reallocation of credit away from firm lending. The coefficient on corporate loans in Column (1) is economically large and statistically significant: a 1 percentage point increase in NBFI lending is associated with a 0.56 percentage point decrease in firm loans. By contrast, substitution from other asset categories, such as loans to banks, household loans, or government bonds and reserves, is considerably weaker in magnitude. This finding suggests that the expansion of lending to NBFIs crowds out direct financing to the corporate sector.

So far, we have argued that an increase in NBFI demand for securities financing leads banks to cut credit to firms. An alternative mechanism is that banks first experience a decline in credit demand from firms and then reallocate balance sheet space toward the NBFI sector. To rule out this reverse-causality interpretation and provide a direct evidence on the substitution between corporate and NBFI lending, we use loan-level data on bank lending to firms, which allows us to control directly for borrower credit demand. To this end, we exploit cross-bank heterogeneity in ex-ante exposure to the NBFI sector and examine whether banks with higher exposure respond differently to increases in privately held government bonds:

$$\log(\text{Lending}_{b,j,t}) = \alpha_{j,t} + \alpha_{b,j} + \beta \log(\text{Priv. Gov. Bonds}_{t-1}) \times \text{Share NBFI Loans}_{2019,b} \times C_j + \varepsilon_{b,j,t}, \tag{4.7}$$

where j denotes either an NBFI borrower or a non-financial firm. Share NBFI $\text{Loans}_{2019,b}$ denotes bank b's pre-period (in 2019) share of loans to NBFIs. Borrower $\times$ time fixed effects absorb borrower-specific credit demand in each month ($\alpha_{j,t}$). In the NBFI sample, Column (1) of Table 7 provides the first stage: as privately held government bonds rise, banks with higher ex-ante NBFI exposure increase their lending to NBFIs. Columns (2)–(3) then show the corresponding real-sector effect in the corporate loan sample. The same exposed banks reduce lending to firms, and the contraction is stronger for risky firms. This pattern is consistent with exposed banks reallocating credit toward securities-financing NBFI lending and away from riskier corporate exposures, rather than banks responding to a decline in corporate credit demand.

So far, we have shown that the expansion of bank lending to NBFIs primarily crowds out bank lending to non-financial firms. However, the extent to which this shift in the composition of bank lending has real effects on firms' credit access further varies with how NBFIs use their bank loans and how much firms can substitute toward loans and other forms of credit, e.g., bonds, extended by NBFIs. To shed light on these effects, we examine firms' borrowing outcomes using firm-level balance sheet data from Orbis and estimate the following regression:

$$\Delta log(\text{borrowing}_f) = \alpha_i + \beta \Delta \text{NBFI loans}_f + \epsilon_f, \tag{4.8}$$

where the outcome variable is the log change in firm-level debt between 2019 and 2024. We consider firm-level loans outstanding from all sources (banks and NBFIs), and total debt, encompassing all loans and bonds. ΔNBFI loans_f denotes firm-level exposure to banks' lending to NBFIs. It is constructed as the weighted average change in the share of each bank's credit to the NBFI sector, with weights given by the firm's outstanding credit with those banks in 2019. α_i denotes industry fixed effects.

Table 8 reports the results. Firms that were initially dependent on banks, which subsequently expanded their NBFI exposures, experienced significantly larger declines in both total bank loans and overall debt between 2019 and 2024. The effect is concentrated among small firms, for which the interaction term roughly doubles in magnitude. These results indicate that the crowding-out of corporate lending by NBFI exposures translates into tangible reductions in external financing for non-financial firms. Bank lending to NBFIs does not appear to channel back to firms, which also fail to replace the lost bank credit through alternative sources, including direct NBFI borrowing or corporate bond issuance.

Together, our findings in this section highlight the real effects of the rise in bank-to-NBFI lending. As banks allocate more balance sheet space toward NBFI loans that predominantly fund securities, they also substitute away from direct lending to non-financial firms. Firms are unable to substitute the loss in bank funding with alternative sources and credit supply contracts, especially for smaller and riskier firms. Therefore, the rise in bank-to-NBFI lending reflects a narrowing of bank balance sheets and a reduction in credit intermediation.

With that said, credit supply to firms is certainly not the only variable of interest. Our results also imply that the rise in bank-to-NBFI lending expanded the funding of government bonds from the two sectors combined. This expansion in funding capacity may be instrumental for supporting the government bond market as issuance rises and central bank holdings decline across advanced economies. To shed light on these implications, our model will quantify the effect of bank-to-NBFI lending on government bond yields alongside credit provision to firms.

5 Model

In this section, we develop a model to rationalize our empirical findings and to quantify how demand, interacted with supply side constraint, influences the aggregate credit to non-financial firms. The economy features three asset classes—government bonds, corporate loans, and stocks—along with a banking sector that funds itself through both retail and institutional deposits and faces regulatory capital and leverage constraints. A heterogeneous NBFI sector borrows from the bank and allocates across the same risky assets, generating the bank–NBFI interconnections documented in the data. In Section 5.1, we present the model setup. We then analyze bank and NBFIs' portfolio optimization problems to shed light on the cross-sectional variation in NBFI balance sheet composition in Section 5.2. Finally, in Section 5.3, we calibrate the model and conduct counterfactual analysis.

Note that in the model section, we will refer to firms' borrowing of loans and the issuance of securities as the supply of loans and securities, respectively. NBFIs and banks will optimally choose the amount of firms' loans and securities they hold, i.e., demand firm loans and securities.

This terminology aligns with modeling convention and does not change the economic intuition of firms demanding loans that are provided by banks and NBFIs.

5.1 Model Setup

We consider a two-period model with a representative bank and a NBFI sector. Both the bank and the NBFIs make portfolio allocation decisions in the first period, and returns are realized in the second period.

Assets There are three types of risky assets with exogenously given supply curves in the economy: government bonds ($j = 1$), corporate loans ($j = 2$), and stocks ($j = 3$). Their cash flows are jointly normally distributed,

$$X = \begin{pmatrix} X_1 \\ X_2 \\ X_3 \end{pmatrix} \sim N\left(\begin{pmatrix} \bar{X}_1 \\ \bar{X}_2 \\ \bar{X}_3 \end{pmatrix}, \; \Sigma_C \right), \tag{5.9}$$

where Σ_C is a 3×3 positive-definite cash-flow covariance matrix. We denote the returns as μ_j and the return covariance matrix as Σ. Consistent with data, we assume that government bonds are the safest and most liquid asset, corporate loans are riskier and less liquid, and stocks are the most volatile: $\Sigma_{C,11} < \Sigma_{C,22} < \Sigma_{C,33}$. Government bonds can be used to collateralize bank debt with low haircuts, as they are highly liquid and carry minimal credit risk.

In addition to the three risky assets, the bank can hold reserves—a risk-free asset with fixed aggregate supply $R > 0$ with a return r_R. Reserves carry zero risk weight under capital regulation and are available only to the bank; NBFIs cannot hold reserves directly.

The supply of each risky asset, $s_j(\mu_j)$ for $j \in \{1, 2, 3\}$, is decreasing in expected returns, i.e., $s'_j(\mu_j) < 0$. Higher expected returns correspond to lower asset prices and hence reduced issuance. These residual supply functions capture net issuances from firms, governments, or other agencies, netting out the demand of other investors outside the banking sector and NBFIs, such as households or foreign investors. Hence, when we analyze the effect of government bond supply shifts, we shift the residual supply curve facing the combined intermediary sector of banks and NBFIs. This is important because these are the two primary sectors that lend to firms in the economy. We specify the exact functional form in the calibration section. In addition to these exogenously supplied assets, the bank can also lend to NBFIs, which we describe in detail below.

NBFIs NBFIs invest externally supplied equity and their borrowing from the bank across the three risky assets—government bonds, corporate loans, and stocks—taking the assets' expected returns and covariances as given. Only government bonds (asset 1), which are highly liquid and carry minimal credit risk, can be pledged as collateral when NBFIs borrow from the bank. NBFIs can borrow from the bank at a loan rate $r_d(\lambda_i, w_{d,i})$, where λ_i is the degree of collateralization and $w_{d,i}$ is the amount borrowed. As we will show later, this loan schedule depends on the bank's optimization problem, and it is decreasing in the degree of collateralization λ_i and increasing in the amount borrowed.

For a given NBFI $i \in \mathcal{I}$, let $\mathbf{w}_i \equiv (w_{1,i}, w_{2,i}, w_{3,i}, w_{d,i})^\top$ denote its portfolio weights on government bonds, corporate loans, stocks, and bank debt, respectively. We consider the parameter regions where NBFIs borrow from the bank so that $w_{d,i} < 0$. The budget constraint implies that

$$w_{1,i} + w_{2,i} + w_{3,i} + w_{d,i} = 1. \tag{5.10}$$

Furthermore, we assume only government bonds can be pledged as collateral for borrowing from the bank. Hence the collateral constraint can be written as

$$0 \ \leq \ w_{1,i} + \lambda_i \, w_{d,i}, \qquad \lambda_i \geq 0. \tag{5.11}$$

When $w_{d,i} < 0$, the NBFI must hold enough government bonds to satisfy the haircut requirement for the chosen degree of collateralization λ_i. Here, λ_i can be interpreted as either the average haircut on NBFI i's bank borrowing or, equivalently, the share of its bank borrowing that is collateralized by safe government securities, as in reverse repos.

Given the asset return distribution and bank loan rate $r_d(\lambda_i, w_{d,i})$, the NBFI's expected portfolio return and portfolio variance are

$$\mu_{p,i} = \mu_1 w_{1,i} + \mu_2 w_{2,i} + \mu_3 w_{3,i} + w_{d,i} \, r_d(\lambda_i, w_{d,i}), \tag{5.12}$$

$$\sigma^2_{p,i} = \mathbf{w}_i^\top \Sigma \, \mathbf{w}_i, \qquad \mathbf{w}_i = (w_{1,i}, \ w_{2,i}, \ w_{3,i})^\top. \tag{5.13}$$

We assume investors' demand for NBFIs' equity claims rises with expected payoffs and falls with risk. In practice, mutual fund flows—and thus assets under management—have been shown to increase with expected returns and decrease with return volatility; pension funds exhibit similar patterns over a longer horizon, attracting more capital when expected returns are higher and risk is lower. We adopt a reduced-form equity-demand function for the NBFIs:

$$E_i \;=\; \bar{E} \;+\; \phi_{\mu,i}\,\mu_{p,i} \;-\; \tfrac{\phi_{\sigma,i}}{2}\,\sigma_{p,i}^2, \qquad \phi_{\mu,i} > 0,\; \phi_{\sigma,i} > 0, \tag{5.14}$$

where $\phi_{\mu,i}$ and $\phi_{\sigma,i}$ capture the sensitivity of investor demand to return and risk, respectively. The parameter $\bar{E}$ captures a baseline level of external equity that is independent of portfolio returns, for example due to locked-in investors or other institutional features.

We capture the heterogeneity in the NBFI sector through differences in risk and return sensitivities $\phi_{\sigma,i}$ and $\phi_{\mu,i}$. While hedge funds and mutual funds may have investors that are more sensitive to risk, lending companies may have more risk tolerant investors. Hence the relative magnitude of ϕ_σ to ϕ_μ is different across institutions. These differences could originate from different investor bases and segmented markets. For example, retail investors may be able to invest in mutual funds, but may not have direct access to private debt funds. Alternatively, differences in sensitivity could come from investors mentally allocating wealth across different financial vehicles for different purposes — investors may be less risk tolerant when thinking about investments in retirement savings compared to other investments. Another way to interpret the risk sensitivity is the convenience and liquidity value provided by the equity claims of NBFIs: high volatility reduces the convenience value provided by equity claims. While there are many other differences across different types of NBFIs, we show that the variation in risk sensitivity generates heterogeneity in NBFIs' asset and liability choices that are consistent with a range of empirical patterns documented in the previous section. One of the key contributions of the paper is to capture the wide degree of heterogeneity in the NBFI sector in a parsimonious way.

Taking asset returns and bank loan rates as given, each NBFI chooses its portfolio weights and collateralization to maximize equity value:

$$\max_{w_1,\, w_2,\, w_3,\, w_d,\, \lambda\in[0,\bar{\lambda}]} E_i(w_1, w_2, w_3, w_d, \lambda) \tag{5.15}$$

subject to constraint (5.10) and (5.11). Economically, NBFIs trade off higher expected returns from holding riskier, less liquid corporate loans (w_2) and volatile stocks (w_3) against the equity-risk penalty captured by ϕ_σ. They can reduce borrowing costs by pledging more collateral, which lowers the loan rate $r_d(\lambda, w_d)$ but requires holding more government bonds.

Bank We consider a representative bank that finances itself with retail deposits d_r and institutional deposits d_i, with a given amount of equity E_B. It allocates funds across reserves, the three risky assets, and loans to NBFIs. Reserve holdings are fixed by the central bank's aggregate supply. Let a_R denote the bank's reserve holdings, a_j its holdings of risky asset $j \in \{1, 2, 3\}$, and ℓ its lending to NBFIs. The balance sheet identity is

$$a_R + a_1 + a_2 + a_3 + \ell \;=\; d_r + d_i + 1, \tag{5.16}$$

where reserve holdings are pinned by the fixed aggregate supply: $a_R = R/E_B$.

The variance of the bank's equity return is given by $\sigma_b^2 = (a_1, a_2, a_3)\,\Sigma\,(a_1, a_2, a_3)^\top$. NBFI loans are treated as carrying negligible variance from the bank's perspective, since NBFI equity absorbs losses first and the loans are partially collateralized.[9]

The bank has access to two types of deposits. Retail deposits are provided by insured, relatively "sleepy" depositors whose supply is insensitive to the bank's portfolio risk. Their rate follows a log-linear schedule:

$$r_{d_r}(d_r) = r_{Dr,0} + \beta_{Dr} \log d_r. \tag{5.17}$$

Institutional deposits, which include wholesale and uninsured funding, are sensitive to the riskiness of the bank's portfolio. Their rate includes a risk premium:

$$r_{d_i}(d_i) = r_{Di,0} + \beta_{Di} \log d_i + \tfrac{\gamma_i}{2}\,\sigma_b^2, \tag{5.18}$$

where $\gamma_i > 0$ captures institutional depositors' sensitivity to the bank's portfolio risk σ_b^2. A more volatile bank portfolio increases the risk of bank failure and reduces the convenience value of deposits for institutional depositors, requiring a higher rate to attract the same volume of funding. In addition, the bank incurs adjustment costs $\tau_{d_r} = \tau_{1,r}\, d_r + \frac{\tau_{2,r}}{2}\,(d_r - \bar{d}_r)^2$ and $\tau_{d_i} = \tau_{1,i}\, d_i + \frac{\tau_{2,i}}{2}\,(d_i - \bar{d}_i)^2$ for retail and institutional deposits, respectively.

The bank is risk-averse and maximizes expected return on equity net of deposit costs, acquisition costs, and a mean-variance penalty:

$$\max_{a_1, a_2, a_3, \ell, d_r, d_i} r_R\, a_R + \sum_{j=1}^{3} \mu_j\, a_j + r_d\, \ell - r_{d_r}\, d_r - r_{d_i} d_i - \tau_{d_r} - \tau_{d_i} - \tfrac{\gamma_b}{2}\,\sigma_b^2, \tag{5.19}$$

where $\gamma_b > 0$ is the bank's intrinsic risk aversion. The effective risk aversion of the bank is

[9] The risk of NBFI loans does enter the bank's problem through the risk-weighted capital constraint, as we describe below.

$\gamma_b + \gamma_i\, d_i$: beyond its own risk preferences, the bank internalizes that a riskier portfolio raises the cost of institutional deposits. The bank's effective risk aversion is what determines its portfolio choice.The bank maximizes subject to the balance sheet identity (5.16), a risk-weighted capital constraint, and a leverage constraint, which we describe next.

The risk-weighted capital constraint limits the bank's total risk-weighted exposures:

$$c(\chi_1)\, a_1 + c(\chi_2)\, a_2 + c(\chi_3)\, a_3 + c(\chi_n)\, \ell \;\leq\; \iota_c, \tag{5.20}$$

where $c(\chi_j)$ denotes the regulatory risk weight associated with each asset class, and ι_c is the bank's risk-weighted capital limit. Reserves carry a zero risk weight and do not appear in the constraint. The risk weights of the assets are linked their default probabilities. In particular, the risk weight on NBFI loans, $c(\chi_n)$, depends on the endogenous default probability of the NBFI, which in turn depends on the NBFI's portfolio composition and leverage. More collateralized NBFI loans are associated with lower default risk and hence lower risk weights. We specify the default probability of NBFI loans is given by $\Phi(\frac{b_p - \mu_{p,i}}{\sigma_{p,i}})$, where b_p is a default threshold, that we calibrate to data to match the average default probability of NBFI loans. The default threshold b_p captures the fact that NBFI claims are a mix of claims that have different seniority relative to bank debt.

In addition, the bank faces a leverage constraint that caps total assets relative to equity:

$$a_R + a_1 + a_2 + a_3 + \ell \;\leq\; \iota_l, \tag{5.21}$$

which reflects the Basel leverage ratio requirement. Unlike the risk-weighted constraint, the leverage constraint applies uniformly to all assets regardless of their risk profile.

In equilibrium, the bank holds some government bonds indirectly through lending to NBFIs. In practice, even though government securities carry similar balance sheet cost as reverse repos, banks may prefer to hold securities through NBFI loans rather than direct holdings of government bonds due to differences in the willingness and cost to bear risk. The bank's depositor base—particularly institutional depositors—may be sensitive to the duration risk that comes with direct holdings of government bonds, compared to the investors of mutual funds or hedge funds.[10] Hedging duration risk using derivatives is also subject to regulatory cost for banks but not for

[10]Even though the insured sleepy depositors are insensitive to duration risk and interest rate fluctuations, the bank's marginal source of funding, including wholesale funding, is sensitive to the bank's portfolio risk. It is the marginal funding source that determines what the bank holds when there is an expansion of balance sheet size.

NBFIs like hedge funds. These factors are internalized by the bank when optimizing its portfolio through the institutional deposit rate it pays, as captured by the risk sensitivity parameter γ_i in equation (5.18), and they rationalize the bank's preference for indirect holdings.

Market Clearing In a competitive equilibrium, the bank and NBFIs choose their optimal portfolios taking as given asset returns and the bank loan schedule. All asset markets and loan markets clear. There are five market-clearing conditions:

$$\text{Reserves:} \qquad a_R\, E_B \;=\; R, \tag{5.22}$$

$$\text{Bank–NBFI credit:} \qquad \ell\, E_B + \sum_{i \in \mathcal{I}} E_i\, w_{d,i} \;=\; 0, \tag{5.23}$$

$$\text{Risky assets } (j = 1, 2, 3)\text{:} \qquad a_j\, E_B + \sum_{i \in \mathcal{I}} E_i\, w_{j,i} \;=\; s_j(\mu_j). \tag{5.24}$$

The reserve market-clearing condition (5.22) pins the bank's reserve holdings to the exogenous supply. Equation (5.23) states that the bank's lending to NBFIs must equal the NBFIs' demand for bank borrowing. Equation (5.24) requires that total demand for each risky asset—from the bank and all NBFIs—equals the exogenous supply.

5.2 Cross-sectional Heterogeneity of NBFIs

To explain the cross-sectional differences in NBFIs' portfolio choices, it is useful to define $\kappa_i := \phi_{\sigma,i}/\phi_{\mu,i}$, which summarizes NBFI i's relative sensitivity to risk versus return.

First, we derive the bank's loan-supply schedule from its first-order conditions. Let η denote the Lagrange multiplier on the bank's balance sheet constraint, let $\nu \geq 0$ denote the multiplier on the risk-weighted capital constraint (5.20) and $\xi \geq 0$ is the multiplier on the leverage constraint (5.21). The first-order condition for lending to NBFIs then yields

$$r_d(\lambda_i) = \underbrace{c(\chi_n)\,\nu}_{\text{capital charge}} + \underbrace{\xi}_{\text{leverage charge}} + \underbrace{\eta}_{\text{funding cost}} . \tag{5.25}$$

The required loan rate equals the bank's marginal cost of funds (taking into account the leverage constraint) plus a capital charge that depends on the shadow cost of capital ν and the risk weight $c(\chi_n)$ of the NBFI loan.

The NBFI's default probability χ_n depends on its portfolio composition. A higher collateralization improves the NBFI's risk profile, while higher leverage makes it riskier. Hence, the risk weight $c(\chi_n)$ is decreasing in the collateralization level λ_i and increasing in the leverage level $|w_d|$. We summarize the result below.

Lemma 1. *The bank's loan-supply schedule $r_d(\lambda, w_d)$ decreasing in the collateralization level λ and increasing in leverage $|w_d|$, i.e., $\frac{\partial r_d}{\partial \lambda} \leq 0$ and $\frac{\partial r_d}{\partial w_d} \leq 0$.*

Second, starting from the NBFI's optimization problem, we derive comparative statics that describe how portfolio choices vary with the relative risk sensitivity parameter, κ_i. To isolate the mechanism cleanly, we consider the two-asset specialization of the model with $w_{3,i} = 0$ and uncorrelated returns. Let $\theta_i := w_{1,i}/(w_{1,i} + w_{2,i})$ denote the share of government bonds in total risky asset holdings. Intuitively, NBFIs that are more risk-sensitive (with higher κ_i) tilt their portfolios toward safer government bonds rather than riskier corporate loans and rely less on bank borrowing. However, conditional on borrowing, they do so at higher collateralization levels, since they hold more bonds and more collateralized loans are cheaper. More formally,

Proposition 1. *Consider the two-asset specialization with $w_{3,i} = 0$ and uncorrelated returns. Under some regularity conditions, when r_d is convex in $|w_d|$ and θ is not too large, NBFIs with higher relative risk sensitivity $\kappa_i = \phi_{\sigma,i}/\phi_{\mu,i}$ hold a higher share of government bonds in their asset portfolio, borrow less from the bank, but choose higher collateralization levels when they do borrow. That is,*

$$\frac{\partial \theta_i}{\partial \kappa_i} \geq 0, \qquad \frac{\partial w_{d,i}}{\partial \kappa_i} \geq 0, \qquad \frac{\partial \lambda_i}{\partial \kappa_i} > 0 \quad \text{when } w_{d,i} < 0 \text{ and the collateral constraint binds.}$$

In Appendix A2, we examine the cross-sectional relationships between NBFIs' asset composition, leverage, and loan type and confirm the predictions in Proposition 1.

5.3 Model Estimation

We are interested in the equilibrium amount of lending to firms from both the bank and the NBFIs. Let this aggregate loan quantity be $L \equiv E_B a_L + \sum_{i \in \mathcal{I}} E_i w_{L,i}$. We calibrate the model to the aggregate euro-area banking and non-bank financial sectors. Since we are interested in the aggregate effect, we collapse the heterogeneous NBFI in the model to one representative NBFI whose attributes are a value weighted average of different NBFIs in the economy. We conduct counterfactual exercises using the calibrated model to understand how demand, interacted with supply-side constraints, affect aggregate lending to firms and bank lending to NBFIs.

5.3.1 Estimating the Demand System for Deposits and Loans

We start by estimating demand curves that individual banks face in three markets: retail deposits, institutional deposits, and corporate loans. These serve as direct inputs to the model calibration. We proxy for retail deposits using total household deposits, while institutional deposits are defined as deposits of non-financial corporations plus repo borrowing. Following the discrete-choice logit demand framework, we estimate two demand systems at the bank–country–month level. For each deposit category (retail and institutional), we capture depositors' sensitivity to deposit rates and risk using

$$\log Q_{D,nmt} = \chi_{D,nt} + \chi_{D,m} + \alpha_D R_{D,nmt} + \delta_D \mathrm{NPL}_{nmt} + \varepsilon_{D,nmt}, \tag{5.26}$$

where $Q_{D,nmt}$ is the deposit stock of type $D \in \{\text{retail}, \text{institutional}\}$ at bank m in country n at month t. $R_{D,nmt}$ is the average deposit rate paid, and NPL_{nmt} is the non-performing loan ratio as a share of total assets, which proxies for bank riskiness. We include a market–time fixed effect $\chi_{D,nt}$ that absorbs unobserved log market size and a bank fixed effect $\chi_{D,m}$ that absorbs unobserved bank heterogeneity. Similarly, for corporate loans, we estimate

$$\log Q_{L,nmt} = \chi_{L,nt} + \chi_{L,m} + \alpha_L R_{L,nmt} + \varepsilon_{L,nmt}, \tag{5.27}$$

where $Q_{L,nmt}$ is the loan stock and $R_{L,nmt}$ is the average loan rate charged.

Identification The identification challenge is that deposit rates, loan rates, and the ratio of non-performing loans are determined by both demand and supply in equilibrium so they can be correlated with unobserved shifts in demand. To consistently trace out depositors' and borrowers's demand, we need to instrument for deposit and loan rates using supply shifters.

The first instrument is banks' ratio of administrative expenses excluding staff costs to total assets from FINREP. The idea is that variation in administrative costs reflects supply-side production technology: high operating cost banks therefore can only offer lower deposit rates and charge higher loan rates. The assumption is that after controlling for the bank's permanent business model through bank fixed effects, the residual variation in administrative costs is plausibly orthogonal to time-varying unobserved demand shifters.

The second instrument is the lagged unexpected component of bank-reported credit-standard changes from the Individual Bank Lending Survey (IBLS), a quarterly panel in which each individual bank reports its own credit-standard movements. Our Lending Standards Surprise instrument takes on a more positive value when lending conditions realized to be more lenient than the bank's expected value in the prior quarter's survey.[11] The exclusion restriction is that the surprise component, which is by construction orthogonal to the bank's own information set one quarter prior, reflects shocks to bank credit-supply realisations rather than contemporaneous depositor demand shifters.

Estimation Results Panel (a) of Table 9 reports the first-stage. The signs on the coefficient for both instruments are consistent with their economic interpretation. Banks with higher costs pay lower deposit rates and charge higher loan rates. The Lending Standards Surprise significantly predicts the NPL ratio with a negative coefficient: a more lenient-than-expected realisation of credit standards is associated with a lower subsequent NPL ratio. This is consistent with the following intepretation: when realised lending conditions turn out tougher than expected, loans originated under the previous, more optimistic assumption default at higher rates, raising NPLs with a lag.

The price-disutility estimates in panel (b) of Table 9 are positive for both deposit types and negative for loans, as expected. consistent with theoretical expectations. Quantitatively, a 10-basis-point increase in the retail deposit rate raises the bank's deposit share by 10.99%; the same change in the institutional deposit rate raises that share by 10.33%. For corporate loans, a 10-basis-point decrease in the loan rate raises the bank's loan share by 16.07%.[12] [13] We further find that the coefficient on the NPL ratio is statistically indistinguishable from zero for retail de-

[11] Specifically, we extract two answers from each bank in each quarter: the realized change in corporate credit standards over the past three months (IBLS Q1) and the expectation of the change over the next three months (IBLS Q8), both on a centered five-point scale rescaled to $[-2, +2]$, where $+2$ denotes "eased considerably" and -2 denotes "tightened considerably". The Lending Standards Surprise is defined as the difference between the realized value and the same bank's one-quarter-prior forecast of that quarter so that a positive value indicates that lending conditions turned out more lenient than the bank had anticipated and a negative value indicates the opposite. In the baseline, we use a six-month lag of this surprise to allow time for the resulting borrower selection and realised credit-quality outcomes to translate into observed deposit-side variables.

[12] These coefficients capture *bank-level* substitution: how a single bank's quantity responds to its own rate, holding fixed the rest of the market. The corresponding *market-level* aggregate elasticity—the response of total deposits or loans in a country to a uniform rate shift across all banks—requires multiplying by the outside-option sensitivity parameter β_o. We estimate β_o following Diamond et al. (2024b) at the country-month level and report the resulting aggregate elasticities in Appendix A3.

[13] Our price-disutility parameters fall within the range reported in prior literature on bank deposit and loan demand. For deposits, Diamond et al. (2024b) estimate $\hat{\alpha}_D = 151$ in U.S. data, and Egan et al. (2017) report price-disutility parameters between approximately 17 and 59. Our estimates of 109.9 (retail) and 103.3 (institutional) sit in the middle of this range, consistent with euro-area depositors exhibiting similar rate sensitivity to that of U.S. depositors. For corporate loans, Diamond et al. (2024b) report $\hat{\alpha}_L$ between -310 and -244 in the U.S. while our estimate of -160.7 is somewhat smaller in magnitude, plausibly reflecting greater bank-dependence of euro-area corporate borrowers and fewer outside-option substitutes (e.g. a less-developed bond financing market for smaller firms).

posits equation but significantly negative for institutional deposits. This asymmetry is consistent with institutional depositors monitoring and reacting to bank asset quality, whereas insured retail depositors do not respond.

5.3.2 Estimating the Sensitivity of NBFI Flows to Returns

Another central object in our quantitative model is the sensitivity of NBFI investor demand to the returns on NBFI claims. We estimate the flow-return sensitivity at the sector $\times$ country $\times$ quarter level using the Eurosystem's Quarterly Sectoral Accounts (QSA) for NBFI sectors from 2019Q1 to 2024Q4 using the following specification

$$Flow_{s,c,t} \;=\; \mu_c + \tau_t + \beta \cdot ROA_{s,c,t} \;+\; \varepsilon_{s,c,t}, \tag{5.28}$$

where $ROA_{s,c,t}$ is realized return on assets for sector s in country c and quarter t, $Flow_{s,c,t}$ is the net flow rate, μ_c and τ_t are country and quarter fixed effects. The coefficient of interest is β, the flow-on-return elasticity. We focus on the two NBFI sectors that borrow most heavily from euro-area banks—investment funds and other financial intermediaries.[14]

Identification Simply regressing flows on ROA is contaminated by the joint determination of asset prices and investor demand: contemporaneous fund-level outflows can mechanically depress measured ROA through fire-sale pressure, while news that moves returns also moves investor sentiment. To isolate plausibly exogenous variation in NBFI returns, we construct an instrument from bank-level loan-pricing shocks similar in spirit to the estimation of bank supply shocks in Amiti and Weinstein (2018).

Using loan-level data on bank lending to NBFIs from AnaCredit, we estimate $\text{Rate}_{b,n,t} = \phi_{b,t} + \psi_{n,t} + \gamma \cdot C_{b,n,t} + u_{b,n,t}$, where $\text{Rate}_{b,n,t}$ is the interest rate charged by bank b on its outstanding lending to NBFI n in month t, $\phi_{b,t}$ is the bank–time fixed effect, $\psi_{n,t}$ is the NBFI–time fixed effect, and $C_{b,n,t}$ denotes loan-level control for the probability of default and loan maturity. The bank–time fixed effect $\phi_{b,t}$ identifies idiosyncratic bank-level shifts in loan pricing—e.g., shocks to funding cost, capital position, or risk appetite—orthogonal to NBFI demand absorbed by $\psi_{n,t}$. We then aggregate $\phi_{b,t}$ to the sector–country–quarter level using lagged bank–NBFI lending volumes

[14] For sector s in country c and quarter t, we use QSA data to compute ROA and net flows as follows. Let $LE_{s,c,t}$ denote total financial assets (closing balance-sheet positions), $F_{s,c,t}$ denote financial transactions (net inflows), $K_{s,c,t}$ denote total other changes in financial assets, and $KA_{s,c,t}$ denote other changes excluding revaluations. We can then define the realized return on assets and the net flow rate as $ROA_{s,c,t} = \frac{K_{s,c,t} - KA_{s,c,t}}{LE_{s,c,t-1}}$ and $Flow_{s,c,t} = \frac{F_{s,c,t}}{LE_{s,c,t-1}}$,, respectively.

as weights, $\widetilde{\phi}_{s,c,t} = \sum_b \omega_{b,s,c,t-1} \cdot \phi_{b,t}$, where $\omega_{b,s,c,t-1} = \frac{\text{Credit}_{b,s,c,t-1}}{\sum_{b'} \text{Credit}_{b',s,c,t-1}}$, and use the one-quarter lagged value $\widetilde{\phi}_{s,c,t-1}$ as instrument.

The exclusion restriction is that $\widetilde{\phi}_{s,c,t-1}$ affects NBFI flows only through its effect on NBFI returns. Because $\phi_{b,t}$ is identified off variation in loan pricing within bank–month that is orthogonal to borrower demand shocks ($\psi_{n,t}$), the aggregated instrument is plausibly excludable from the second stage. Tighter bank loan pricing raises NBFIs' cost of leverage and compresses the realized return on their leveraged asset portfolios; this is the mechanism we exploit for identification.

Estimation Results Column (1) of Table 10 reports the first-stage estimate. The coefficient on the lagged aggregated bank loan-rate shock is negative: an increase in $\widetilde{\phi}_{s,c,t-1}$—a tightening of bank loan pricing toward NBFI borrowers—is associated with a decline in NBFI ROA. The sign matches the mechanism: tighter bank loan pricing lowers NBFI returns by raising the cost of leverage. Column (2) reports the 2SLS estimate. A one-percentage-point increase in instrumented NBFI ROA raises the quarterly net flow rate by 0.71 percentage points.

5.3.3 Model Calibration

We solve the general equilibrium model for a given set of parameters. The calibration of the model is done in two steps. We take the first set of parameters from our reduced-form demand estimates and the asset-pricing literature. We then calibrate the remaining structural parameters jointly to match a set of empirical moments by minimizing the weighted sum of squared deviations between the model-implied and empirical moments.

We let the supply of each risky asset j (government bonds, corporate loans, and equities) belog-linear in its return, $s_j(p_j) = \exp\big(\alpha_j + \delta_j \bar{X}_j/p_j\big)$, so that $\delta_j < 0$ is the elasticity of the residual supply of asset j. Higher return implies less issuance and more demand from other investors, hence the residual supply to the bank and NBFIs is downward sloping.

We set the risk-weight in capital constraint according to the Basel III IRB formula. In particular, we assume government bonds have zero risk-weight, equities have a fixed risk-weight of 0.20, and corporate and NBFI loans have risk-weights that depend on the default probability of the borrower, the loss-given-default, the asset correlation, and the effective maturity of the loan. Details are in Appendix A5. The default probability of NBFI loans is endogenously determined by the NBFI's portfolio choice and leverage. In practice, NBFIs borrowing include both bank debt and bonds. Given our purpose, we treat the bonds issued by NBFIs as external investor claims and only count bank debt as NBFI leverage so that the market clearing condition of NBFI loans is consistent with the amount from the bank's balance sheet. The default probability of NBFI loans is given by $\Phi(\frac{b_p - \mu_p}{\sigma_p})$, where the default threshold b_p captures the fact that NBFI claims are a mix of claims that may have different seniority relative to bank debt.

Table 11 shows the parameters fixed outside the joint calibration. The deposit-rate slopes β_{Dr}, β_{Di} and the corporate-loan supply elasticity δ_2 are set to match the demand elasticities estimated in Table 9. The government-bond residual supply elasticity $\delta_1 = -3.2$ and the equity residual supply elasticity $\delta_3 = -1.2$ are set from the asset-demand-system literature (Koijen and Yogo, 2026). We normalize asset payoffs at $\bar{X}_j = 1$.

We jointly calibrate the remaining structural parameters to match a set of empirical moments. Table 12 lists the moments matched in the joint calibration, their empirical values and their calibrated model counterparts. Balance-sheet moments—the bank and NBFI portfolio shares and the two leverages—are computed as the average values from sectorial balance-sheet data.[15] The flow–performance sensitivity comes from our estimates in Table 10. Average NBFI-loan default probability and lending rates are obtained from our loan-level data. For asset return moments, we calculate means and covariance from return series beginning in 2000 or whenever the earliest data point is available to capture long-run expectations. We use the corporate loan return from the S&P Euro Loan Index, equity return from the STOXX index, and government bond return from the FTSE index.[16] We normalize the adjustment cost coefficient for retail deposits to 1 and calibrate the adjustment cost coefficient for institutional deposits to match the marginal deposit-response split between retail and institutional depositors. Specifically, using individual bank responses from the IBLS, we estimate how retail and institutional deposits respond to an increase in corporate loan demand. We find that, in response to higher loan demand, banks increase retail and institutional deposits in proportions of 0.33 and 0.67, respectively.

We also calibrate the parameters ι_c and ι_l in the capital constraint and the leverage constraint, instead of setting them to the regulatory minimum. The reason is that the regulatory minimum is a lower bound on the capital and leverage ratios. Even though they might not bind in a given period, they may still bind dynamically as the bank is forward looking. We are not able to capture the dynamic effect in our static model, so we infer the role of these parameters from the bank's portfolio choice.

[15] The "other" category from the bank the NBFI's balance sheet is small. "Cash" for NBFIs is also small. We rescale the rest of the balance sheet items to sum up to 1.

[16] The government-bond return is computed as the portfolio-weighted average of U.S. and euro-area government-bond returns, using banks' and NBFIs' portfolio weights.

The model matches most of the moments well, for example, the NBFI portfolio shares, the bank's NBFI-loan and reserve holdings, the institutional deposit share, the marginal deposit-response split, the two leverages, the corporate-loan return, and the return covariances. The gap is bigger for the bank's remaining asset composition—the model holds more government bonds and fewer corporate loans than the data. This may be because we are using loan index series for returns, not fully capturing the true volatility of corporate loans for banks. The model also overshoots the equity return, but the empirical equity return is sensitive to the sample period. Finally, we find that the empirical moments are most consistent with the capital constraint being binding and the leverage constraint being slack. Table 13 reports the full set of calibrated structural parameters.[17]

5.4 Counterfactual Analysis

Finally, we use the calibrated model to trace out how an expansion in the supply of government securities to the private sector propagates to firm credit, bank lending to NBFIs, and government bond yields. We further evalaute how these effects depend on the ease at which banks are allowed to lend to NBFIs.

5.4.1 Increase in Bond Supply

We first consider the effect of a 5% outward shift in the supply of government bonds for the combined financial sector (we increase α_1 by 5%), motivated by the rise in sovereign issuance and the decline in central-bank holdings documented in our empirical analysis. A larger supply of government bonds raises the equilibrium bond yield. Both the bank and the NBFI tilt their portfolios toward the higher-yielding bond and away from corporate loans, which contracts lending to firms.

Further, on the margin, the bank's cost of holding securities outright—through its own risk aversion and its depositors' preference—is higher than that of the NBFI sector, whose more risk-tolerant investors make it the better marginal holder of the additional bonds. Hence in response to a supply shock, the bank prefer to extend short-term, collateralized reverse repos to NBFIs over holding the additional government securities directly on their own balance sheets. Access to reverse repos from banks allow NBFIs to lever up and fund more securities. As a result, the bank also reallocates away from direct lending to firms toward lending to NBFIs, bank-to-NBFI

[17]Note that we cannot separately identify the bank equity holder's risk aversion from the institutional depositors' risk aversion — what matters for the bank's portfolio choice is the effective risk aversion, which incorporates both. Hence, in the table, we report the effective risk aversion of the bank.

lending rises, and total lending to non-financial firms contracts.

Quantitatively, the degree of substitution depends on how sensitivite the aggregate intermediary sector is to changes in government bond returns and the supply elasticity in the loan market. In our calibration, the holdings of the intermediary sector is sensitive to bond returns, and given a relatively elastic loan market, the negative spillover effect to corporate loans is economically significant. Our estimates show that bank lending to NBFIs grows by 3.6%, while lending to firms contracts by 6.3% in the aggregate. At the same time, the government bond yield rises by 2.2 basis points as a result of the supply shock.[18]

5.4.2 Increase in Bond Supply with Costlier Bank-to-NBFI Lending

The extent to which firm credit is crowded out depends crucially on the connection between the bank and the NBFI sector. To better understand the impact of bank-to-NBFI lending, we consider the same 5% increase in government bonds supply on top of costlier bank-to-NBFI lending. In the model, we alter the cost of bank-to-NBFI lending through changing the risk weight on NBFI loans. In practice, the cost can vary through a range of other factors as well, such as regulations on NBFIs' borrowing and improvements in lending technology and infratstructure.

Recall that the NBFI is more willing to absorb additional bonds than the bank because of their higher risk tolerance, for a given change of bond yields. When NBFI loans are costlier, the bank is less willing to lend to the NBFI, and the NBFI is less able to lever up against the new bonds. As a result, the combined bank and NBFI sector is less able to absorb the new bonds, and the government-bond yield rises by more than if the same government bond supply shock alone occured with more flexible bank-to-NBFI lending. At the same time, as the bank rebalances less into NBFI loans, it also retains more of its balance sheet in corporate loans, so the negative spillover to firm credit is attenuated.

Our calibration confirms both the effect on firm credit and government bond yields. When we increase the risk weight on NBFI loans by 5%, the bank's willingness to lend to NBFIs is reduced — the response of NBFI loans turns from the 3.6% expansion under the supply shock alone to a 1.3% contraction. At the same time the contraction in firm credit is reduced from from 6.3% to 5.4% as the bank rebalances less into NBFI loans and retains more corporate loans on its balance sheet. At the same time, the NBFI sector is no longer able to lever up against the new bonds as much as before and the government-bond yield rises by 17 basis points, which is much

[18]Given that the bank and NBFI sector make up 40% of the government bond market, the 2.2 basis point increase in government bond yield results from an equivalent increase in total government bonds outstanding of 2%.

larger than under the baseline supply shock. In other words, reducing the extent of bank-to-NBFI lending partially protects against the crowding out of firm credit, but comes at the cost of a larger repricing of government bonds.

6 Conclusion

This paper studies how bank lending to NBFIs shapes the supply of credit to the real economy. Using granular data, we document that a substantial share of bank credit to NBFIs takes the form of reverse repos to entities that primarily invest in securities. At the same time, the expansion of bank lending to NBFIs has come largely at the expense of credit to non-financial firms.

We trace the predominant driver of this trend to rising NBFI borrowing demand for financing government securities, spurred by the unwinding of quantitative easing and the expansion of sovereign bond issuance in major economies. This is why loan growth is concentrated in reverse repos and disproportionately taken up by investment funds. Banks' supply-side constraints further amplify the reallocation: because NBFI loans carry lower risk weights and are more liquid, constrained banks are incentivized to shift their balance sheets away from riskier firm loans and toward NBFI lending.

Our model rationalizes these findings and quantifies the aggregate effects. In the model, differences in NBFI investors' risk sensitivity generate cross-sectional variation in asset allocation, leverage, and borrowing instruments that are consistent with the data. NBFIs with more risk-sensitive investors hold more securities, use more collateralized borrowing, and are the natural marginal holders of additional government bonds. When privately-held government bond supply expands, banks prefer to extend reverse repos to NBFIs—whose higher risk tolerance makes them willing holders of the additional bonds—rather than hold securities outright. This reallocation crowds out direct bank lending to firms and is not offset by increased NBFI lending to firms, resulting in a net contraction in credit supply to the real economy.

Our counterfactual analysis highlights a key tradeoff. The ease of bank-to-NBFI lending amplifies the crowding out of firm credit but makes the government bond market more elastic by enabling the NBFI sector to absorb additional supply. Restricting bank-to-NBFI lending partially protects firm credit, but at the cost of a larger repricing of government bonds. This tradeoff is especially relevant as the unwinding of central bank balance sheets, rising government bond issuance, and the growing importance of the NBFI sector all continue to evolve.

7 Figures and Tables

Figure 1: Loan Volumes to NBFIs by Instrument

This figure shows the volume of loans lent to NBFIs by instrument, which includes credit lines, term loans, revolving credit, reverse repos, and others.

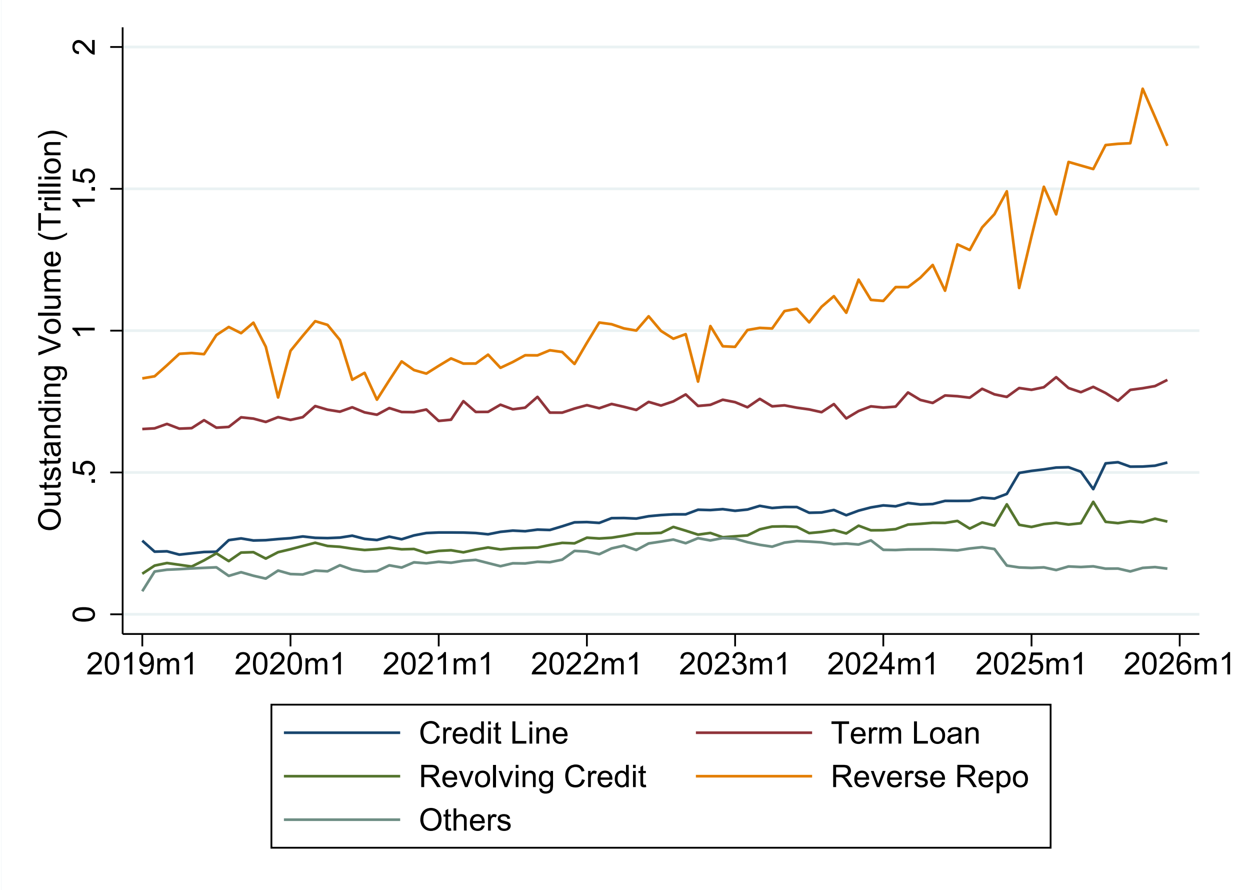
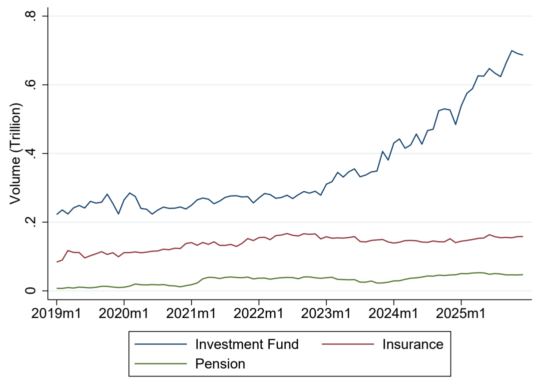


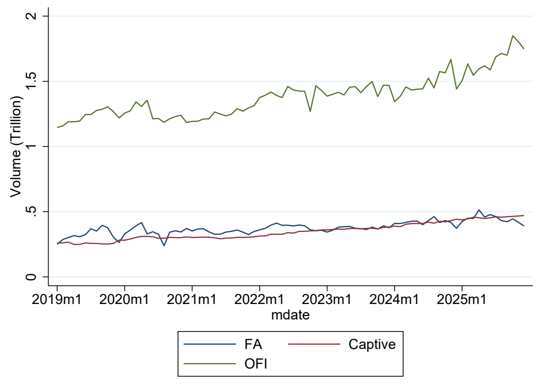
Figure 2: Loans to NBFIs by Sector

This figure shows the volume of loans lent to different non-bank financial institutions (NBFIs). Panels (a) and (b) show the overall breakdown between investment funds, insurances, pensions, financial auxiliaries, captive financing institutions, and other financial institutions. Panels (c) to (e) provide a more granular breakdown of volumes by sector, including loans to different investment funds and loans to different other financial institutions, financial auxiliaries, and captive financing institutions.

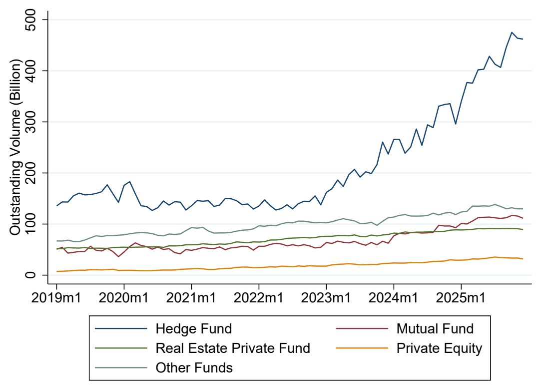
(a) Investment Funds, Pensions, and Insurances



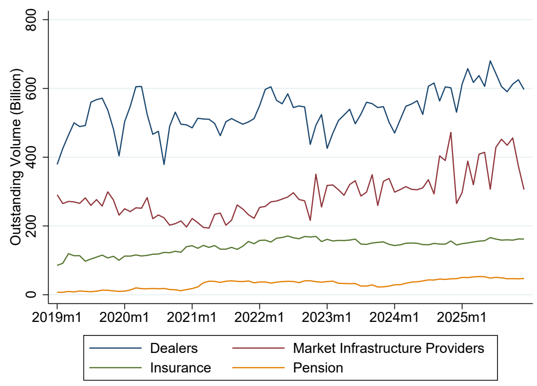
(b) Other Financial Institutions



(c) Investment Funds



(d) Dealers, Pensions, and Insurances



(e) Lending and Holding Companies

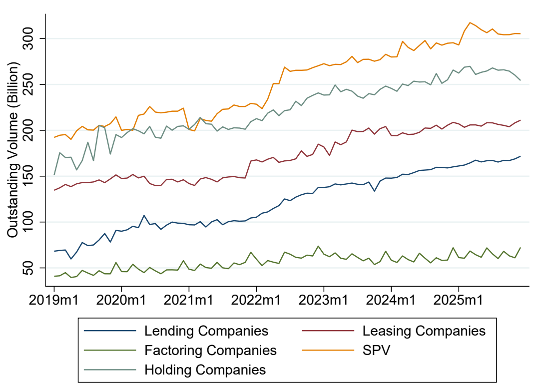
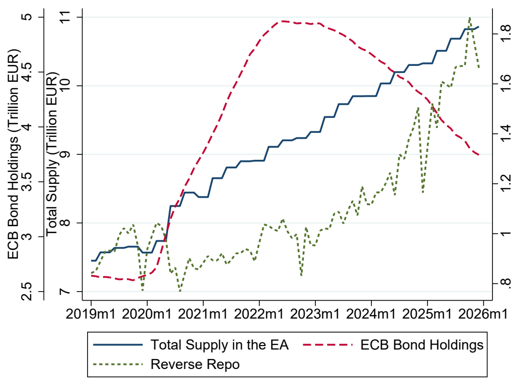


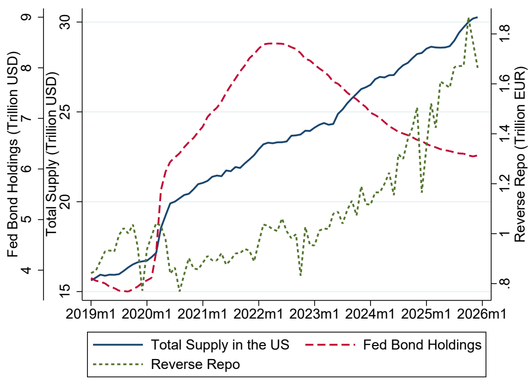
Figure 3: Sovereign Debt Supply, Central Bank Holdings, Privately Held Government Bonds and Reverse Repo Lending to NBFIs

This figure plots the evolution of sovereign debt markets and reverse repo lending to NBFIs. Panels (a) and (b) show the total outstanding supply of government debt and central bank holdings of government securities for the euro area and the United States, respectively. Panels (c) and (d) show privately held government bonds, defined as total government debt outstanding net of central bank holdings, for the euro area and the United States, respectively. In all panels, the green dotted line plots reverse repo lending by banks to NBFIs on the right axis. The sample period is 2019m1 to 2025m12.

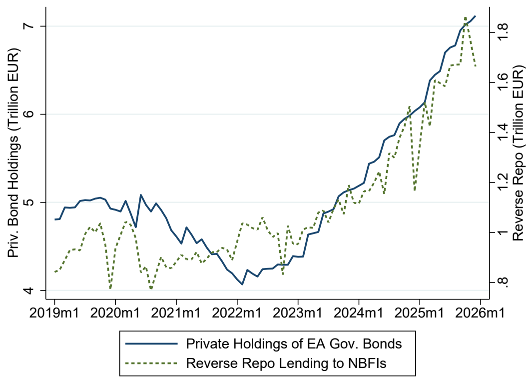
(a) Euro Area



(b) US



(c) Euro Area



(d) US

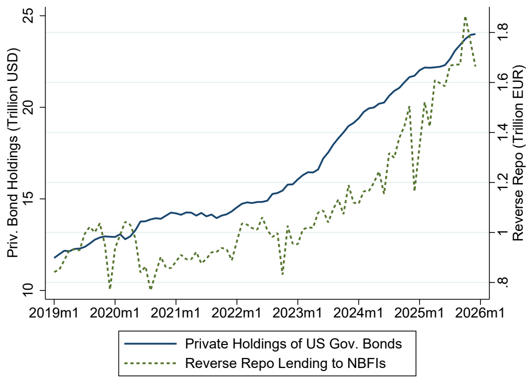


Figure 4: QT versus Conventional Monetary Policy

The figure plots reverse repo lending to NBFIs, privately held euro-area government bonds, and the ECB deposit facility rate.

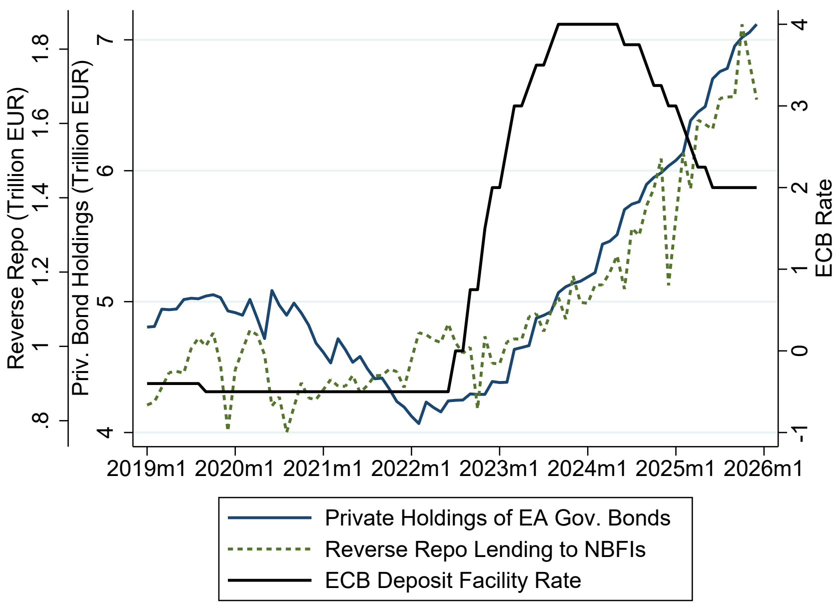


Figure 5: Loan Volumes to NBFI and firms

This figure shows the volume of loans lent to non-bank financial institutions (NBFIs) versus non-financial corporations. The volumes are normalized by their value in January, 2019.

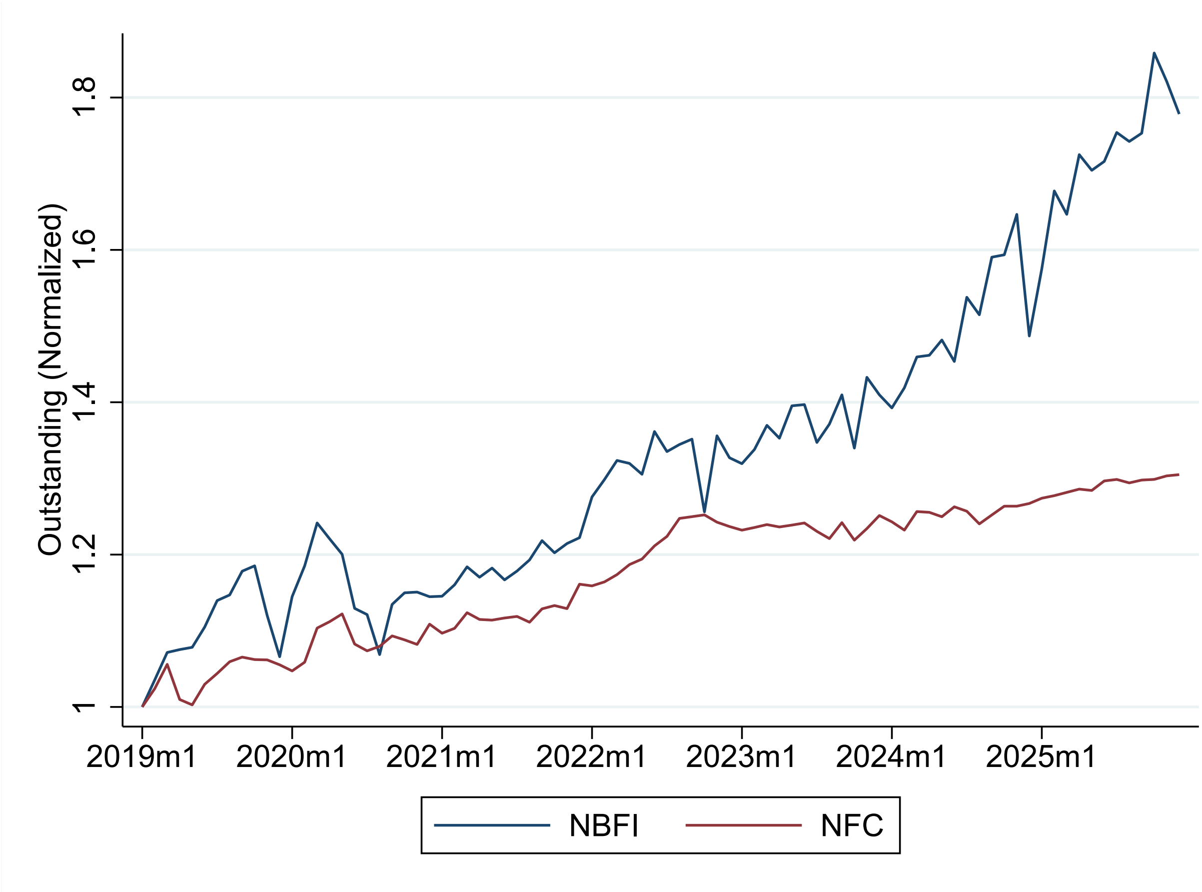


Figure 6: Substitution between corporate and NBFI lending: change between 2019m12 and 2025m12 at the bank-level

This figure presents a binscatter plot showing the relationship between changes in bank lending to non-financial corporations and to non-bank financial intermediaries (NBFIs) between December 2019 and December 2025. The variables on both axes are expressed as changes in the ratio of each loan type to total loans and securities. Each point represents the mean value within a bin of banks, and the fitted line shows the linear relationship between the two variables.

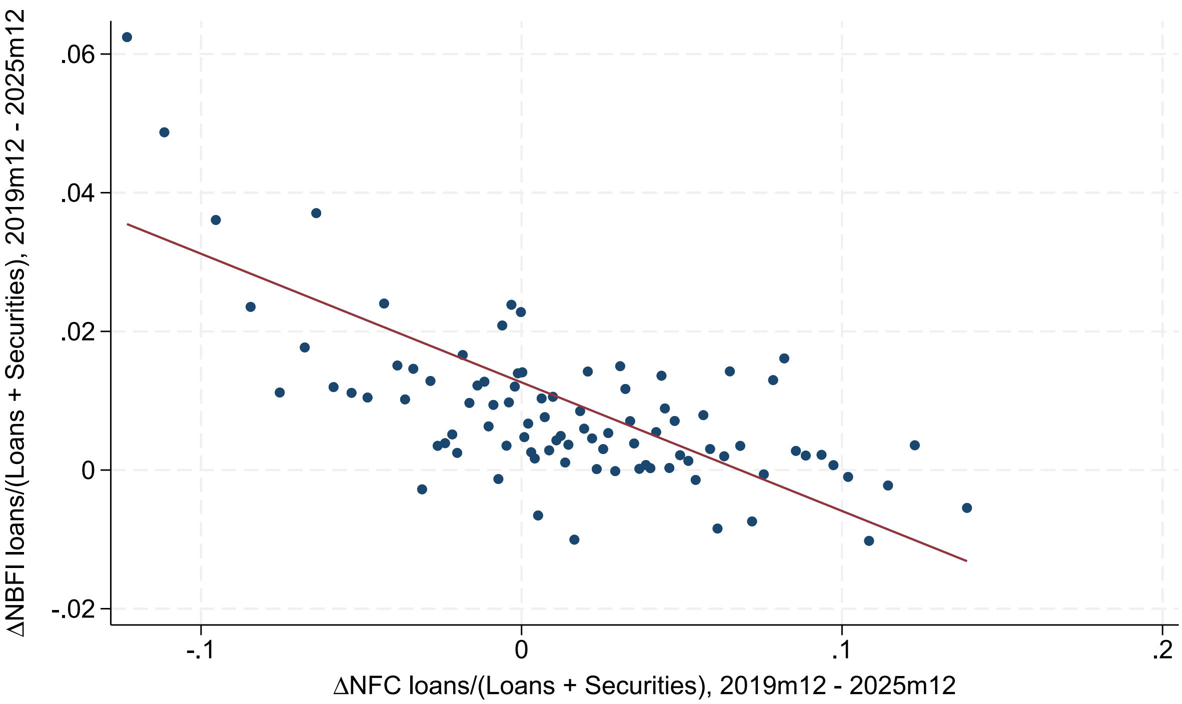


Table 1: Changes in Loan Volume by Instrument and NBFI Sector

This table shows the relationship between changes in loan volume to different NBFI sectors and changes in the aggregate loan volume for each instrument. Observations are at the instrument-sector-month level. The dependent variable, changes in the aggregate loan volume for each instrument, is calculated as the log difference in aggregate loan volume for each instrument. The independent variables are the log differences in loan volume for each sector and instrument. Standard errors are clustered by sector and month.

	Credit Line	Term Loan	Revolving	Repo	Other
Dealers/Market Infrastructure $\times$ ΔLoans	0.20***	0.17***	0.15***	0.72***	0.54***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.10)
Hedge Funds/Mutual Funds $\times$ ΔLoans	0.35***	0.24***	0.05	0.50***	0.19*
	(0.06)	(0.04)	(0.04)	(0.07)	(0.09)
Other Funds $\times$ Δ Loans	0.66***	0.41***	0.37***	0.19***	0.17
	(0.15)	(0.06)	(0.04)	(0.03)	(0.09)
Lending/Factoring/Leasing $\times$ Δ Loans	0.72***	0.64***	0.20***	-0.06	0.49***
	(0.09)	(0.05)	(0.04)	(0.03)	(0.13)
Holding Companies and SPVs $\times$ Δ Loans	0.93***	0.94***	0.40***	0.10**	0.37*
	(0.14)	(0.11)	(0.02)	(0.03)	(0.16)
Insurances $\times$ Δ Loans	0.37***	0.10***	0.08*	0.30***	0.17
	(0.03)	(0.01)	(0.03)	(0.07)	(0.11)
Pensions $\times$ Δ Loans	-0.01	0.02***	0.05***	0.10**	0.03
	(0.01)	(0.00)	(0.01)	(0.03)	(0.04)
Observations	504	504	504	504	504
Adjusted R2	0.48	0.27	0.18	0.21	0.26

Table 2: Bank Lending to NBFIs: Loan-Level Evidence on Credit Demand Channels

This table investigates the demand-side channels driving banks' substitution from corporate to NBFI lending. Columns (1)–(3) compare lending to different borrower types across non-financial firms and NBFIs at the bank–borrower–month level. The outcome variable in these columns is the log level of lending by bank b to borrower n at time t. Columns (4)–(7) restrict the sample to NBFI borrowers and conducts the analysis at the bank–NBFI–loan instrument–month level. In these columns, the outcome variable is the log level of lending by bank b to NBFI borrower n through instrument i at time t. $\log(\text{Priv. Gov. Bonds}_{t-1})$ denotes the log stock of privately held government bonds, lagged by one month. Hedge Fund_n is a dummy variable equal to 1 if the borrower is a hedge fund, and 0 otherwise. Other NBFI_n is a dummy variable equal to 1 if borrower n is a non-bank financial intermediary other than a hedge fund, and 0 otherwise, while the omitted category is non-financial firms. Repo $\text{Loan}_{b,n,i}$ is a dummy variable equal to 1 if the loan is a reverse repo, and 0 otherwise. All specifications include controls and additional lower-order interactions. Standard errors are clustered at the bank × time and borrower × time levels. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	$\log(\text{Lending}_{b,n,i,t})$						
	All Loans			Loans to NBFIs			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times$ Hedge Fund_n	2.536***	2.592***	2.434***	1.547***	1.584***	1.248***	0.107
	(0.103)	(0.105)	(0.110)	(0.0857)	(0.0890)	(0.0965)	(0.261)
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times$ Other NBFI_n	0.0343***	0.182***	0.106***				
	(0.00609)	(0.00654)	(0.00623)				
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times$ Repo $\text{Loan}_{b,n,i}$							0.762***
							(0.0728)
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times$ Repo $\text{Loan}_{b,n,i} \times$ Hedge Fund_n							0.974***
							(0.284)
Controls and Other Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	No	No	Yes	No	No	No
Bank × Time FE	No	Yes	No	No	Yes	No	No
Bank × Loan Bucket × Time FE	No	No	Yes	No	No	Yes	Yes
Bank × Borrower FE	Yes	Yes	Yes	No	No	No	No
Bank × Borrower × Instrument FE	–	–	–	Yes	Yes	Yes	Yes
N	176,790,456	176,789,835	176,749,061	6,587,682	6,585,788	6,561,329	6,561,329
R^2	0.872	0.876	0.891	0.862	0.863	0.882	0.882

Table 3: Reverse Repo Lending to NBFIs: Quantity and Pricing Evidence on Credit Demand Channels

This table investigates the demand-side channels driving banks' reverse repo lending to NBFIs. The sample is restricted to reverse repo loans to NBFI borrowers. In columns (1)–(3), the outcome variable is the log quantity of reverse repo lending by bank b to borrower n at time t. In columns (4)–(6), the outcome variable is the spread charged by bank b to borrower n on reverse repo loans at time t. $\log(\text{Priv. Gov. Bonds}_{t-1})$ denotes the log stock of privately held government bonds, lagged by one month. Hedge Fund_n is a dummy variable equal to 1 if the borrower is a hedge fund, and 0 otherwise. Non-EUR $\text{Loan}_{b,n,i}$ is a dummy variable equal to 1 if the loan is denominated in a currency other than Euros, and 0 otherwise. Low $\text{Haircut}_{b,n,i}$ is a dummy variable equal to 1 if the loan has a haircut below 5%, and 0 otherwise. All specifications include controls and additional lower-order interactions. Standard errors are clustered at the bank $\times$ time and borrower $\times$ time levels. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	$\log(\text{Lending}_{b,n,t})$			$\text{Spread}_{b,n,t}$		
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times \text{Hedge Fund}_n$	1.357***	1.210***	-0.242	0.296***	0.142	0.764***
	(0.107)	(0.223)	(0.261)	(0.0437)	(0.0900)	(0.271)
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times \text{Non-EUR Loan}_{b,n,i}$		-0.537**			1.739***	
		(0.234)			(0.121)	
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times \text{Hedge Fund}_n$		1.315***			0.678***	
$\times \text{Non-EUR Loan}_{b,n,i}$		(0.357)			(0.155)	
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times \text{Low Haircut}_{b,n,i}$			1.066***			-1.448***
			(0.166)			(0.189)
$\log(\text{Priv. Gov. Bonds}_{t-1}) \times \text{Hedge Fund}_n$			1.629***			0.622**
$\times \text{Low Haircut}_{b,n,i}$			(0.313)			(0.283)
Controls and Other Interactions	Yes	Yes	Yes	Yes	Yes	Yes
Bank $\times$ Loan Bucket $\times$ Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank $\times$ Borrower FE	Yes	Yes	Yes	Yes	Yes	Yes
N	148,643	106,039	61,660	91,130	61,373	34,278
R^2	0.639	0.640	0.736	0.907	0.912	0.865

Table 4: The Effect of ECB Holdings on Reverse Repo Volumes and Rates

This table examines how changes in ECB holdings of government bonds are associated with changes in the volumes and rates of reverse repos backed by the same govnernment bonds. The explanatory variable is the change in the fraction of bond j with maturity m issued by country n in month t held by the ECB out of the total outstanding volume. In columns (1) to (3), the outcome variable is the log differences in volumes backed by the same bond j in month t. In columns (4) to (6), the outcome variable is the rate change on reverse repos backed by the same bond j in month t. The sample covers reverse repos backed by government bonds in the MMSR data from 2018m1–2025m12. Fixed effects included in each specification are denoted at the bottom of the table. Standard errors are clustered at the country × maturity × time level. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	Δ log(Lending$_{j,m,n,t}$)			ΔRate$_{j,m,n,t}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ ECB Holdings$_{j,m,n,t}$	-0.835**	-0.691*	-0.927**	-0.030**	-0.028**	-0.029**
	(0.398)	(0.397)	(0.418)	(0.013)	(0.013)	(0.012)
Country × Time FE	Yes	No	No	Yes	No	No
Maturity × Time FE	No	Yes	No	No	Yes	No
Country × Maturity × Time FE	No	No	Yes	No	No	Yes
ISIN FE	No	No	Yes	No	No	Yes
N	60727	60862	60006	62554	62687	61846
R^2	0.11	0.08	0.14	0.72	0.70	0.74

Table 5: Bank Lending to NBFIs: Loan-Level Evidence on Credit Supply Channels

This table examines the credit supply mechanisms underlying banks' reallocation of lending from non-financial corporations to non-bank financial intermediaries (NBFIs). The outcome variable is the log level of bank b's credit to NBFI n at time t. $\log(\text{Priv. Gov. Bonds}_t)$ is the log of privately held government bonds. The Total Capital Ratio and Excess Reserves are reported as of 2021m12. ΔHH+Corporate Deposits$_b$ is the change in household and corporate deposits, also expressed as a share of total loans and securities, between 2021m12 and 2025m12. The sample period spans 2021m12 to 2025m12. Standard errors are clustered at the bank × time and borrower × time levels. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	log(Lending to NBFI$_{b,n,t}$)		
	(1)	(2)	(3)
$\log(\text{Priv. Gov. Bonds}_t)\times$ Total Capital Ratio$_{b,2021}$	-1.288***		
	(0.481)		
$\log(\text{Priv. Gov. Bonds}_t)\times$ Excess Reserves$_{b,2021}$		-0.468***	
		(0.168)	
$\log(\text{Priv. Gov. Bonds}_t)\times$ ΔHH Deposits$_{b,2025-2021}$			-0.807***
			(0.236)
Controls and Other Interactions	Yes	Yes	Yes
Borrower $\times$ Time FE	Yes	Yes	Yes
Bank $\times$ Borrower FE	Yes	Yes	Yes
N	775903	1423315	1835000
R^2	0.951	0.950	0.951

Table 6: Substitution from NBFI Lending across Bank Asset Classes: Bank-Level Evidence

This table examines how changes in bank lending to non-bank financial intermediaries (NBFIs) are associated with adjustments in other asset holdings on banks' balance sheets, capturing patterns of asset substitution. The explanatory variable is the change in NBFI lending by bank b at month t, normalized by total loans and securities in t. The dependent variables represent contemporaneous changes in different asset categories: loans to firms (Column 1), loans to other banks (MFIs; Column 2), loans to households (Column 3), government bond holdings and reserves (Column 4), and bonds issued by other MFIs (Column 5). The sample covers 2021m12–2025m12. Standard errors are clustered at the bank and time level. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	Δ Corporate loans	Δ MFI loans	Δ HH loans	Δ Gov. Bonds + Reserves	Δ MFI Bonds
	(1)	(2)	(3)	(4)	(5)
$\Delta \frac{\text{NBFI loans}_{b,t}}{\text{All Loans and Securities}_{b,t}}$	-0.562***	-0.149***	-0.166***	-0.388***	-0.0672***
	(0.0214)	(0.0475)	(0.0108)	(0.0507)	(0.00517)
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
N	82111	75387	82117	70931	82069
R^2	0.206	0.0413	0.0976	0.0344	0.0757

Table 7: Corporate and NBFI Lending by Banks: Loan-Level Evidence on Credit Reallocation

This table examines whether banks with greater ex-ante exposure to NBFI lending increase lending to NBFIs when privately held government bonds rise, and whether the same banks reduce lending to non-financial firms. The dependent variable is the log level of lending by bank b to borrower n in month t. Column (1) restricts the sample to NBFI borrowers. Columns (2)–(3) restrict the sample to non-financial firms. $\log(\text{Priv. Gov. Bonds}_t)$ is the log of privately held government bonds. Share NBFI Loans_b is the bank's ex-ante share of lending to NBFIs in 2019. High PD_n is an indicator for firms with above median default probability. Standard errors are clustered at the bank $\times$ time and borrower $\times$ time levels. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	$\log(\text{Lending}_{b,n,t})$		
	NBFIs	Non-financial Firms	
	(1)	(2)	(3)
$\log(\text{Priv. Gov. Bonds}_t)\times$ Share NBFI Loans_b	0.217^{**}	-1.257^{***}	-1.071^{***}
	(0.0889)	(0.0705)	(0.0571)
$\log(\text{Priv. Gov. Bonds}_t)\times$ High PD_n			-0.0493^{***}
			(0.0180)
$\log(\text{Priv. Gov. Bonds}_t)\times$ Share NBFI Loans_b $\times$ High PD_n			-0.637^{***}
			(0.171)
Borrower $\times$ Time FE	Yes	Yes	Yes
Bank $\times$ Borrower FE	Yes	Yes	Yes
N	2,224,951	156,663,156	156,663,156
R^2	0.952	0.916	0.916

Table 8: Firm-level credit and exposure to bank lending to NBFIs

This table examines how firms' overall borrowing and debt respond to their exposure to banks that expand lending to NBFIs. The outcome variable is the log change in firm-level debt between 2019 and 2024. Columns (1)–(3) consider firm-level loans outstanding from all sources (banks and non-banks), while columns (4)–(6) include total debt, encompassing all loans and bonds. ΔNBFI loans$_f$ denotes firm-level exposure to banks' lending to NBFIs. It is constructed as the weighted average change in the share of each bank's credit to the NBFI sector, with weights given by the firm's outstanding credit with those banks in 2019. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	Δ log(loans$_f$)			Δ log(total debt$_f$)		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ NBFI loans$_f$	-0.389***	-0.369***	-0.147	-0.133**	-0.172***	0.00829
	(0.123)	(0.122)	(0.140)	(0.0647)	(0.0638)	(0.113)
Δ NBFI loans$_f$ $\times$ Small Firm$_f$			-0.804***			-0.276*
			(0.280)			(0.157)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	Yes	No	Yes	Yes
N	132680	132614	132614	171101	171064	183095
R^2	0.00130	0.0137	0.0139	0.00486	0.0307	0.0236

Table 9: Demand System Estimates

This table reports the two-stage least squares results for estimating the demand systems for retail deposits, institutional deposits, and corporate loans. *Retail deposits* are total household deposits at the bank. *Institutional deposits* are total non-financial corporate deposits plus repo borrowing. *Corporate loans* are total outstanding loans to non-financial corporates. *NPL* is the ratio of non-performing exposures to total assets, as reported in FINREP. The instrument vector $Z_{nmt} = (\text{Administrative Costs}_{nmt}, \text{Lending Standards Surprise}_{n,t-6})$ is used in the deposit specifications; the loan specification uses only the cost instrument $Z^c_{nmt} = \text{Administrative Costs}_{nmt}$. *Administrative Costs* is the bank's other administrative expenses (excluding staff costs) divided by total assets, from FINREP. *Lending Standards Surprise* is the lagged unexpected component of the change in lending standards reported by the bank in the Individual Bank Lending Survey (realized minus prior expectation), measured at the country-quarter level. All regressions include bank fixed effects and country $\times$ time fixed effects. *, **, and *** denote significance at the 10%, 5%, and 1% level.

Panel (a): First Stage

	Retail Dep.	Institutional Dep.	Deposits	Corporate Loans
	Deposit Rate	Deposit Rate	NPL	Loan Rate
	(1)	(2)	(3)	(4)
Administrative Costs	-0.1208***	-0.2841***	0.3181*	0.0978***
	(0.0282)	(0.0370)	(0.1762)	(0.0302)
Lending Standards Surprise	-0.0002	-0.0008***	-0.0023***	
	(0.0001)	(0.0002)	(0.0006)	
Bank & Country×Time FE	Yes	Yes	Yes	Yes
N	9,155	9,190	9,529	12,506
Adj. R^2	0.865	0.835	0.843	0.947

Panel (b): 2SLS Panel Regression

	Market Share		
	Retail Dep.	Institutional Dep.	Corp. Loans
	(1)	(2)	(3)
Deposit Rate (with IV)	109.9424***	103.3149***	
	(16.4749)	(15.3364)	
NPL Ratio (with IV)	0.1501	-21.7229***	
	(2.2493)	(3.8003)	
Loan Rate (with IV)			-160.6832***
			(55.0013)
Bank & Country×Time FE	Yes	Yes	Yes
N	8,293	8,292	12,506

Table 10: Flow–Return Sensitivity of NBFI Investor Demand

This table reports the two-stage least squares estimate of the flow–return sensitivity of NBFI investor demand. The panel is at the sector $\times$ country $\times$ quarter level and covers six NBFI sectors: S124 (non-MMF investment funds), S125 (other financial intermediaries), S126 (financial auxiliaries), S127 (captive financial institutions and money lenders), S128 (insurance corporations), and S129 (pension funds) over 2019Q1–2024Q4. The outcome is net flow rate defined as net financial transactions normalized by lagged closing-balance financial assets, from the ECB Quarterly Sectoral Accounts. ROA is the return on assets. Aggregated Bank Loan-Rate Shock is the lagged volume-weighted bank–time fixed effect from the Amiti and Weinstein (2018)-style decomposition of loan-rate setting in AnaCredit, aggregated to the sector–country–quarter level using lagged bank–NBFI lending volumes as weights. All regressions include sector fixed effects and country $\times$ time fixed effects. *, **, and *** denote significance at the 10%, 5%, and 1% level.

	First Stage	2SLS
	ROA	Flow
	(1)	(2)
Aggregated Bank Loan-Rate Shock	-13.525^{***}	
	(4.245)	
Return on Assets (with IV)		0.713^{***}
		(0.214)
Sector FE	Yes	Yes
Country $\times$ Time FE	Yes	Yes
N	2,620	2,620
Adj. R^2	0.657	

Table 11: Externally set parameters

Parameter	Value	Source
Demand elasticities		
Retail deposit demand elasticity β_{Dr}	$1/109.9$	Demand estimates (Table 9)
Institutional deposit demand elasticity β_{Di}	$1/103.3$	Demand estimates (Table 9)
Corporate-loan supply elasticity δ_2	-160.68	Demand estimates (Table 9)
Asset supply elasticities		
Government-bond residual supply elasticity δ_1	-3.2	Literature
Equity residual supply elasticity δ_3	-1.2	Literature

Table 12: Internally targeted moments: data vs. model

Moment	Data	Model
Deposits		
Institutional deposit share	0.34	0.345
Marginal deposit-response split (inst.)	0.67	0.642
Retail deposit (gross) return	1.0049	0.9889
Institutional deposit (gross) return	1.0053	1.0213
Bank portfolio shares		
Cash / reserves	0.317	0.338
Government bonds	0.158	0.266
Corporate (NFC) loans	0.247	0.165
NBFI loans	0.221	0.230
Equities	0.057	0.001
Bank leverage	10.46	9.81
NBFI portfolio shares		
Government bonds	0.249	0.249
Corporate loans	0.165	0.188
Equities	0.586	0.564
NBFI leverage	1.18	1.11
NBFI sector / flows		
NBFI flow–performance sensitivity	0.713	0.691
NBFI-loan default probability	0.78%	0.94%
NBFI-loan rate	1.55%	0.73%
Asset returns		
Government-bond return	3.47%	2.65%
Corporate-loan return	4.69%	4.70%
Equity return	3.08%	6.80%
Return volatility (bond / loan / equity)	4.4% / 6.5% / 14.8%	4.4% / 6.5% / 14.8%

Table 13: Calibrated structural parameters

Parameter	Symbol	Value
Bank		
Bank equity	E_B	0.070
Bank effective risk aversion	$\gamma_b + d_i\gamma_i$	5.28
Risk-weighted capital budget	ι_c	0.298
NBFI		
NBFI baseline equity	$\bar{E}$	0.404
Flow–performance sensitivity (mean)	ϕ_μ	1.013
Flow–performance sensitivity (variance)	ϕ_σ	1.999
NBFI default threshold	b_p	0.823
Asset supply / demand intercepts		
Government-bond supply intercept	α_1	2.751
Corporate-loan demand intercept	α_2	167.378
Equity supply intercept	α_3	1.194
Deposits		
Institutional deposit adjustment-cost slope	τ_{2i}	0.498
Retail deposit linear cost	τ_{1r}	0.001
Institutional deposit linear cost	τ_{1i}	-0.032
Retail deposit-rate intercept	r_{Dr0}	0.973
Institutional deposit-rate intercept	r_{Di0}	1.004

Table 14: Counterfactual responses

	Firm loans	NBFI loans	Gov.-bond yield
(1) Bond supply ↑	-6.3%	$+3.6\%$	$+2.2$ bps
(2) $+$ higher NBFI risk weight	-5.4%	-1.3%	$+16.7$ bps

Notes. Equilibrium responses to a 5% increase in the supply of government bonds. Row (2) additionally raises the regulatory risk weight on NBFI loans by 5%. "Firm loans" and "NBFI loans" are percent changes in the equilibrium quantities relative to the baseline; "Gov.-bond yield" is the change in the government-bond yield in basis points (baseline yield 2.65%).

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A1 Appendix: Additional Figures and Tables

Figure A.1: Loans to NBFIs by Sector (Remaining Institutions)

This figure shows the volume of loans lent to non-bank financial institutions (NBFIs) that remain unclassified in the more granular classification of NBFI sectors in Figure 2.

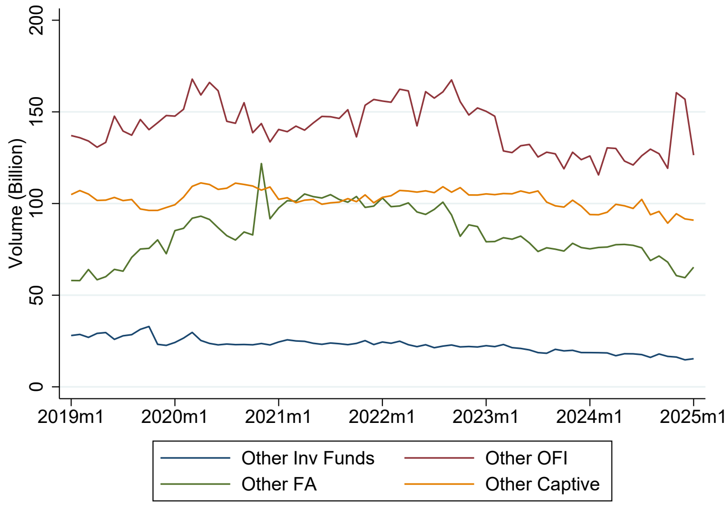
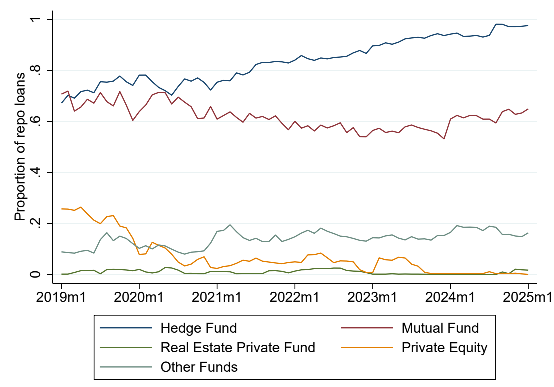


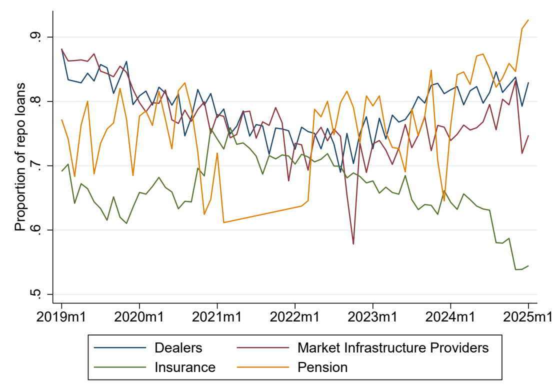
Figure A.2: Reverse Repos to NBFIs by Sector (Detailed Breakdown)

This figure shows the volume of reverse repos to different non-bank financial institutions (NBFIs). Panels (a) to (c) provide a granular breakdown of volumes by institution types, including loans to different investment funds and loans to different other financial institutions, financial auxiliaries, and captive financing institutions. Panel (d) shows the volume of loans that remain unclassified in the classification.

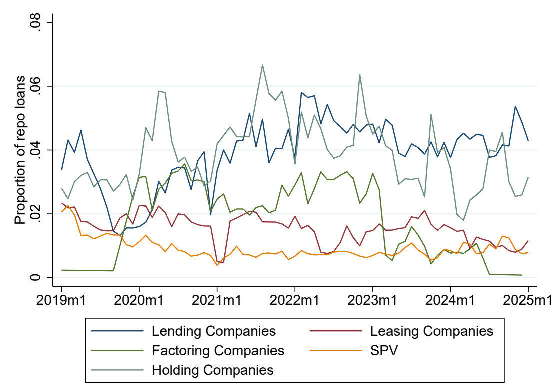
(a) Investment Funds



(b) Dealers, Pensions, and Insurances



(c) Other Financial Institutions



(d) Remaining Institutions (Optional)

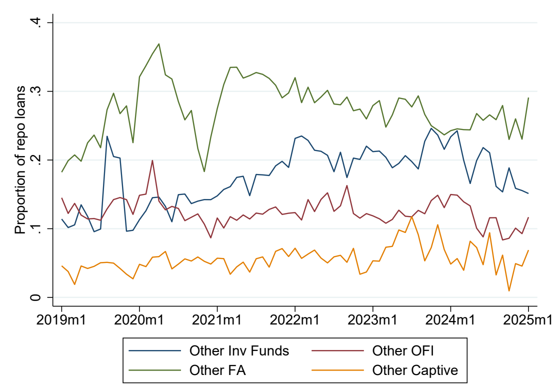
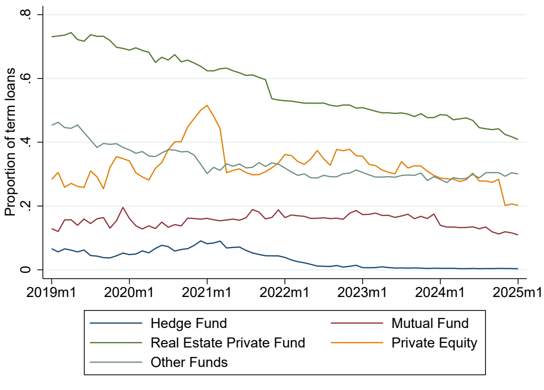


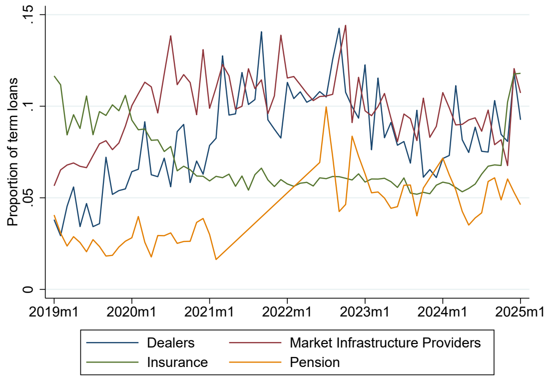
Figure A.3: Term Loans to NBFIs by Sector (Detailed Breakdown)

This figure shows the volume of term loans to different non-bank financial institutions (NBFIs). Panels (a) to (c) provide a granular breakdown of volumes by institution types, including loans to different investment funds and loans to different other financial institutions, financial auxiliaries, and captive financing institutions. Panel (d) shows the volume of loans that remain unclassified in the classification.

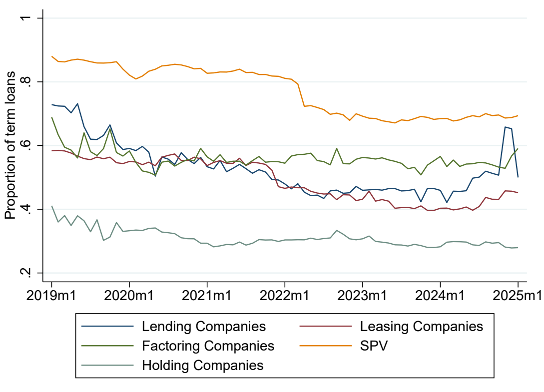
(a) Investment Funds



(b) Dealers, Pensions, and Insurances



(c) Other Financial Institutions



(d) Remaining Institutions (Optional)

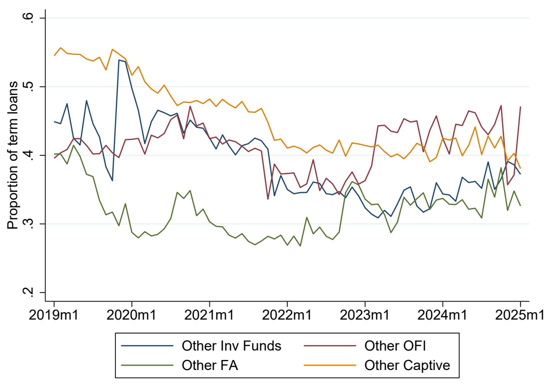
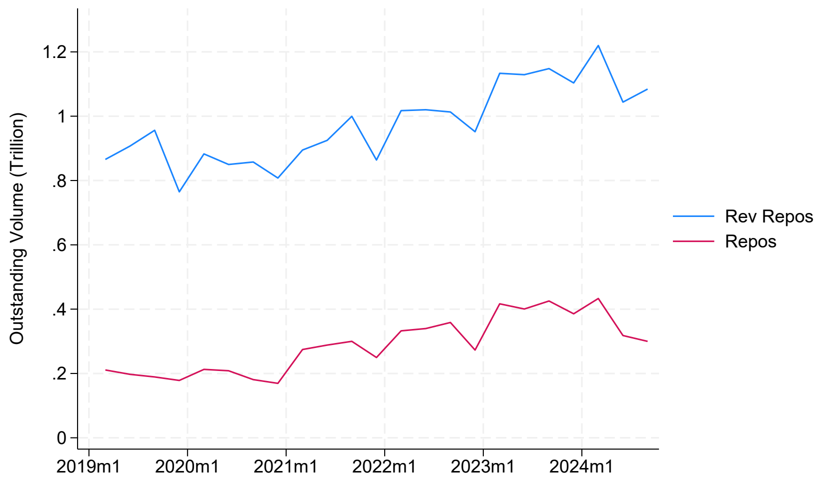


Figure A.4: Reverse Repos and Repos on Bank Balance Sheets

Panel (a) shows the volume of reverse repos and repos for our sample of banks that are not reporting agents in the MMSR data based on bank balance sheet data in FINREP. Panel (b) shows the volume of reverse repos and repos for our sample of banks that are reporting agents in the MMSR data. In panel (b), we report reverse repo and repo volumes based on both FINREP and MMSR data.

(a) Banks not in MMSR



(b) Banks in MMSR

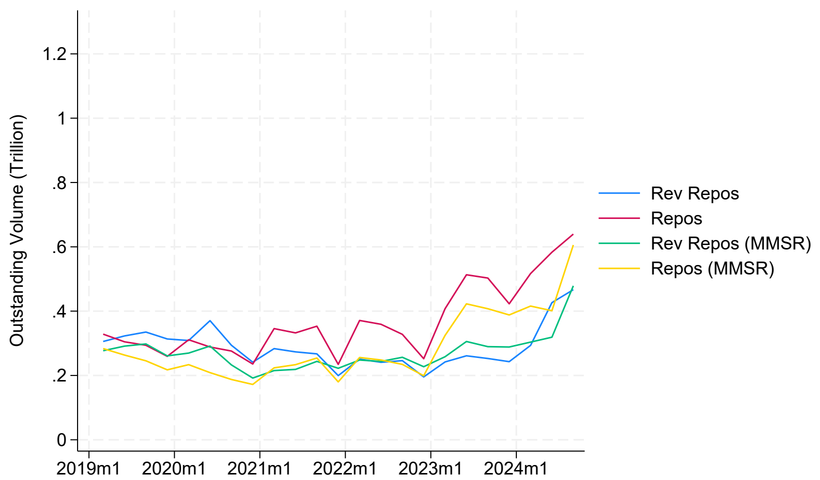
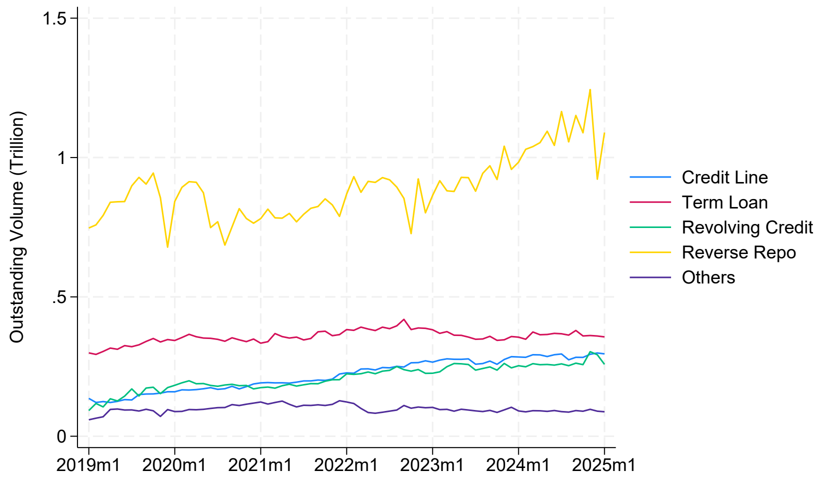


Figure A.5: Loan Volumes to NBFIs by Instrument (External and Within Group Loans)

This figure shows the volume of loans lent to NBFIs by instrument, which includes credit lines, term loans, revolving credit, repos, and others. Panel (a) shows the volume of loans lent to NBFIs that are not part of the same holding company as the lending bank. Panel (b) shows the volume of loans lent to NBFIs that are part of the same holding company as the lending bank.

(a) External Loans



(b) Within-Group Loans

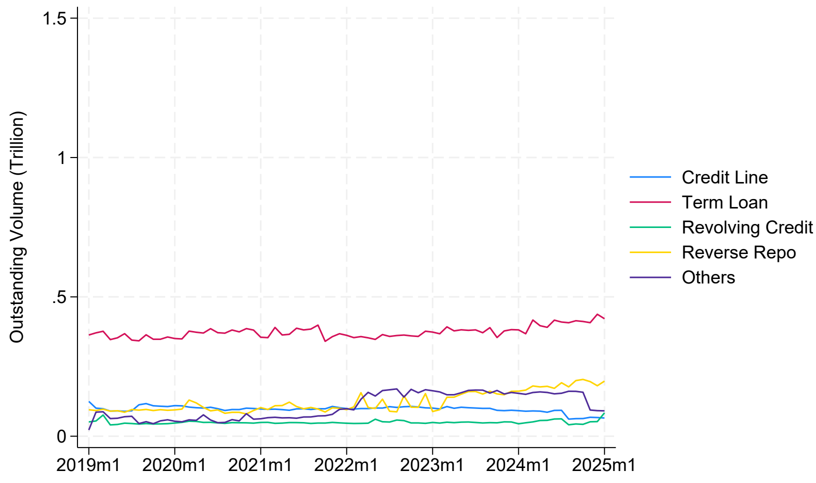
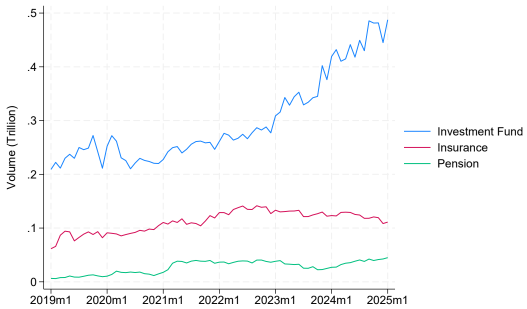


Figure A.6: Loans to NBFIs by Sector (External Loans)

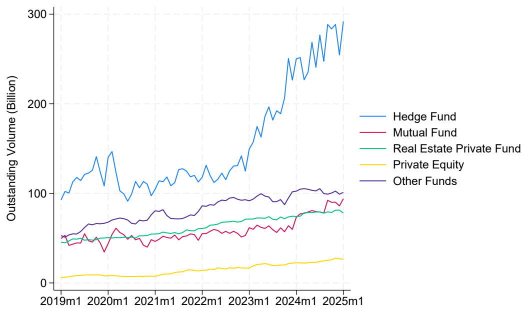
This figure shows the volume of loans lent to different non-bank financial institutions (NBFIs) that are not part of the same holding company as the lending bank. Panels (a) and (b) show the overall breakdown between investment funds, insurances, pensions, financial auxiliaries, captive financing institutions, and other financial institutions. Panel (c) to (e) provide a more granular breakdown of volumes by sector, including loans to different investment funds and loans to different other financial institutions, financial auxiliaries, and captive financing institutions.

(a) Investment Funds, Pensions, and Insurances

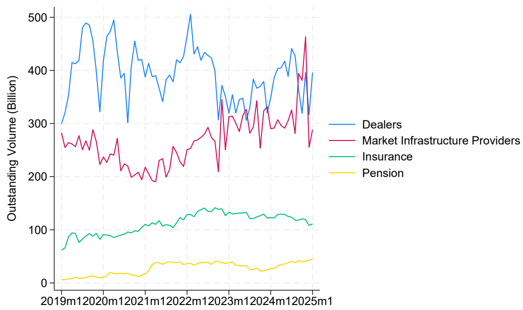


(b) Other Financial Institutions

(c) Investment Funds



(d) Dealers, Pensions, and Insurances



(e) Lending and Holding Companies

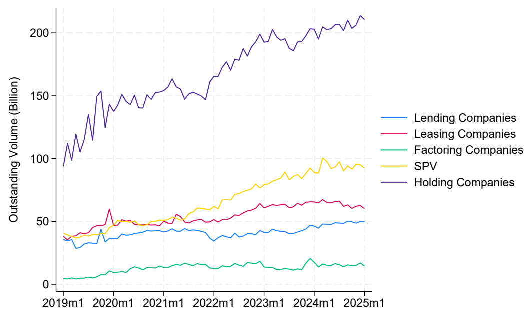
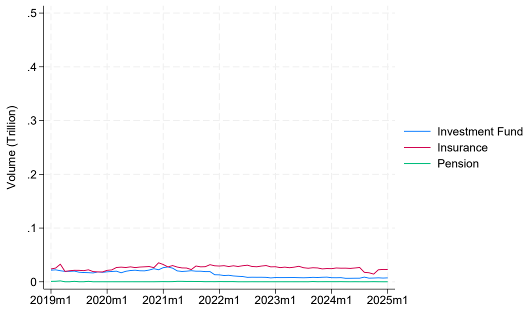


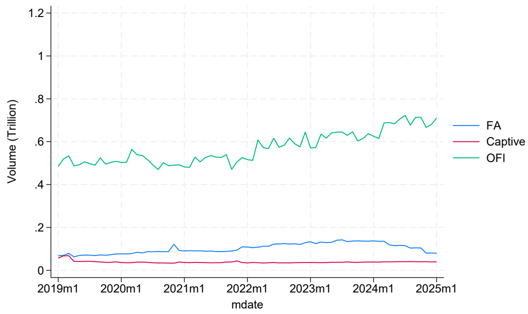
Figure A.7: Loans to NBFIs by Sector (In-Group Loans)

This figure shows the volume of loans lent to different non-bank financial institutions (NBFIs) that are part of the same holding company as the lending bank. Panels (a) and (b) show the overall breakdown between investment funds, insurances, pensions, financial auxiliaries, captive financing institutions, and other financial institutions. Panel (c) to (e) provide a more granular breakdown of volumes by sector, including loans to different investment funds and loans to different other financial institutions, financial auxiliaries, and captive financing institutions.

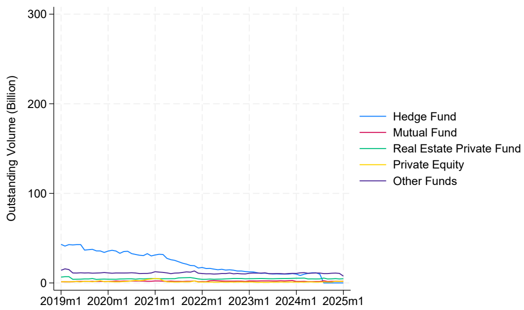
(a) Investment Funds, Pensions, and Insurances



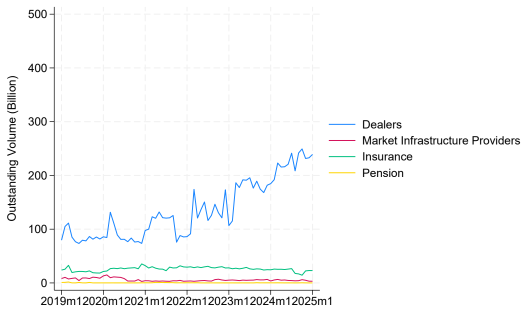
(b) Other Financial Institutions



(c) Investment Funds



(d) Dealers, Pensions, and Insurances



(e) Lending and Holding Companies

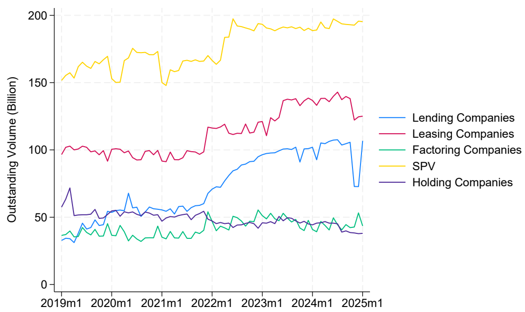


Figure A.8: Sovereign Debt Supply and Central Bank Holdings Across Major Economies

This figure plots the evolution of the total outstanding supply of sovereign debt (blue line, left axis), central bank holdings of sovereign securities (red line, left axis) for (a) the United Kingdom, (b) Japan. The figure also plots reverse repo borrowing by NBFIs from banks in Euro Area (green dotted line, right axis). The sample period spans 2019 to 2024. Central bank holdings include government securities held outright by the respective monetary authorities.

(a) United Kingdom (b) Japan

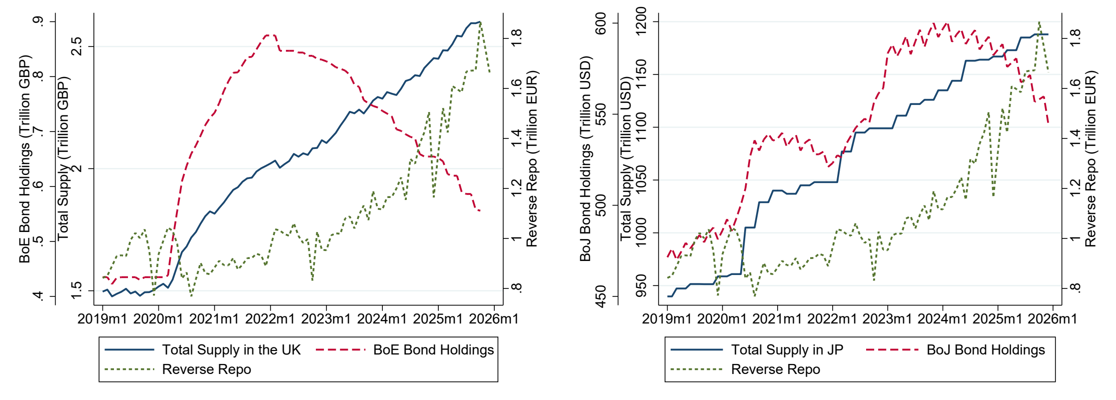


Figure A.9: Hedge Fund Repo Borrowing and Private Holdings of U.S. Treasuries and MBS

The figure plots hedge fund net repo borrowing against changes in private holdings of U.S. Treasuries and MBS. The comovement is consistent with hedge funds using repo borrowing to finance cash securities positions.

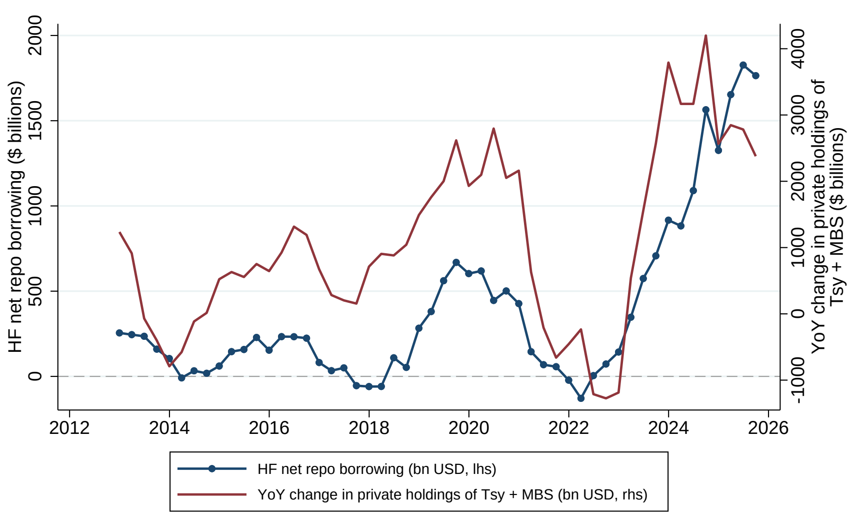


Figure A.10: QT and Repo Spreads

The figure plots secured lending spreads over the ECB deposit facility rate together with ECB holdings of euro-area securities.

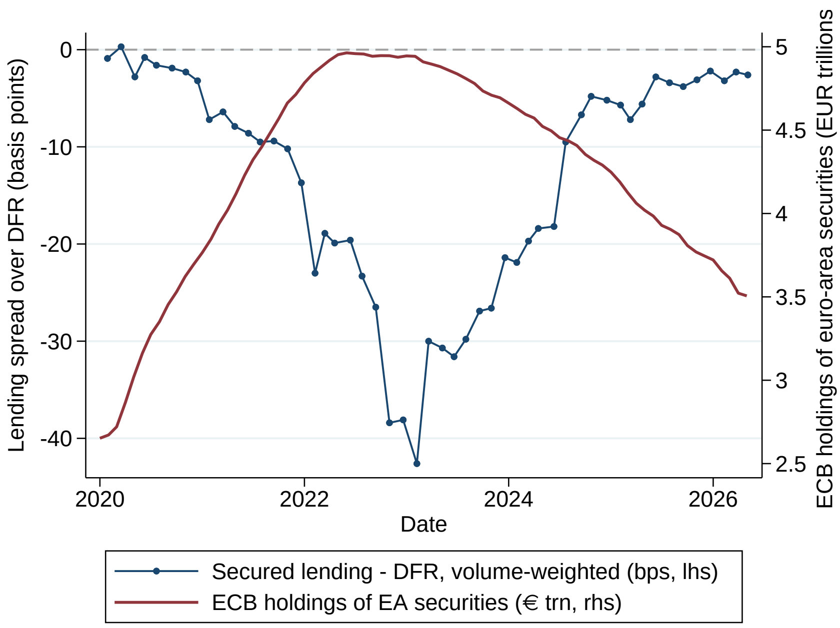
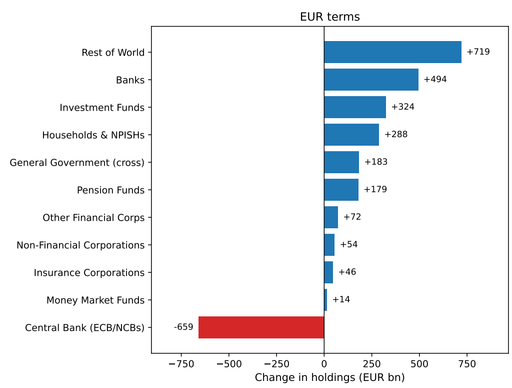


Figure A.11: Who Bought the Securities Released by QT?

This figure plots changes in government securities holdings by sector during the QT period. Panel (a) reports changes in euro-area government securities holdings by sector in EUR billions. Panel (b) reports changes in U.S. Treasury holdings by sector in USD billions. Positive bars indicate an increase in holdings, while negative bars indicate a decrease in holdings. The euro-area panel uses data from ECB SHSS and total issuance from ECB CSEC. The U.S. panel uses Federal Reserve Z.1 Financial Accounts data. Changes in holdings are computed between 2022Q2 and 2025Q3.

(a) Euro Area



(b) US

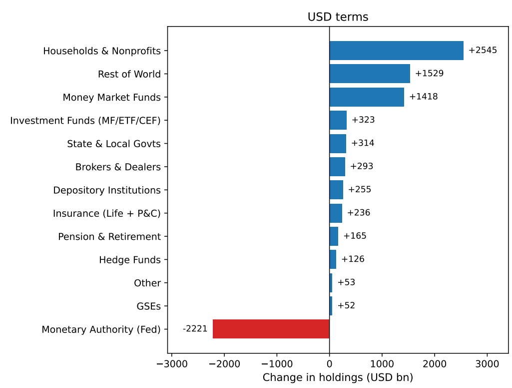


Figure A.12: Reverse Repo Lending to Domestic and Foreign NBFIs

The figure separates reverse repo lending by euro-area and non-euro-area NBFI borrowers.

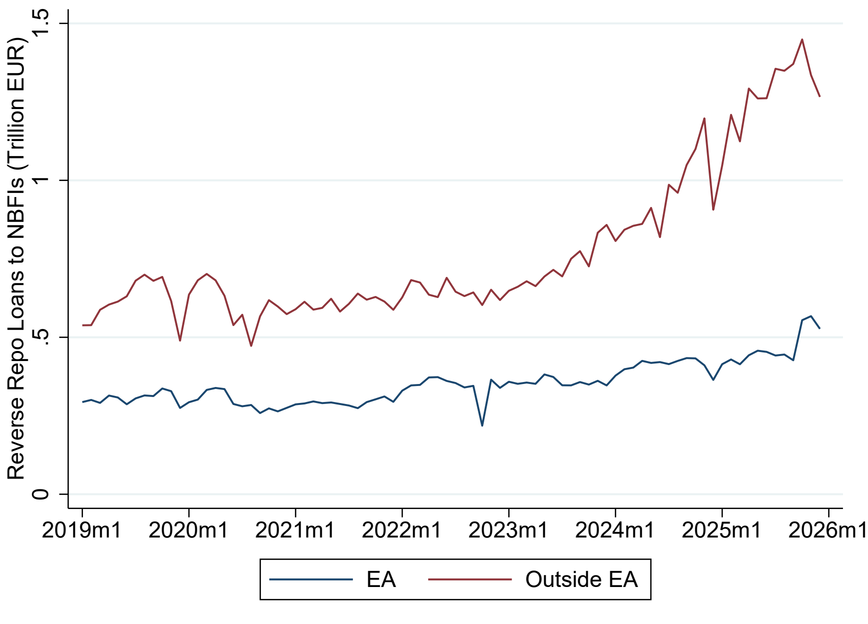


Figure A.13: Reserves and NBFI lending

This figure presents a binscatter plot showing the relationship between changes in bank reserves and bank lending to non-bank financial intermediaries (NBFIs) between December 2022 and December 2025. The variables on both axes are expressed as changes in the ratio of each loan type to total assets. Each point represents the mean value within a bin of banks, and the fitted line shows the linear relationship between the two variables.

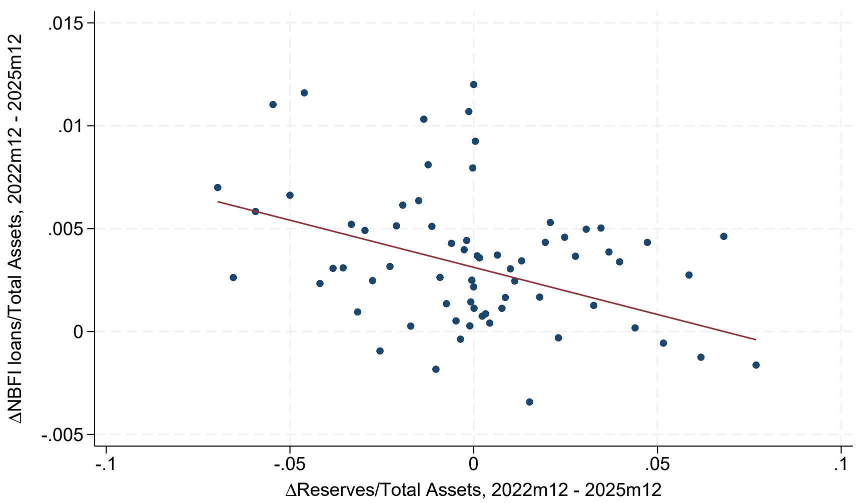


Table A.1: Collateral Breakdown for Reverse Repo Loans

This table shows the breakdown of reverse repos by collateral. The first four columns of Panel (a) show the proportion of reverse repos backed by government bond collateral by issuer country using the SFTDS data. The last column of Panel (a) shows the corresponding result for reverse repos in the MMSR data. Panel (b) shows the proportion of reverse repos collateral issuing country using the SFTDS data. The sample period for the SFTDS data is from 2021 to 2015, while that for the MMSR data is from 2018 to 2025.

(a) By Government Bond versus Non Government Bond Collateral

	Euro Area	US	UK	Japan	MMSR
Proportion of Government Bond Collateral	0.92	0.93	0.96	0.98	0.83

(b) By Collateral Issuing Country

	Euro Area	US	UK	Japan	Others
Proportion of Reverse Repo Volume	0.70	0.19	0.06	0.03	0.02

Table A.2: Sector-Country Securities Holdings and Bank Lending to NBFIs

This table examines the relationship between securities holdings by NBFI sectors and bank lending to NBFIs. The dependent variable is the log level of lending by bank b to NBFI borrower n through instrument i at time t. $\log(\text{Securities Holdings}_{s,c,t})$ denotes the log holdings of government bonds by NBFI sector s in country c at time t. Hedge Fund_n is a dummy variable equal to one if borrower n is a hedge fund, and zero otherwise. All specifications include controls and additional lower-order interactions. Standard errors are clustered at the bank $\times$ time and borrower $\times$ time levels. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	$\log(\text{Lending}_{b,n,t})$			
	(1)	(2)	(3)	(4)
$\log(\text{Securities Holdings}_{s,c,t})\times$ Hedge Fund_n	1.499***	1.770***	1.317***	0.878***
	(0.0922)	(0.107)	(0.133)	(0.162)
Controls and Other Interactions	Yes	Yes	Yes	Yes
Time FE	Yes	No	No	No
Bank $\times$ Time FE	No	Yes	No	No
Bank $\times$ Loan Bucket $\times$ Time FE	No	No	Yes	Yes
Country $\times$ Time FE	No	No	No	Yes
Bank $\times$ Borrower $\times$ Instrument FE	Yes	Yes	Yes	Yes
N	432,225	429,324	412,048	411,361
R^2	0.815	0.821	0.839	0.840

Table A.3: Bank Lending to NBFIs and Country-Specific Government Bond Supply: Currency Breakdown

This table estimates the relationship between country-specific government bond supply and bank lending to NBFIs using loan-level AnaCredit data on lending to NBFIs by currency of denomination. The outcome variable is the log outstanding amount of lending by bank b to borrower n with instrument i in currency c and month t. $\log(\text{Priv. Gov. Bonds}_t^c)$ denotes the log stock of privately held government bonds in the country or currency area associated with currency c. The columns report separate interactions for EUR, USD, GBP, and JPY. Columns (1)–(4) interact country-specific private government bond holdings with Hedge Fund$_n$. Columns (5)–(8) interact country-specific private government bond holdings with Repo$_{b,n,i}$. Repo$_{b,n,i}$ is an indicator for reverse repo lending. Hedge Fund$_n$ is an indicator for hedge-fund borrowers. All specifications include controls and additional lower-order interactions. Standard errors are clustered at the bank $\times$ time and borrower $\times$ time levels. ***, **, and * denote significance at the 1%, 5%, and 10% (two-sided) levels, respectively.

	log(Lending$_{b,n,c,i,t}$)							
	Hedge Fund Borrowers				Repo Loans			
	EUR (1)	USD (2)	GBP (3)	JPY (4)	EUR (5)	USD (6)	GBP (7)	JPY (8)
$\log(\text{Priv. Gov. Bonds}_t^c)\times$ Hedge Fund$_n$	0.867***	0.802***	0.936***	0.837***				
	(0.0880)	(0.0812)	(0.0951)	(0.0925)				
$\log(\text{Priv. Gov. Bonds}_t^c)\times$ Repo$_{b,n,i}$					0.790***	0.749***	0.923***	0.900***
					(0.0629)	(0.0583)	(0.0681)	(0.0656)
Controls and Other Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank $\times$ Loan Bucket $\times$ Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank $\times$ Currency $\times$ Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank $\times$ Borrower $\times$ Instrument FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6,630,345				6,630,345			
R^2	0.885				0.885			

Table A.4: Default Probability of NBFI and corporate loans

This table compares the risk profiles of loans to non-bank financial intermediaries (NBFIs) and non-financial corporations. Panel (a) reports average and median default probabilities by loan type, and Panel (b) by loan maturity.

(a) By Loan Type

	NBFI Median	Corporate Median	NBFI Mean	Corporate Mean	Diff in Means
	(1)	(2)	(3)	(4)	(5)
Credit Lines	0.64	0.79	5.30	6.55	1.25***
Term Loans	1.12	1.19	6.63	10.74	4.11***
Revolving Credit	1.00	1.83	10.01	16.06	6.06***
Repo	0.26	0.32	1.03	1.89	0.86***
Others	0.75	1.40	6.37	8.97	2.60***

(b) By Maturity

	NBFI Median	Corporate Median	NBFI Mean	Corporate Mean	Diff in Means
	(1)	(2)	(3)	(4)	(5)
Less than 1 month	1.04	1.37	8.22	11.13	2.91***
1 to 12 months	0.51	1.59	5.09	10.12	5.03***
1 to 5 years	0.97	1.29	6.64	9.88	3.24***
5 to 10 years	1.05	1.26	5.91	9.52	3.61***
More than 10 years	0.89	0.92	5.86	9.61	3.75***
Indefinite	1.00	1.67	10.45	17.97	7.53***

A2 Appendix: NBFIs' Asset and Liability Composition

In this Appendix, we examine the cross-sectional relationships between the asset composition of NBFI's portfolios, their leverage and the type of borrowing from the bank in the data. Panels (a) and (b) of Figure B.14 plot the ratio of loans and securities of different NBFI sectors. We observe that investment funds, insurances, and pensions have a smaller fraction of loans on their asset side than OFIs, FAs, and Captives, which include the institutions in Figure 2 that are more engaged in lending. In contrast, investment funds, insurances, and pensions hold a larger fraction of securities than OFIs, FAs, and Captives.

At the same time, investment funds, insurances, and pensions also have lower leverage than OFIs, FAs, and Captives, as evident from panel (c) of Figure B.14. Panel (d) confirms that the same relationship holds for the fraction of bank loans over total assets. Out of these bank loans, panel (e) further shows that investment funds, insurances, and pensions borrow a higher proportion of reverse repos than OFIs, FAs, and Captives. This finding is consistent with the results in Table 1, where the growth of reverse repos is more tied to hedge funds and mutual funds.

So far, we have shown that NBFIs that lend more have higher leverage and a smaller fraction of repo borrowing. Unfortunately, the data on NBFIs asset and liability composition is not available at an institution level. The most granular data available covers NBFI sectors by country. We use this data to more formally show the relationship between NBFIs' asset composition, leverage, and repo funding in Figure B.15. In panel (a), the binscatter plot shows a clearly negative relationship between the ratio of bank loans borrowed against the ratio of securities held controlling for time fixed effects. The negative relationship remains when we include country-time fixed effects (panel (b)) and when we consider the ratio of debt over total assets (panels (c) and (d)). In other words, NBFIs that hold more securities also borrow less. In contrast, panels (e) and (f) show a positive relationship between the ratio of reverse repos versus the ratio of securities. That is, NBFIs that hold more securities borrow less but their loans borrowed are concentrated in reverse repos.

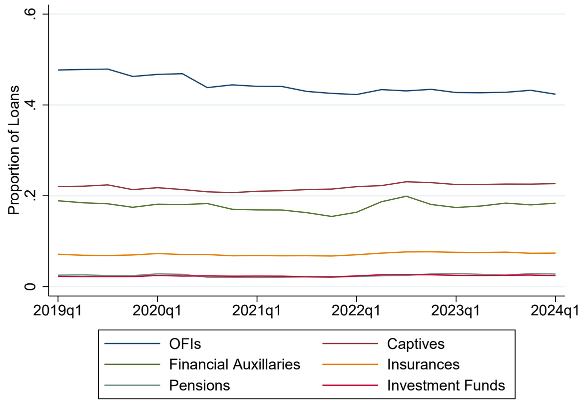
Table B.5 complements this analysis by presenting the composition of collateral pledged by NBFIs against their borrowing from banks across all instrument types. The collateral structure is highly informative about the asset composition of NBFIs' balance sheets. Institutions that primarily invest in securities, such as mutual funds, hedge funds, insurance companies, pension funds and dealers, have a larger fraction of securities within assets used as collateral. By contrast, NBFIs more directly engaged in credit intermediation, such as leasing, factoring, or lending companies, private funds, have a broader mix of assets, including loans, accounts receivables and other non-marketable claims, that are pledged to secure their borrowing. The composition of collateral thus provides indirect evidence on the heterogeneity of NBFI asset holdings and their underlying business models.

Taken together, we find that NBFIs holding more securities have lower leverage but borrow a higher fraction of their loans in the form of reverse repos, which is highly collateralized by safe government securities. These empirical findings are consistent with our model predictions. Although there are other differences across NBFIs, our results suggest that the heterogeneity in risk sensitivity across NBFIs can generate rich cross-sectional patterns consistent with the data.

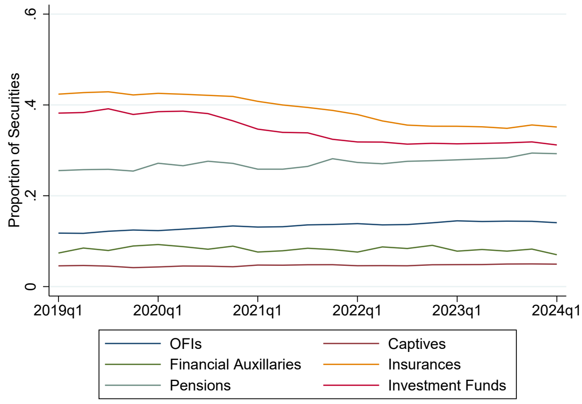
Figure B.14: Asset and Liability Composition of NBFIs

Panels (a) and (b) show loans and securities on the asset side of the balance sheet as a proportion of total assets by NBFI sector. Panels (c) and (d) show debt and bank loans on the liability side of the balance sheet as a proportion of total assets by NBFI sector. Panel (e) shows reverse repos as a proportion of bank loans by NBFI sector.

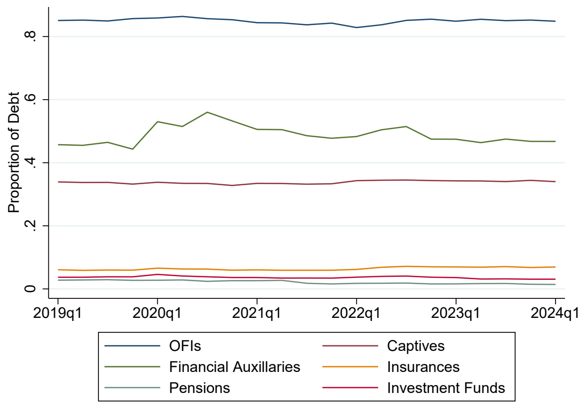
(a) Loans/Assets



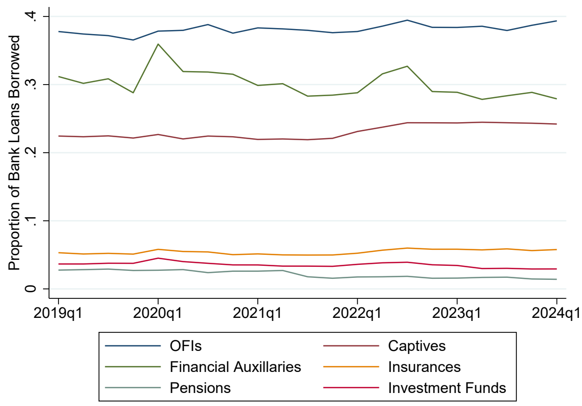
(b) Securities/Assets



(c) Debt/Assets



(d) Loans Borrowed from Banks/Assets



(e) Reverse Repos/Loans Borrowed from Banks

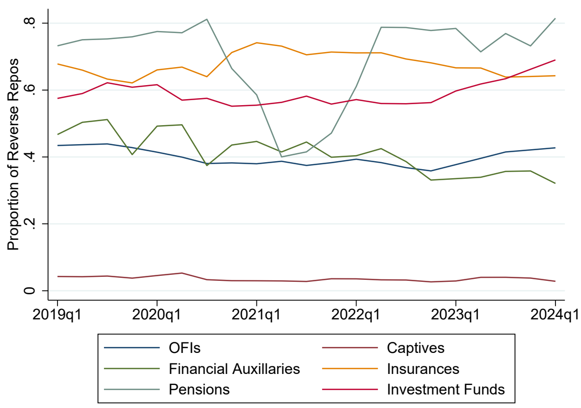
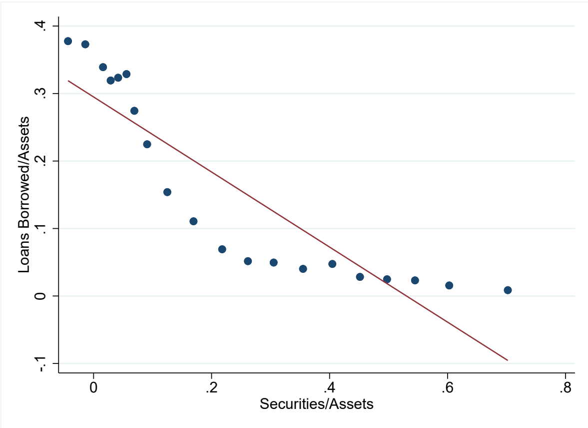


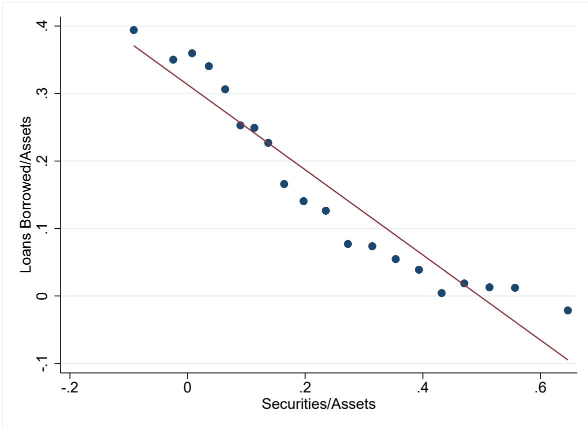
Figure B.15: Liability Composition versus Asset Composition of NBFIs

This figure illustrated the relationship between NBFIs' liability and asset composition. Observations are at the country-NBFI-quarter level. Panel (a) shows the binscatter of the ratio of bank loans over total assets borrowed against the ratio of securities over total assets with a quarter fixed effect. Panel (c) shows the binscatter of the ratio of debt over total assets against the ratio of securities over total assets with a quarter fixed effect. Panel (e) shows the binscatter of the ratio of reverse repos over total loans against the ratio of securities over total assets with a quarter fixed effect. Panels (b), (d), and (f) show the corresponding plots with country-quarter fixed effects.

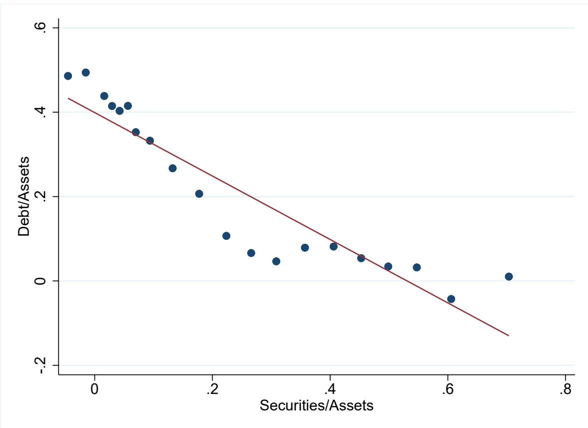
(a) Bank Loans vs Securities (Time FE)



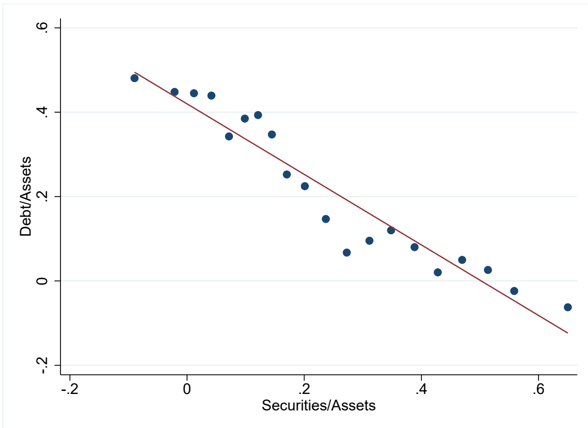
(b) Bank Loans vs Securities (Country-Time FE)



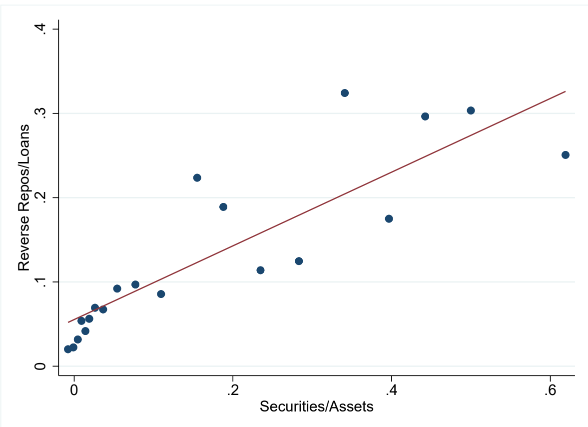
(c) Debt vs Securities (Time FE)



(d) Debt vs Securities (Country-Time FE)



(e) Rev Repos vs Securities (Time FE)



(f) Rev Repos vs Securities (Country-Time FE)

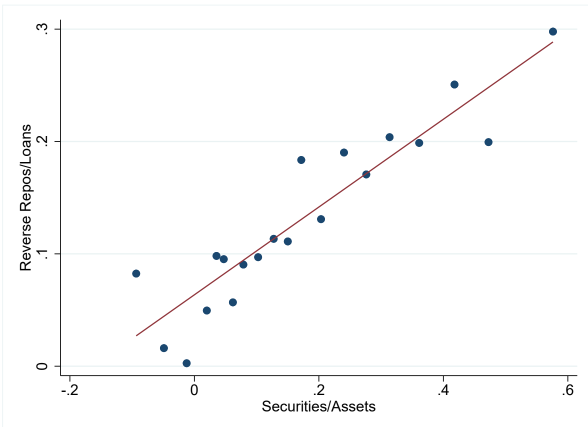


Table B.5: Collateral composition of NBFIs

This table reports the average composition of collateral pledged by different types of NBFIs in their borrowing from banks. The shares are calculated for each sector as the fraction of total collateral value accounted for by a given collateral category—real estate, cash, equity, securities, and other instruments (including loans). The "Sectoral Breakdown" panel aggregates NBFIs into broad groups such as Captives, Financial Auxiliaries, Insurance Corporations, Investment Funds, Other Financial Institutions (OFIs), and Pension Funds. The "Detailed Sectoral Breakdown" panel reports the corresponding averages for individual sub-sectors (e.g., Asset Management Companies, Hedge Funds, Leasing Companies). All values are expressed as fractions and rounded to three decimal places.

Sector	Real estate	Cash	Equity	Securities	Other (incl. loans)
Sectoral Breakdown					
Captives	0.446	0.202	0.044	0.056	0.252
Financial auxiliaries	0.225	0.081	0.057	0.437	0.201
Insurance Corporations	0.014	0.364	0.014	0.525	0.084
Investment Funds	0.221	0.071	0.031	0.512	0.165
OFIs	0.048	0.035	0.024	0.783	0.110
Pension Funds	0.015	0.037	0.019	0.859	0.071
Detailed Sectoral Breakdown					
Asset Management Companies	0.263	0.095	0.088	0.399	0.154
Factoring Companies	0.323	0.049	0.006	0.243	0.379
Financial Corporations Engaged in Lending	0.185	0.052	0.019	0.164	0.579
Financial Vehicle Corporations/Special Purpose Vehicles	0.240	0.235	0.021	0.049	0.456
Hedge Fund	0.008	0.047	0.039	0.875	0.030
Holding Companies of Non-Financial Institutions	0.316	0.290	0.036	0.068	0.290
Leasing Companies	0.327	0.080	0.022	0.106	0.464
Market Infrastructure Providers	0.008	0.018	0.003	0.954	0.017
Mutual Fund	0.015	0.105	0.063	0.766	0.051
Private Equity	0.314	0.081	0.152	0.081	0.371
Private Fund	0.368	0.126	0.058	0.206	0.241
Real Estate Private Fund	0.909	0.015	0.004	0.005	0.066
Security and Derivatives Dealers	0.009	0.008	0.033	0.912	0.038

A3 Outside Option Adjustment

The price-disutility parameters α_D and α_L estimated in Section 5.3.1 govern *bank-level* substitution: how a single bank's quantity responds to its own rate, holding fixed the rest of the market. To recover the *market-level* elasticity—the response of total deposits or loans in a country to a uniform rate shift across all banks—we additionally need to estimate the sensitivity of the aggregate market to changes in the overall desirability of the product. Following Diamond et al. (2024b), we define the aggregate observable desirability

$$\psi^o_{nt} = \log\left(\sum_{m\in n} \exp(\hat{\alpha}\, R_{nmt})\right), \tag{A1}$$

and estimate the outside-option parameter β_o from the country–month regression

$$\log Q_{nt} = \rho_n + \rho_t + \beta_o\, \psi^o_{nt} + \eta_{nt}, \tag{A2}$$

where Q_{nt} is the total market quantity within the country–month, ρ_n and ρ_t are country and month fixed effects, and standard errors are clustered by country. The parameter β_o measures how the size of the entire market (rather than the within-market split) responds to changes in the overall attractiveness of the available alternatives: $\beta_o \to 0$ corresponds to a captive market in which depositors or borrowers cannot leave (so total market quantity is invariant to all-bank rate shifts), and $\beta_o \to 1$ corresponds to perfectly elastic substitution to the outside option.

Results. Table C.6 reports the outside-option estimates for each product. The estimated β_o is 0.088 for retail deposits, 0.037 for institutional deposits, and 0.008 for corporate loans.

Implied Aggregate Elasticities. Combining $\hat{\alpha}$ from Table 9 with $\hat{\beta}_o$ from Table C.6, the aggregate elasticity of demand satisfies

$$\frac{\partial \log Q_{nt}}{\partial R_{nt}} = \hat{\alpha}\cdot\hat{\beta}_o. \tag{A3}$$

This formula implies that when all banks in a country raise their deposit rates by 10 basis points, total retail deposits in the country increase by 0.96% and total institutional deposits increase by 0.38%. When all banks lower their loan rates by 10 basis points, total corporate loans increase by 0.13%. The deposit aggregate elasticities are economically meaningful and in line with prior literature, while the corporate loan aggregate elasticity is small in absolute value, reflecting the captive nature of bank-dependent corporate borrowing in the euro area.

Table C.6: Outside Option Estimates

This table reports the sensitivity of market-level quantities to the aggregate observed desirability ψ^o_{nt}:

$$\log Q_{nt} = \alpha_n + \alpha_t + \beta_o\, \psi^o_{nt} + \eta_{nt}.$$

The regression is estimated at the country-month level. Total market quantities for *retail deposits*, *institutional deposits*, and *corporate loans* are constructed by summing bank-level quantities within each country-month. The aggregate desirability ψ^o_{nt} is constructed from the bank-level price-disutility parameter α (estimated in Table 9) and bank-level rates: $\psi^o_{nt} = \log\left(\sum_m \exp(\hat{\alpha}\, R_{nmt})\right)$. Each regression includes country and time fixed effects. Standard errors clustered by country are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level.

	Retail Deposits	Institutional Deposits	Corporate Loans
	(1)	(2)	(3)
ψ^o_{nt}	0.0876	0.0369	0.0080
	(0.0545)	(0.0452)	(0.0302)
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
N	3,959	3,959	3,918
R^2	0.990	0.986	0.981

A4 Proofs

Proof of Proposition 1. Consider the two-asset specialization with $w_3 = 0$, uncorrelated asset returns, and $0 < \sigma_1 < \sigma_2$. Let borrowing be $b := -w_d > 0$ and define the loan-rate schedule in positive borrowing units by

$$R(\lambda, b) := r_d(\lambda, -b).$$

Suppose R is twice continuously differentiable and satisfies

$$R(\lambda, b) > 0, \qquad R_\lambda(\lambda, b) < 0, \qquad R_b(\lambda, b) > 0, \qquad R_{bb}(\lambda, b) \geq 0.$$

Let $\theta := w_1/(w_1 + w_2)$ denote the share of the safe asset in the risky asset portfolio. We require an interior borrowing solution $(\theta, b) \in (0,1) \times (0, \infty)$, a binding collateral constraint, and the condition

$$\theta < \theta^{MV} := \frac{\sigma_2^2}{\sigma_1^2 + \sigma_2^2}, \tag{A4}$$

which states that the NBFI holds fewer government bonds than the minimum-variance portfolio, a natural condition when bonds have lower expected returns than corporate loans.

After dividing the objective by ϕ_μ, the two-asset NBFI problem can be written as

$$\max_{w_1,w_2,b,\lambda} \ \mu_1 w_1 + \mu_2 w_2 - bR(\lambda, b) - \frac{\kappa}{2}\left(\sigma_1^2 w_1^2 + \sigma_2^2 w_2^2\right)$$

subject to

$$w_1 + w_2 = 1 + b, \qquad w_1 - \lambda b \geq 0, \qquad b > 0.$$

Because $R_\lambda < 0$,

$$\frac{\partial}{\partial \lambda}\left[-bR(\lambda, b)\right] = -bR_\lambda(\lambda, b) > 0.$$

Hence, conditional on (w_1, w_2, b), the NBFI chooses the largest feasible λ. The collateral constraint therefore binds:

$$w_1 - \lambda b = 0, \qquad \lambda = \frac{w_1}{b}. \tag{A5}$$

Set $s := 1 + b$, so $w_1 = s\theta$ and $w_2 = s(1-\theta)$. Using (A5), the reduced objective is

$$H(\theta, b; \kappa) = (1+b)\left[\theta\mu_1 + (1-\theta)\mu_2\right] - bR\left(\frac{(1+b)\theta}{b}, b\right) - \frac{\kappa}{2}(1+b)^2 V(\theta), \tag{A6}$$

where

$$V(\theta) := \sigma_1^2\theta^2 + \sigma_2^2(1-\theta)^2.$$

The derivative of risky-portfolio variance with respect to the safe share is

$$V_\theta(\theta) = 2\sigma_1^2\theta - 2\sigma_2^2(1-\theta).$$

The condition (A4) is equivalent to $V_\theta(\theta) < 0$: the NBFI holds fewer bonds than the minimum-variance portfolio, so shifting toward bonds reduces portfolio variance.

The direct effects of κ on the two first-order conditions are

$$H_{\theta\kappa} = -\frac{1}{2}(1+b)^2 V_\theta(\theta) > 0, \qquad H_{b\kappa} = -(1+b)V(\theta) < 0.$$

Define $p := H_{\theta\kappa} > 0$ and $m := -H_{b\kappa} > 0$.

At an interior optimum, $H_\theta = 0$ and $H_b = 0$. Differentiating these two first-order conditions with respect to κ gives

$$\begin{pmatrix} H_{\theta\theta} & H_{\theta b} \\ H_{\theta b} & H_{bb} \end{pmatrix} \begin{pmatrix} \theta_\kappa \\ b_\kappa \end{pmatrix} = -\begin{pmatrix} H_{\theta\kappa} \\ H_{b\kappa} \end{pmatrix}.$$

Define $A := -H_{\theta\theta} > 0$, $B := -H_{bb} > 0$, and $C := H_{\theta b}$. The second-order condition requires

$AB - C^2 > 0$. Solving:

$$\theta_\kappa = \frac{Bp - Cm}{AB - C^2}, \qquad b_\kappa = \frac{Cp - Am}{AB - C^2}.$$

The cross-effect dominance conditions $Bp > Cm$ and $Am > Cp$ therefore imply

$$\theta_\kappa > 0, \qquad b_\kappa < 0.$$

Since $w_d = -b$, this gives $w_{d,\kappa} = -b_\kappa > 0$, i.e., the debt weight becomes less negative and the NBFI borrows less.

Finally, from (A5),

$$\lambda = \frac{(1+b)\theta}{b}.$$

Therefore

$$\lambda_\theta = \frac{1+b}{b} > 0, \qquad \lambda_b = -\frac{\theta}{b^2} < 0.$$

Combining with $\theta_\kappa > 0$ and $b_\kappa < 0$ yields

$$\lambda_\kappa = \lambda_\theta\,\theta_\kappa + \lambda_b\,b_\kappa > 0.$$

This completes the proof. □

A5 Regulatory Risk Weight Calculation

We calibrate the regulatory capital charges on corporate and NBFI loans to the Basel III internal-ratings-based (IRB) formula. For a loan with one-year default probability PD, loss-given-default LGD, asset correlation ρ, and effective maturity M (in years), the per-unit capital charge K is

$$K(\mathrm{PD}, \mathrm{LGD}, \rho, M) = \mathrm{LGD} \cdot \left[\Phi\left(\frac{\Phi^{-1}(\mathrm{PD}) + \sqrt{\rho}\,\Phi^{-1}(0.999)}{\sqrt{1-\rho}} \right) - \mathrm{PD} \right] \cdot b(\mathrm{PD}, M), \quad \text{(A7)}$$

where Φ is the standard normal cumulative distribution function and Φ^{-1} its inverse, and the maturity adjustment is

$$b(\mathrm{PD}, M) = \frac{1 + (M - 2.5)\,a(\mathrm{PD})}{1 - 1.5\,a(\mathrm{PD})}, \qquad a(\mathrm{PD}) = \big(0.11852 - 0.05478\,\ln \mathrm{PD}\big)^2. \quad \text{(A8)}$$

The bracketed term in (A7) is the unexpected-loss rate. The inner expression $\Phi\big((\Phi^{-1}(\mathrm{PD}) + \sqrt{\rho}\,\Phi^{-1}(0.999))/\sqrt{1-\rho}\big)$ is the default probability conditional on a severe realization of the common (systematic) risk factor, evaluated at the 99.9% confidence level, under the Vasicek single-factor model with asset correlation ρ. Subtracting PD removes expected loss (which is assumed already provisioned), leaving unexpected loss; multiplying by LGD scales it to loss severity. The maturity adjustment $b(\mathrm{PD}, M)$ raises the charge for longer-maturity exposures.

We apply equations (A7)–(A8) with the following inputs. For corporate loans, we take the probability of default and maturity as averages from the data. We set $\mathrm{LGD} = 0.45$ (the Basel foundation-IRB value) and $\rho = 0.12$. For NBFI loans, we solve for default probability to match the average value from the data. We set $\mathrm{LGD} = 0.75$, $\rho = 0.12$, and $M = 1.68$ years. The effective maturity of NBFI loans is the share-weighted average of reverse repos and other loans: reverse repos—about 41% of NBFI loans in the data—are assigned a maturity of 0.5 years, and the remaining loans a maturity of 2.5 years. Government bonds carry a zero risk weight, and equities a fixed charge of 0.20.

The bank's risk-weighted capital constraint uses the per-unit capital charge K in (A7) directly — that is, the regulatory weight $c(\chi_j)$ on asset j equals K evaluated at that asset's parameters.

Table E.7: Regulatory / capital charge parameters

Parameter	Value	Source
Corporate-loan effective maturity	3.49	NFC loan data
NBFI-loan effective maturity	1.68	NBFI loan data
Corporate-loan default probability	3.4%	NFC loan data
NBFI-loan default probability	0.78%	NBFI loan data