Transformation of Risks across Banks and NBFIs[1]

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Abstract

We argue that the rapid asset growth of nonbank financial intermediaries (NBFIs) relative to banks has been accompanied by transformations of risks that increase the interconnectedness of the two sectors. First, the balance sheets of the two sectors exhibit large liability-dependencies. Second, both routinely and in times of stress, banks fund NBFIs through senior loans and credit lines that NBFIs use for acquiring junior credit claims, warehouse financing, and liquidity management. Third, the systemic risks and stock returns of the sectors are increasingly connected. We finish with a clarifying conceptual framework that suggests policy approaches.

Keywords: non-bank financial intermediaries, nonbanks, shadow banking, bank regulation, regulatory arbitrage, systemic risk, credit lines, derivatives margin.

JEL: G01, G21, G23, G28

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Non-bank financial intermediaries (NBFIs) have surpassed banks as the largest global financial intermediaries. Data from Financial Stability Board (2022) show that global financial assets of NBFIs have grown faster than those of banks since 2012, to about $239 trillion and $183 trillion in 2021, respectively. Or, in percentage terms, the share of the NBFI sector has grown from about 44% in 2012 to about 49% as of 2021, while banks' share has shrunk from about 45% to about 38% over the same period. This trend is even more striking in the United States, where the NBFI share of financial assets exceeded 60% in 2021.

The apparent rise in the importance of NBFIs relative to banks has attracted significant attention because the former are so lightly regulated relative to the latter. True, in an aspirational, *parallel* view of the two sectors, banks focus on deposits, loans, and payments, while NBFIs focus on capital markets; banks have to be heavily regulated to protect depositors and the real economy; and NBFIs can be lightly regulated and allowed to fail (Volcker, 2009). And this parallel view has, in fact, influenced financial regulation in the United States through laws that attempt to restrict the scope of bank activities (e.g., the National Bank Acts of the 1860s, the Glass-Steagall Act of 1933, and the Volcker Rule in 2010). In practice, however, NBFIs have not been allowed to fail and have received official support, most notably during the great financial crisis (GFC), but more recently as well (e.g., the Federal Reserve's interventions in the repo markets in 2019 and through the COVID pandemic and shutdowns (Duffie, 2020, Schrimpf, Shin, and Sushko, 2020); the Bank of England's support of the gilt market in response to the liquidity problems of UK pension funds in 2022; and European governments' protection of energy producers and derivatives users, also in 2022). Furthermore, as a matter of law, while the Dodd Frank Act (DFA) of 2010 modified the Federal Reserve's 13(3) powers to lend to NBFIs, it essentially left these broad powers in place.

In an alternate, *substitution* view of the evolution of the NBFI and bank sectors, intermediation activities flow over time from banks to NBFIs at least in part because of relatively burdensome bank regulation. Consequently, NBFIs take on intermediation roles, in kind and volume, that can be systemically important and can lead to rescues by authorities in times of financial stress. This substitution view is consistent with the powers given to authorities by the DFA to designate NBFIs as systemically important financial institutions (SIFIs), to regulate them accordingly, and to resolve large and complex financial companies that are failing. Metrick and

Tarullo (2022) suggest mitigating the dangers of NBFIs substituting for banks through a "congruence principle" that would regulate similar activities similarly, wherever they take place.

In this paper, we argue that much of the observed asset growth of NBFIs is not a displacement of banks, but is, in fact, supported by banks through a *transformation* of their businesses and risks: instead of making and holding loans, and instead of funding their own securitization warehouses, banks provide senior loans and credit lines to NBFIs who, in turn, with this bank financing, hold junior credit claims, warehouse for securitization, and manage contingent liquidity risks. Furthermore, as a result of these transformations, NBFI and bank businesses and risks have become increasingly intertwined, which presents its own set of policy challenges.

Our working assumption – consistent with other research (see Section V) – is that the particular nature of these transformations has been influenced by two drivers: one, the tightening of post-GFC bank regulations, which has discouraged banks from holding weaker credits and encouraged banks to hold larger liquidity buffers; and two, the special role of banks, as both routine and emergency providers of liquidity, given their inherent funding and liquidity advantages from deposit franchises and access to explicit or implicit official backstops such as deposit insurance and central bank's discount window or lender-of-last-resort (LOLR) facilities. In other words, banks give ground to NBFIs on the direct provision of commercial credit, which banks now find relatively expensive. At the same time, banks increasingly exploit their unique status to provide stable funding and contingent liquidity that NBFIs need in their expanding role as intermediaries but cannot easily provide for themselves.

In broad terms, Figure 1 illustrates the increasing interconnectedness of banks and NBFIs. The figure uses FR Y-14 non-public, loan-level data, which are collected as part of the Federal Reserve's supervisory stress tests. From Panel A, bank loans to NBFIs rose from about 12% of all bank loans in 2013 to about 28% in 2024. And from Panel B, over the same period, unused credit lines from banks to NBFIs rose from about 15% to 22% of all unused credit lines.

I. Liability-Interdependencies of Banks and NBFIs

The transformation view of the NBFI and bank sectors predicts that NBFI and bank businesses will be interwoven with complex interdependencies. But, given the special role of

banks from their deposit franchises and access to official backstops, NBFIs can be expected to be more liability-dependent on banks than *vice versa*, and also more liability-dependent on banks than on each other.

We provide empirical evidence for these conjectures using a new version of the Federal Reserve System's Flow of Funds data, namely, FWTW (From Whom To Whom), introduced in Spring 2023. Our Figure 2, which we call the "Matrix of Liability-Dependencies," gives the percentage of the issuance of each sector that is held by each of its creditor sectors.[2]

We draw three overall lessons from the FWTW interdependency data. First, while banks are significantly dependent on the NBFI sector as a whole, consistent, for example, with Forbes, Friedrich, and Reinhardt (2023), banks do not have significant liability-dependence on any individual sector of NBFIs. More specifically, as mentioned above, banks get 77% of their funding from the *Real* and *Rest of the World* sectors and 10% from other banks, which leaves the liability-dependence of banks on the NBFI sector as a whole at a small though non-negligible 13%. This 13%, by the way, includes deposits and commercial paper investments from money market funds; bonds bought by insurance companies, pension funds and mutual funds; and repo loans from broker-dealers. However, banks are not liability-dependent on any individual NBFI sub-sector, with the largest sub-sector, *GSEs*, supplying only 4% of bank funding.

The second lesson from the interdependency data is that NBFIs have significant liability-dependence on banks, in addition to their significant dependencies on the *Real* and *Rest of World* sectors. According to Figure 2, several NBFI sub-sectors depend meaningfully on banks for funding: *GSEs* at 35% of their liabilities; *Broker-Dealers* at 25%; *Equity REITs* at 25%; *Finance Companies* at 15%; and *ABS Issuers* at 10%. Furthermore, we note that FWTW understates these dependencies because these data do not include undrawn bank credit commitments to NBFIs.

The third and final lesson from these figures is that individual NBFI sub-sectors are, in general, not liability-dependent on other sub-sectors. In terms of Figure 2, most of the relevant entries (i.e., those outside of the *Banks*, *Real*, and *Rest of World* rows and columns) are relatively small, though there are some exceptions here.[3]

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[2] For convenience, we have aggregated across all financial instruments and across some subsectors. Details are available on request.

[3] We note that the exact extent of dependencies across banks and NBFIs would need to account for foreign banks and NBFIs included in the Rest of World aggregate. Presently, this decomposition is unavailable.

We also find, but do not report here, that the Q1 2023 data referenced here are relatively robust representations of dependencies over longer periods of time. In summary then, the FWTW data are consistent with the interconnectivity of balance sheets predicted by the transformation view of the NBFI and bank sectors, and that much of the observed growth of NBFIs is in fact supported by banks.

With respect to systemic risk, liability-dependencies between banks and NBFIs mean, most obviously, that losses in one sector can directly result in losses to the other. And indirectly, fire-sale liquidations can transmit shocks across sectors that hold positions in the same asset class. More subtly, however, Cetorelli, Landoni, and Lu (2023) show theoretically and empirically that, because forced liquidations can result in the sale of assets *beyond* those directly impacted by a particular negative shock, fire sales can propagate shocks across entities with *any* balance sheet commonalities.

II. Examples and Case Studies of the Transformation View

Having established that banks and NBFIs have extensive financial claims on each other, with NBFIs more dependent on banks than *vice versa*, this section uses examples and case studies to reveal how these interconnecting claims are manifestations of transformations of business lines. In short, banks had typically made and held loans or made and warehoused loans for future sale, but now tend to extend senior loans and credit lines to NBFIs, which use these funds for junior claim acquisition, warehouse financing, and liquidity risk management. Figure 3 presents an overview of recent transformations divided into three broad categories: loans and mortgages, activities using short-term funding, and contingent funding.

A. *Loans and Mortgages*

Not too long ago, banks typically made and held corporate and mortgage loans. More recently, however, in part due to higher capital requirements and tighter regulations on leveraged lending, large volumes of these loans no longer reside on bank balance sheets. Instead, banks hold indirect exposures through senior loans and credit lines to private credit companies, collateralized loans to mortgage Real Estate Investment Trusts (REITs), and the generally more

senior claims of mortgage-backed securities (MBS) and collateralized loan obligations (CLOs). Hence, bank exposures to the underlying loans have not fully left the banking system; they have been transformed into senior exposures to NBFIs.

The private credit market, which typically lends to medium- and small-sized businesses, has recently attracted a great deal of interest from market participants, regulators, and academics because it has grown so quickly: private credit assets under management currently exceed 30% of the total outstanding of high-yield bonds, syndicated loans, and private credit.[4] As an example of private credit as a transformation rather than as a displacement of banks, consider Blackstone Private Credit Fund (BCRED), one of the largest private credit fund in the world with over $50 billion of assets.[5] According to its 10-K, BCRED subsidiaries had 19 secured credit commitment facilities as of December 2022, 18 of which and 98% of the total committed amount were provided by 13 banks. Furthermore, the outstanding or amounts drawn on these facilities accounted for about 50% of BCRED's total debt liabilities.

It has been argued that the relatively low balance-sheet leverage of private credit lenders imply that they contribute little to systemic risk. But the transformation view instead highlights the liquidity risks of private credit lending as significant enough for these NBFIs to rely on bank funding and credit lines. Therefore, to the extent that disruption of private credit intermediation disrupts the real economy, private credit liquidity risk can contribute to systemic risk, either directly or through the banking sector.[6]

B. *Activities Using Short-Term Funding*

Traditionally, banks participated in various businesses that rely on regular or continuing short-term funding. Examples include the following: securitization, in which the purchases of underlying assets are funded until they are securitized and sold as MBS (mortgage-backed securities), collateralized loan obligation (CLOs), or other ABS (asset-backed securities); financing acquisitions in general, and leveraged buyouts (LBOs) in particular, in which acquisitions are funded in anticipation of bond sales to investors; and mortgage servicing, which

[4] See, Blackstone (2022), Exhibit 2, Ren (2023), and van Steenis (2023).

[5] See privatedebtinvestor.com

[6] See Board of Governors (2023). Fleckenstein et al. (2024) and Ben-David, Johnson, and Stulz (2022) show that NBFI difficulties in funding themselves during stress periods led to overall declines in lending to businesses.

requires servicers to fund payments of delinquent amounts to MBS investors until government insurance pays the related claims. These activities used to be dominated by banks, but are now dominated by NBFIs. However, banks provide NBFIs with the short-term funding used to carry out these activities in the forms of direct loans, warehouse financing, credit lines, subscription finance loans, and bank-sponsored (or credit-enhanced) commercial paper. Another potential example is proprietary trading, which the Volcker Rule forced out of banks and into entities like hedge funds, but which still relies on bank funding through their prime brokerage businesses.[7]

In short, then, activities using short-term funding are another category of activities that seem to have moved from banks to NBFIs, but are better described as having transformed. Furthermore, the transformed role of banks does not mean that authorities need not intervene in times of stress: government-sponsored enterprises (GSEs) and other government insurers chose to provide liquidity support to NBFI originators and servicers in 2020.[8]

C. *Contingent Funding*

The previous two categories of transformations describe how – despite activities seemingly moving to NBFIs – banks indirectly hold credit exposures and provide short-term funding through NBFIs. This category, contingent funding, describes how – again despite seeming shifts of businesses to NBFIs – banks provide unusual or emergency funding, or liquidity insurance, to and thus through NBFIs. Bank contingent funding manifests itself most often by the drawing down of bank credit lines in unusually high volumes.

While sometimes hard to detect given data limitations, this transformation is perhaps the least surprising because of the special role of banks in the financial system. First, deposit and lending franchises diversify liquidity risk because depositor demand for liquidity is not perfectly correlated with borrower demand for drawdowns (Kashyap, Rajan, and Stein, 2002). Second, bank access to official backstops such as deposit insurance, central bank lender-of-last-resort financing, access to funds from Federal Home Loan Banks (in the United States), and implicit too-big-to-fail guarantees has enormous and unique value due to the high correlation of liquidity demand with financial conditions. Third, banks gain deposits in a systemic "flight to safety"

[7] See, for example, Levine (2024).
[8] See Bancroft (2022), FDIC (2019), Chart 2, and Loewenstein (2021).

because of these official backstops, precisely when liquidity is most scarce and valuable (Gatev and Strahan, 2006).

Figure 1, Panel B, discussed earlier, shows the growing importance of committed (but unused) bank credit lines to NBFIs as a fraction of all committed bank lines. Figure 4, using the same non-public, loan-level data from FR Y-14, shows the growing importance of drawdowns of bank credit lines by NBFIs, broken down by private vs. publicly-traded NBFIs. Panels A and B show NBFI drawdowns in billions of dollars and as a share of both NBFI and non-financial corporation drawdowns, respectively. By both metrics, NBFI drawdowns have generally increased over time, particularly due to private NBFIs, with large upward spikes during the COVID pandemic and shutdowns and again through 2021. Over the sample period, the NBFI share of drawdowns rose from about 55% in mid-2013 to about 85% at the end of 2023.[9]

A relatively unheralded example of a transformation in which banks now provide contingent funding to NBFIs is derivatives clearing. Before the GFC, bank-dealers did not collect margin on interest rate swaps (IRS) from many of their clients, like pension funds. Instead, bank-dealers managed their portfolio of counterparty risks by charging fees and imposing credit limits. Post-GFC, however, regulations mandated that most derivatives, including IRS, be cleared by central counterparties (CCPs), which require initial and variation margin. To manage the liquidity risks arising from these margin requirements, many derivatives users, like pension funds, arranged loans and credit lines from their bank-dealers.

When long-term U.K. interest rates spiked higher in September 2022, in response to a government budget proposal, the IRS positions that hedged the liabilities of U.K. pension funds suffered losses and triggered significant margin calls. Pension liabilities also fell in value, but those portfolio gains did not generate cash that could be used to offset IRS margin calls. While banks provided liquidity through a variety of loans and advances, many pension funds were forced to sell government bonds to raise cash, which pushed prices lower (and rates higher), which in turn led to additional margin calls, fire sales of bond positions, and liquidation of IRS hedges that left funds exposed to additional losses when rates ricocheted back down. In response, the Bank of England intervened by committing to purchase and fund large volumes of bonds and

[9] Similarly emphasizing the importance of the increasing importance of NBFI drawdowns, Acharya, Gopal, Jager, and Steffen (2024) show that, for REITs, credit line utilization rates are particularly high relative to nonfinancial corporates and other types of NBFIs, and especially so during market downturns.

by expanding the scope of eligible collateral against loans made to banks to be passed on to pension funds.[10]

A similar situation arose as energy prices increased in 2021 and 2022. Electricity producers that had sold electricity futures contracts to hedge against falling prices faced liquidity pressures both from variation margin calls and increases in initial margin rates. While several banks supplied significant liquidity, many governments nevertheless decided to intervene by offering these producers financial guarantees. Note that while electricity producers are not normally considered NBFIs, derivatives margin requirements mean that they have to manage liquidity like other NBFIs.[11]

III. Empirical Implications of the Interconnectedness of Banks and NBFIs

The transformation view we proposed and illustrated above not only provides a nuanced perspective on the observed growth of NBFIs, but – we claim – changes in a fundamental way the related predictions on risk transmission between bank and NBFI sectors, and in turn, on systemic risk amplification. Specifically, according to the parallel or substitution views, the growth of NBFIs may imply a sectoral shift as to where financial risks are generated and warehoused in the system, but they also predict greater insulation of bank balance sheets and taxpayer-backed liabilities. The transformation view, by contrast, implies an increasing level of exposure of banks associated with the expanding footprint of NBFIs. Along these lines, this section presents two empirical manifestations of the interconnectivity across banks and NBFIs. First, we show that, as measured by *SRISK*, the systemic risks of the bank and NBFI sectors have increased since the GFC. Second, we show that the stock returns of banks are dependent on the stock return of the NBFI sector to the extent that each individual bank has extended credit lines to the NBFI sector.

SRISK is a measure of market-equity-based capital shortfall under aggregate market stress (Acharya, Engle and Richardson, 2012). It can be calculated for publicly-traded banks and NBFIs using the following equation:[12]

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[10] See Plender (2022), for example, for a news account of this episode.

[11] See Turnstead (2023), Wilkes and Turnstead (2022), and Wilson and Stafford (2022) for accounts of this episode.

[12] We include only entities with market capitalizations greater than $100 million. Furthermore, the restriction to public listed entities with observable daily stock prices means that privately held NBFIs (e.g., CLOs, pension funds,

$$SRISK = Exp_0[k(D_t + E_t) - E_t|Crisis] = kD_0 - (1-k)(1-LRMES)E_0$$

where Exp_0 is the expectations operator at time 0; *Crisis* is an aggregate market stress scenario from time 0 to *t* (e.g., a 40% correction to the S&P 500 or MSCI Global index over a six-month period); D_t denotes all non-equity liabilities of the entity at time *t*, which, for simplicity, is assumed to be the constant D_0 between time 0 and *t*; E_t denotes the market equity value of the entity at time *t*; *LRMES* is the entity's long-run marginal expected shortfall, i.e., the expected percentage loss in the market value of its equity in the crisis scenario (estimated using dynamic conditional beta econometrics), so that $Exp_0[E_t|Crisis] = (1-LRMES)E_0$; and, *k* is a prudential market-equity-based capital ratio with which the capital shortfall *SRISK* is computed, e.g., 8%. *SRISK* measurements are publicly available at vlab.stern.nyu.edu/srisk.

The capital shortfall for a subsector, in particular, for banks and NBFIs, is taken to be the sum of the positive *SRISK* values across the individual entities in that subsector. This aggregation assumes imperfect mobility of capital surpluses and shortfalls across entities, which is reasonable with respect to financial stability given the uncertainties associated with the resolution of even mid-sized financial institutions. In any case, these calculations result is one aggregate *SRISK* time series for banks and another for NBFIs.

To study the correlation of the systemic risks across the NBFI and bank sectors, we define several sequential subperiods of interest from Jan 2000 to the end of April 2023: pre-GFC, GFC, post-GFC, Oil Price Shock, Rate Hike + Quantitative Tightening (QT), Pandemic, Post-Pandemic, and the Silicon Valley Bank (SVB) or, more broadly, regional banking stress.[13] We then compute the median 20-day rolling correlation of log changes in bank and NBFI *SRISK* over each subperiod.

The results show that the correlation of bank and NBFI *SRISK* has risen from 64% in the pre-GFC period, to between 80% and slightly more than 85% through the subsequent four periods (cumulatively 8/1/07-12/31/19), to about 90% in the final three periods (cumulatively 1/1/20-5/1/23). This increasing correlation over time is consistent with this paper's view that transformations of business lines have resulted in greater interconnectivity across the bank and

mutual funds, and ETFs) are not covered in this analysis. There is good coverage, however, of insurance companies, standalone broker-dealers, REITs, and financial services companies.

[13] The exact dates of these periods are, respectively; 1/1/00-7/31/07; 8/1/07-10/31/09; 11/1/09-11/30/14; 12/1/14-6/30/16; 7/1/16-12/31/19; 1/1/20-10/31/21; 11/1/21-12/31/22; and 1/1/23-5/1/23. While QT ended in September 2019, for simplicity, we extend that period through the end of that year.

NBFI sectors. Or, from a different perspective, despite post-GFC reforms designed to strengthen the banking system and mitigate its exposure to NBFIs, banks and NBFIs may be operating less in parallel now than before the GFC.

It might be argued, however, that these observed *SRISK* correlations reflect common exposures to market and macroeconomic conditions rather than interconnectivity. For further corroboration, therefore, we examine whether *individual* banks are differentially exposed to risks from the NBFI sector on the basis of their own specific portfolios of loans and credit-line commitments to NBFI obligors. To this end, we estimate the following regression model:

$$R_{it} = \beta_1^J \boldsymbol{w_{it}^{NBFIJ}} \boldsymbol{R_t^{NBFI}} + \beta_2^J \boldsymbol{w_{it}^{NFCJ}} \boldsymbol{R_t^{NFC}} + \gamma_1^J X_t \boldsymbol{w_{it}^{NBFIJ}} \boldsymbol{R_t^{NBFI}} + \gamma_2^J X_t \boldsymbol{w_{it}^{NFCJ}} \boldsymbol{R_t^{NFC}} + \Gamma_i + \Psi_t + \varepsilon_{it}$$

where

R_{it} : the stock return of bank *i* at day *t*;

$\boldsymbol{R_t^{NBFI}}$: the market capitalization-weighted stock return index for NBFIs at day *t*, i.e., the weighted-average of stock returns at day *t* for each public corporation in the CRSP database with NAICS industry code ={52, 53};

$\boldsymbol{w_{it}^{NBFIJ}}$: the holdings of bank *i* at day *t* of credit product *J* ={Credit Lines, Term Loans} of NBFI obligors, as a fraction of bank *i* total assets (FR Y-14 data);

$\boldsymbol{R_t^{NFC}}$: the market capitalization-weighted stock return index for non-financial corporations (NFC) at day t, namely for corporations in the CRSP database with NAICS industry code ≠{52, 53};

$\boldsymbol{w_{it}^{NFCJ}}$: the holdings of bank *i* at day *t* of credit product *J* ={Credit Lines, Term Loans} of NFC obligors, as a fraction of bank *i* total assets (FR Y-14 data);

X_t: time-varying control factors, in particular a simple time trend and the VIX;

Γ_i , Ψ_t: bank and time (day) fixed effects, respectively.

The power of this regression specification comes from the time-varying exposures of each bank to the NBFI sector through its own portfolio of exposures to NBFI obligors, and, furthermore, the separation of those exposures into credit line and term loan components. The analogous exposures to NFCs help isolate the impact of NBFIs on bank returns, and interactions with time-varying control factors and time fixed effects help absorb any common exposures of

banks and NBFIs to market and macroeconomic factors. The data include daily stock returns and quarterly exposures from FR-Y14 over the years 2013 to 2023.

The results of three particular regression specifications are reported in Figure 5. The first specification, which includes the credit-line and term-loan exposure-weighted returns of NBFIs and NFCs, shows that, at the 95% confidence level, bank returns significantly depend on the returns of NBFIs to which they have extended credit lines. In terms of economic magnitude, an increase in a bank's credit lines relative to assets of 6%, which is approximately its first quartile to third quartile range in data, increases its stock return sensitivity ("beta") to NBFI sector return by about 0.12 (1.942 x 0.06). This confirms an important aspect of risk transmission via credit lines: as explained by Acharya, Engle, Jager and Steffen (2024), drawdowns by obligors tend to be highly state-contingent and episodic, so that even if capital and liquidity charges against bank credit lines are correctly calibrated on average, the drawdowns still amplify how sectoral- or market-wide returns ("news") affect bank stock returns.

The second specification, which adds interaction terms with a simple time trend, shows that, at the 95% confidence level, the dependence of bank returns on the returns of NBFIs to which they have extended credit lines significantly increases over time, consistent with the growing dependence of NBFIs on banks for management of funding risks.

The third specification, which adds interaction terms with the VIX instead of with a simple time trend, shows that, at the 95% confidence level, the dependence of bank returns on the returns of NBFIs to which they have extended credit lines is significantly higher when market volatility is high.

Taken together, these regression results support the interconnectivity of banks and NBFIs in the sense that bank stock returns depend on the stock returns of NBFIs to which they have exposure. Interestingly, the exposure generating the statistical significance of that dependence comes from credit lines rather than term loans.

IV. Conceptual Framework and Policy Approaches

In this section, we propose a simple conceptual framework to rationalize the natural emergence of transformation of risks across intermediaries subject to prudential regulation, namely banks, and alternative intermediaries that operate outside the scope of prudentially-

imposed constraints, namely NBFIs. Our framework also helps understand why it is particularly challenging to design regulation that prevents such transformations from creating risk slippages in the financial system.

A. Conceptual Framework

Consider a pool of loans in a particular assets class (e.g., mortgages, corporate loans, auto loans, credit card receivables) normalized to unit size. Regardless of whether a bank or an NBFI originates the loan, the transformations described in this paper have an NBFI providing a level of subordination $s \in [0,1]$, or, equivalently, holding the junior tranche of the pool of size *s*, and a bank holding the senior tranche of size *1-s*. Transformations may also include bank credit lines, and these are incorporated below.

In holding the junior tranche of subordination *s*, an NBFI incurs a cost of capital $\kappa_n(s)$, increasing and convex in *s*. Conversely, in holding the senior tranche with subordination *s*, the bank incurs a cost of capital $\kappa_b(s)$, decreasing and convex in *s*. We assume that the return on the loan, *R*, is unaffected by the transformation. For simplicity, we also assume that banks have bargaining power relative to a competitive NBFI sector, that is, banks earn the entire profit from the loan of $R - \kappa_n(s) - \kappa_b(s)$. The bank's objective, then, is to choose a level of subordination to maximize its net return, that is,

$$\max_s R - \kappa_n(s) - \kappa_b(s)$$

The first order condition maximizing the bank's net return is $\kappa_b'(s^*) = -\kappa_n'(s^*)$ for the optimal subordination s^*, and the second order condition is satisfied by the assumptions on the costs of capital. In words, a bank equates the marginal reduction of capital cost from selling the junior tranche to the marginal return it has to pay on that tranche.

We incorporate regulation with additional structure on capital and its costs. Bank capital is relatively inexpensive due both to the special, money-like characteristics of deposit liabilities and to bank access to both explicit and implicit public backstops. In exchange, however, banks are subject to minimum equity capital requirements. As a result, the cost of bank capital is the weighted-cost of deposit and equity funding, where the weights are set by regulatory requirement. Mathematically,

$$\kappa_b(s) = \big(1 - w(s)\big)\big(\beta r_f - y\big) + w(s)\big(r_f + \pi_b\big)$$

where the deposit rate $\beta r_f - y$ is determined by the risk-free rate, r_f, the deposit beta or sensitivity to the risk-free rate, $\beta < 1$, and a convenience yield, y. The cost of equity capital $r_f + \pi_b$ is determined by the risk-free rate and a risk premium π_b, which reflects bank equity investor assessments of government policy with respect to bank failures and, consequently (for simplicity), does not depend on s. Finally, the regulatory equity capital requirement $w(s) \in (0,1)$ is decreasing and convex in s, which preserves the previous assumptions on $\kappa_b(s)$.

By contrast, the cost of capital of NBFIs is completely market determined and depends on the subordination provided by the junior tranche. Mathematically,

$$\kappa_n(s) = \Big(r_f + \pi_n(s)\Big)\, s$$

where $\pi_n(s)$ is increasing and convex in s, which preserves the previous assumptions on $\kappa_n(s)$.

With this structure on the costs of capital, the bank's first order condition, namely, $\kappa_b'(s^*) = -\kappa_n'(s^*)$, becomes

$$w'(s^*)\big[(1-\beta)r_f + y + \pi_b\big] = -\Big(r_f + \pi_n(s^*)\Big) - \pi_n'(s^*)s^*$$

with the following implications:

Result 1: (i) The optimal size of the junior tranche held by the NBFI, s^*, is increasing in the risk premium on bank equity capital, π_b, and in the convenience yield on deposits, y, while it is decreasing in the deposit beta, β.

(ii) If the structure of NBFI capital costs is further specialized so that $\pi_n(s) = \pi_{n1} + \pi_{n2}(s)$, then s^* is decreasing in the "level" of NBFI capital, π_{n1}.

(iii) If the regulatory capital requirement is further specialized so that $w(s) = K(1 - w_1 s + w_2 s^2)$, with parameters satisfying the previously stated conditions on $w(s)$, then s^* is increasing in the "level" of bank capital requirements, K, and the "slope" of the requirements, w_1.

Taken together, these results confirm the intuition that NBFIs provide more subordination as the cost of bank capital and bank regulatory capital requirements increase, while NBFIs provide less subordination as their own cost of capital increases.

We now turn to bank credit lines, which lower an NBFI's cost of raising capital, but also raises the bank's required equity capital. Mathematically, let $\Gamma(s)L$ be the reduction in the NBFI cost of capital from receiving a credit line in the amount $L \in (0, s)$, with $\Gamma(s) > 0$ but decreasing in s. In general, $\Gamma(s)$ would be expected to differ from the overall NBFI cost of capital $\pi_n(s)$ as

credit lines tend to be drawn down episodically, i.e., more in some contingencies within the space of risks associated with an asset class, notably when there is aggregate funding stress (see Figure 4). Let the bank incur an intermediation or monitoring cost for offering a credit line of $(\lambda/2)L^2$, $\lambda > 0$, and an additional regulatory capital requirement of $K_L\mu(s)L$, where $K_L\mu(s) \in (0,1)$ and decreasing in *s*. Then, continuing with a bank's cost of capital being a weighted cost of its deposit and equity funding, the additional cost of capital for a bank extending a unit of credit line *L* is

$$\kappa_{bL}(s) = \big(1 - K_L\mu(s)\big)\big(\beta r_f - y\big) + K_L\mu(s)\big(r_f + \pi_b\big)$$

Finally, continuing with the assumption that all profits are earned by a bank, a bank optimizes its provision of credit lines with

$$\max_L \Gamma(s)L - \kappa_{bL}(s)L - (\lambda/2)L^2$$

The solution to this optimization is

$$L^* = \frac{1}{\lambda}\big(\Gamma(s) - \kappa_{bL}(s)\big)$$

which says that banks equate the marginal increase in their own cost of capital from providing a credit line to the marginal reduction in the cost of capital of the NBFI from receiving that credit line. Rewriting the solution by substituting in for $\kappa_{bL}(s)$,

$$L^* = \frac{1}{\lambda}\big(\Gamma(s) - \big(\beta r_f - y\big) - K_L\mu(s)\big[(1-\beta)r_f + y + \pi_b\big]\big)$$

which has the following intuitive implications:

Result 2: The provision of credit lines by a bank, L^*, decreases in the cost of monitoring, λ, the level of the capital requirement against credit lines, K_L, the risk premium charged on bank capital, π_b, and the deposit beta, β, but increases in the convenience yield of deposits, *y*.

Of course, the optimal levels of subordination and credit lines are determined simultaneously. We leave a detailed analysis of the implications for future research, but for now we write down the problem of optimizing *s* given the optimal L^*

$$\max_s R - \kappa_n(s) - \kappa_b(s) + \Gamma(s)L^* - \kappa_{bL}(s)L^* - (\lambda/2)L^{*2}$$

and then, by the envelope theorem on the optimality of L^*, derive the following first order condition for *s*:

$$[\Gamma'(s) - \kappa'_{bL}(s)]L^* = \kappa'_n(s) + \kappa'_b(s)$$

Because both $\kappa_n(s)$ and $\kappa_b(s)$ are assumed convex in *s*, this condition together with the expression for L^* above gives the following result:

Result 3: The optimal subordination level s^* is lower in the presence of bank credit lines, and the optimal credit line L^* decreases in the subordination level, if and only if $\Gamma'(s) - \kappa'_{bL}(s) < 0$.

This result shows that, in this framework, the extent of the partition of the transformation of bank and NBFI businesses across subordination and credit lines depends in a relatively complex way on the relationship between how the market reduces capital costs for NBFIs with credit lines and on how those credit lines affect bank capital requirements. Intuitively, as subordination increases, if reduction in the NBFI cost of capital with a credit line is lower than the increase in bank's cost of capital for a credit line, then credit lines are "expensive" to use in transformations; therefore, they are chosen to be smaller in size and in turn subordination is lower too. However, if this condition is reversed, then credit lines are "cheap" to employ, and therefore, they are chosen to be larger in size and correspondingly subordination is higher too.

Our final result underscores the difficulty of setting bank capital requirements in a way that rules out regulatory arbitrage through transformation.

Result 4: (i) When subordination is the only transformation available, the capital requirement $W(s)$ under which banks are indifferent to the level of *s* is, for some constant $\bar{\kappa}$,

$$W(s) = \frac{\bar{\kappa} - \left(r_f + \pi_n(s)\right)s - \left(\beta r_f - y\right)}{r_f + \pi_b - \left(\beta r_f - y\right)}$$

(ii) If credit lines are also available for transformation, and assuming for simplicity they are fully drawn in scenarios of NBFI funding stress, the cost of bank capital is invariant to subordination and credit line transformations if and only if

$$\kappa_b(s - l) = \kappa_b(s) + \kappa_{bL}(s)L$$

Part (i) highlights that bank capital requirements need to be set in a manner that offsets the incentive to engage in transformations arising from the possibly time-varying gap between bank and NBFI costs of capital. This is a tall order, particularly because bank capital requirements might reflect a Pigouvian tax relating to fragility and associated multipliers, the *raison d'etre* for providing banks with public backstops, but these multipliers will almost surely not match perfectly the market-based NBFI cost of capital.

Part (ii) highlights a further challenge. In practice, bank credit lines are treated for regulatory purposes on a stand-alone basis and their regulatory treatment is linked only to the credit quality of the obligor, which in our case is the subordination s. But unless the regulation of credit lines when they are drawn maintains a *homogeneity* property with the regulation of bank exposure to NBFIs, that is, unless regulation recognizes that a part of NBFI subordination is reduced during times of stress due to bank provision of credit lines, there will inevitably be an incentive for transformations using credit lines, and such transformations will likely entail a state-contingent slippage of funding risks from the NBFI sector to banks. This insight is also consistent with the regression results exhibited earlier, showing a positive and significant effect on banks' stock returns of their loadings of credit line exposures to NBFI obligors.

B. Policy Approaches

The evidence and conceptual framework of this paper strongly imply that the risks in the financial system cannot be understood by examining banks and NBFIs separately, and that absent adequate recognition in prudential regulations for the divergence between banks and NBFIs in costs of capital, risk transformations and slippages across banks and NBFIs are likely. We leave for future research a more holistic policy approach to the financial sector. In this section, however, we provide some conjectures.

A first policy goal could be simply to improve the measurement and monitoring of systemic risks that appear in the NBFI-bank interdependencies described in this paper. Existing work along these lines include ECB (2023), FDIC (2019), and FSB (2022). A related policy goal is to incorporate NBFI-bank interdependencies into the supervision of banks and currently supervised NBFIs. Progress here has been made on CCPs: CFTC (2019) and Bank of England (2022) conducted stress tests of CCPs that considered not only defaults of large derivatives counterparties, including clearing members, but also the resulting demands on all of their banks.

If cross-sector monitoring and supervision reveal that there are indeed systemic risk externalities in bank financing of NBFIs, a second policy goal could be to find approaches to internalize these externalities. A possibility is to require banks to preposition collateral for NBFI exposures (both term loans and especially credit lines) recognizing that these might lead to future bank borrowing from central banks during times of aggregate funding stress. Three existing

proposals along these lines are Committed Liquidity Facilities (Nelson, 2023), Pawnbroker for All Seasons (King, 2016), and Federal Liquidity Options (Tuckman, 2012).

Finally, given the history of regulation – particularly the design of bank capital requirements – trailing transformations, authorities might also try to internalize systemic risk externalities by making credible *ex-post* commitments. For example, Acharya (2022) suggests that NBFIs receiving LOLR support could be presumptively subject to regulation by the Federal Reserve, while Acharya and Tuckman (2014) explore imposing one-off corrective actions after such support, such as gradually deleveraging or increasing liquidity buffers.

V. Related Literature

Our paper falls in the tradition of research that recognizes and analyzes changes in the business of banking as they occur. Boyd and Gertler (1995) argued that the perceived decline of the banking sector at that time, measured as a share of assets, ignored the growth of off-balance sheet exposures from derivatives, lines of credit, and guarantees. In particular, as large corporations shifted from bank borrowing to commercial paper issuance, banks shifted to wrapping that issuance with lines of credit and guarantees. Over a decade later, Cetorelli, Mandel, and Mollineaux (2012), Cetorelli and Peristiani (2012), Mandel, Morgan, and Wei (2012), and Acharya, Schnabl, and Suarez (2013) show that banks were not displaced by the growth of securitization, but, in fact, facilitated that growth with liquidity and credit guarantees. Cetorelli, Jacobides, and Stern (2021) and Cetorelli and Prazad (2024) add that these earlier transformations were often facilitated by an NBFI providing liquidity to a bank affiliate (i.e., a bank that is part of the same bank holding company), but that post-GFC regulatory reforms, like living wills and the liquidity coverage ratio, made such liquidity support untenable. Notably, and different from the more recent transformations we describe, these earlier transformations were often characterized by banks taking first-loss exposures.

While we argue that many recent, seemingly distinct developments are all transformations that follow a particular blueprint, several recent papers have described what we have called transformations in individual markets. In the mortgage market, Kim, Laufer, Pence, Stanton, and Wallace (2018) describe bank provision of lines of credit to nonbank mortgage originators and servicers; Benson et al. (2023) show that banks exiting the businesses of

purchasing, pooling, and securitizing government-guaranteed mortgages funded the nonbanks that replaced them; and Jiang (2023) shows that banks both fund and compete with nonbank residential mortgage originators. Jiang (2023) also makes the case that bank market power with respect to funding enables the capture of NBFI profits, which motivates parts of our conceptual framework. More generally in real-estate markets, Acharya, Gopal, Jager, and Steffan (2024) document the extent of bank loans and particularly credit-line exposure to REITs. And more generally with respect to credit lines, Yankov (2020) shows that the LCR and other changes to the financial landscape have resulted in banks holding more liquidity and offering more credit lines to NBFIs, while, conversely, NBFIs hold less liquidity and rely more on bank credit lines. Finally, in the private credit market, Berlin, Nini, and Yu (2020) show that NBFI lenders can make term loans with lighter covenants because stricter covenants characterize bank revolvers. And for business development companies (BDCs) in particular, Chernenko, Ialenti, and Scharfstein (2024) show that relative capital requirements make it more attractive for banks to lend through senior tranches to middle-market lenders than to make loans directly to middle-market borrowers. They also quantify the extent to which, in times of stress, BDC credit provision might contract.

While we do not link transformations with particular regulatory changes, others, in addition to some in the previous paragraph, have done so. Chen et al. (2017), Cortes et al. (2018), Gopal and Schnabl (2022), and Irani et al. (2020) show that bank regulations contributed to the migration of small-business lending from banks to NBFIs such as finance companies and FinTech lenders. Chernenko et al. (2022) and Kim et al. (2016) show the same, with a particular focus on the riskiest loans. Buchak et al. (2024) argue that the long-term shift from bank to nonbank lending has been partly due to regulation. Lastly, Buchak et al. (2018) and Buchak et al. (2022) highlight the impact of regulation on the growth of NBFI market share in residential mortgages.

VI. Conclusion

This paper argues that a transformation of business lines and risks have accompanied the rapid asset growth of the NBFI sector relative to the bank sector and that, as a result, NBFIs and banks have become deeply interconnected. We support this argument using relatively new data

on the liability-dependencies of the two sectors, case studies of transformations in particular markets, and empirical evidence that linkages of bank and NBFI systemic risks and stock returns have grown since the GFC. Furthermore, we present a conceptual framework that rationalizes the emergence of these interconnections and the regulatory challenges to minimize any resulting systemic externalities from risk slippages across banks and NBFIs.

Fleshing out an important part of our argument is left to future research, namely, to identify with much more care the components of the current regulatory regime that explain the profitability of NBFIs and banks transforming in the way we describe. Other research possibilities include: creating a more complete taxonomy of the relevant regulatory arbitrages; further quantifying NBFI and bank interdependencies; conducting more rigorous econometrics as to the systemic risk linkages across the sectors; and expanding the agenda to countries and areas other than the United States. All of these agendas would be invaluable in better understanding our financial systems and in forming more effective policy responses.

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Figure 1. Bank Loans and Credit Line Commitments to NBFIs as Shares of Total Bank Loans and Credit Line Commitments, 2013-2024

Term loans and credit line commitments from U.S. bank holding companies, U.S. intermediate holding companies of foreign banking organizations, and savings and loans holding companies subject to consolidated financial statement reporting requirements. Source: Form FR Y-9C.

Panel A **Panel B**

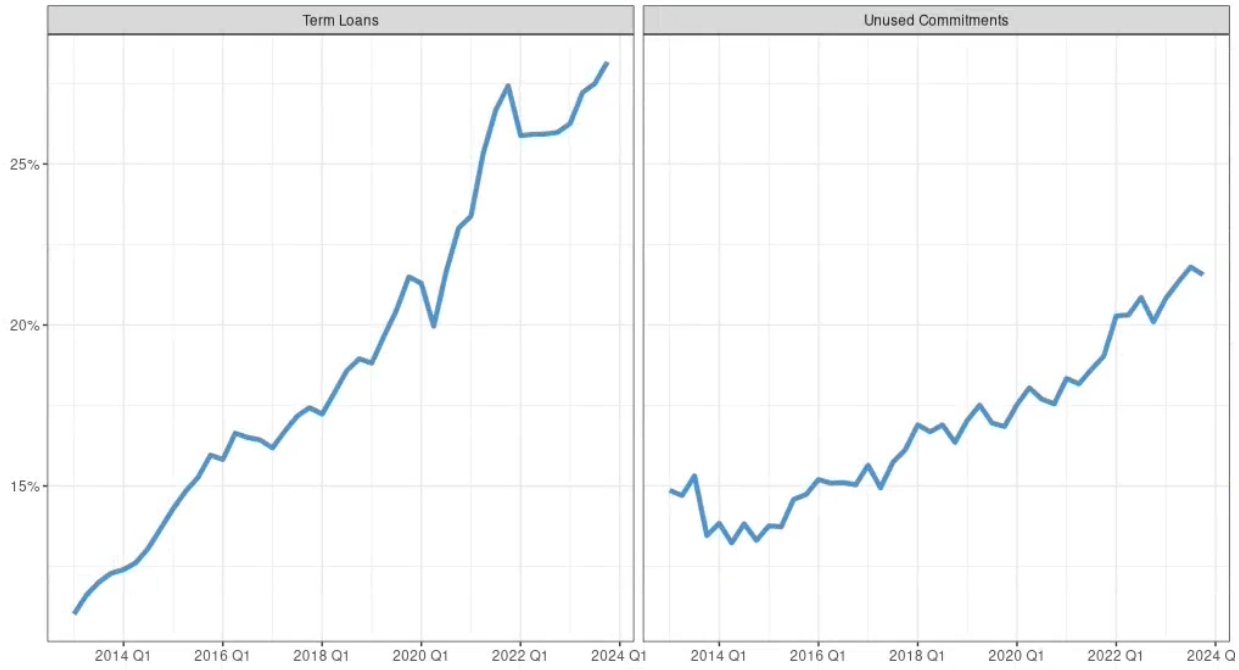

Figure 2: Matrix of Liability-Dependencies, Q1 2023

Percentage of total issued liabilities. For example, 25% of Broker/Dealers liabilities are held by banks. Source: Federal Reserve System, Enhanced Financial Accounts (From Whom To Whom)

		HOLDERS															
			NBFIs														
	ISSUERS	Banks	ABS issuers	Broker/Dealers	Equity REITs	Finance Companies	GSE and Agency	Life Ins.	MMF	Mortgage REITs	Mutual Funds	Other Fin. Bus.	PC Ins.	Pensions	Real Sector	Rest of World	TOTAL
	Banks	10	0	2	0	0	4	2	1	0	1	1	0	1	62	15	100
NBFIs	ABS Issuers	10	0	0	0	0	1	40	3	0	3	5	8	2	3	26	100
	Broker/Dealers	25	0	24	0	0	2	0	8	0	1	0	0	0	11	29	100
	Equity REITs	25	3	0	1	1	1	14	0	2	7	0	3	7	19	18	100
	Finance Companies	15	0	0	0	0	0	11	0	0	7	1	3	6	22	33	100
	GSE and Agency	35	0	1	0	0	3	3	9	2	6	0	1	4	21	15	100
	Life Ins.	4	2	0	0	0	2	6	0	0	0	0	0	11	73	2	100
	MMF	0	0	0	0	0	0	1	0	0	4	8	1	5	77	4	100
	Mortgage REITs	8	0	13	0	0	3	8	10	0	6	0	2	5	7	38	100
	Mutual Funds	0	0	0	0	0	0	8	0	0	0	0	0	27	59	6	100
	Other Fin. Bus.	3	0	54	0	0	0	2	1	0	1	7	0	4	25	2	100
	PC Ins.	1	0	0	0	0	0	1	0	0	0	0	8	2	74	13	100
	Pensions	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	100
	Real Sector	14	1	1	0	1	9	3	1	0	3	0	1	11	37	19	100
	Rest of World	22	0	3	0	3	1	7	3	0	5	1	3	4	48	0	100

Figure 3. Examples of Transformations of Intermediation Activities Across the NBFI and Bank Sectors

Transformation	Activities and Products Historically Within the Banking System	Activities and Products Spread Across Banks and NBFIs
Loans and Mortgages Loans shift from being made and held by banks to being made by NBFIs with collateralized or senior financing provided by banks.	· Corporate loans · Mortgage loans	· Banks make senior loans to private credit companies. · Banks make collateralized loans to mortgage REITs. · Banks hold senior tranches of MBS and CLOs.
Activities Using Short-Term Funding Activities that require short-term funding transform from being conducted and funded by banks to being conducted by nonbanks and funded by banks.	· Mortgage, CLO, and other ABS origination · Acquisition/LBO financing · Mortgage servicing	· Banks offer warehouse financing to nonbank mortgage, CLO, and other ABS originators. · Banks make short-term loans to private equity companies, including subscription finance loans. · Banks sponsor CP or directly lend to nonbank mortgage servicers.
Contingent Funding While the footprint of NBFIs has grown relative to that of banks, banks retain responsibility for providing contingent funding in the form of credit lines to the NBFI sector.	· Credit lines to nonfinancial businesses · OTC bilateral derivatives	· Banks provide credit lines to NBFIs to be drawn down during periods of stress. · Banks bear mutualized counterparty risk as derivative clearinghouse members and provide credit lines to NBFIs to meet margin requirements.

Figure 4: Quarterly Drawdowns of Bank Credit Lines to NBFIs

Panel A in $Billions and Panel B as a share of aggregate drawdowns (NBFIs and non-financial corporations). Source: Form FR Y-14Q, Schedule H.1

Panel A **Panel B**

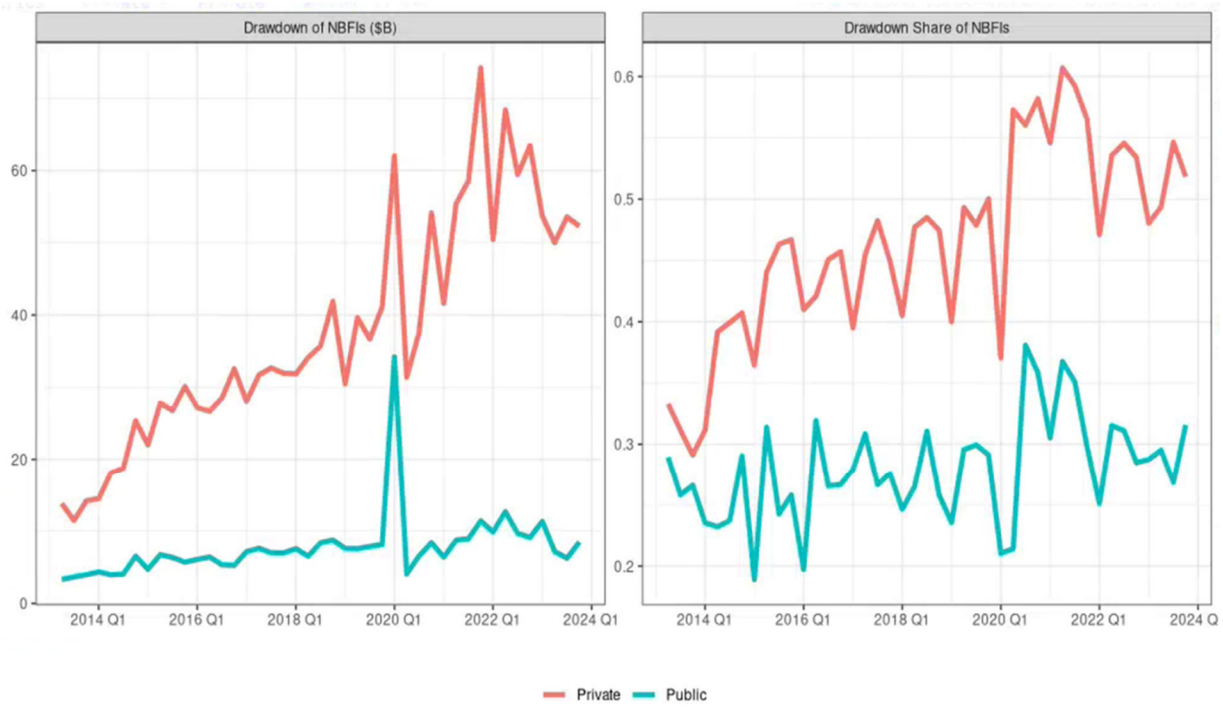

Figure 5: Regressions of Bank Stock Returns on Returns of NBFI and Non-Financial Corporate Stock Returns

The dependent variable in all regressions is R_{it} : the stock return of bank *i* at day *t*. $\boldsymbol{R_t^{NBFI}}$ is the market capitalization-weighted stock return index for NBFIs at day *t*, i.e., the weighted-average of stock returns at day *t* for each public corporation in the CRSP database with NAICS industry code ={52, 53}. $\boldsymbol{w_{it}^{NBFI,J}}$: the holdings of bank *i* at day *t* of credit product *J* ={Credit Lines - CL, Term Loans - TL} of NBFI obligors, as a fraction of bank *i* total assets (FR Y-14 data). $\boldsymbol{R_t^{NFC}}$ is the market capitalization-weighted stock return index for non-financial corporations (NFC) at day t, namely for corporations in the CRSP database with NAICS industry code ≠{52, 53}. $\boldsymbol{w_{it}^{NFC,J}}$ is the holdings of bank *i* at day *t* of credit product *J* ={Credit Lines - CL, Term Loans - TL} of NFC obligors, as a fraction of bank *i* total assets (FR Y-14 data). *Time* is a time trend and *VIX* is the CBOE volatility index. Both Bank *i* and Time (day) *t* fixed effects are included in all regressions.

Dependent Variable	**Bank Stock Return**	**Bank Stock Return**	**Bank Stock Return**
$\boldsymbol{w_{it}^{NBFI,CL}R_t^{NBFI}}$	1.942**	-0.737	0.661
	(0.78)	(1.07)	(1.00)
$\boldsymbol{w_{it}^{NBFI,TL}R_t^{NBFI}}$	-3.038	5.164	-3.489
	(3.12)	(4.14)	(3.84)
$\boldsymbol{w_{it}^{NFC,CL}R_t^{NFC}}$	-0.458	0.278	-0.144
	(0.41)	(0.41)	(0.45)
$\boldsymbol{w_{it}^{NFC,TL}R_t^{NFC}}$	3.815*	-2.750	3.283
	(2.02)	(2.12)	(2.51)
$\boldsymbol{Time * w_{it}^{NBFI,CL}R_t^{NBFI}}$		0.0012**	
		(0.000)	
$\boldsymbol{Time * w_{it}^{NBFI,TL}R_t^{NBFI}}$		-0.0038	
		(0.003)	
$\boldsymbol{Time * w_{it}^{NFC,CL}R_t^{NFC}}$		-0.0003	
		(0.0003)	
$\boldsymbol{Time * w_{it}^{NFC,TL}R_t^{NFC}}$		0.0030*	
		(0.00)	
$\boldsymbol{VIX * w_{it}^{NBFI,CL}R_t^{NBFI}}$			0.0468**
			(0.02)
$\boldsymbol{VIX * w_{it}^{NBFI,TL}R_t^{NBFI}}$			-5.23e-5
			(0.10)
$\boldsymbol{VIX * w_{it}^{NFC,CL}R_t^{NFC}}$			-0.0116
			(0.01)
$\boldsymbol{VIX * w_{it}^{NFC,TL}R_t^{NFC}}$			0.0179
			(0.06)
Fixed-Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	56652	56652	56652
R2	0.75831	0.75976	0.75849