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Bank Regulation and the Rise of Nonbank Intermediation*

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Abstract

We study the rise of nonbank financial intermediation and its implications for systemic risk. We develop a structural network model of banks and nonbank financial institutions (NBFIs) that decomposes intermediation into a capacity channel, driven by bank balance-sheet constraints, and a reliance channel, reflecting NBFI funding reliance. Using U.S. banking confidential supervisory data, we estimate key structural parameters and quantify both channels. We find that fluctuations in bank-NBFI intermediation are primarily explained by the reliance channel, with variation in NBFI fragility emerging as the dominant driver. We show that NBFI intermediation can amplify shocks through funding interconnectedness.

Keywords: Bank regulation; nonbank financial intermediation; systemic risk; financial networks; balance-sheet constraints; NBFI fragility; capacity and reliance channels; supervisory data

JEL Classification: G21, G23, G28, C51, D85

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1 Introduction

In the aftermath of the Global Financial Crisis, regulatory reforms substantially increased bank capital requirements and strengthened the resilience of the banking sector. At the same time, financial intermediation—here defined as the provision of credit to non-financial firms—has increasingly shifted toward NBFIs (including insurance companies, asset managers, hedge funds, and other shadow banking entities). This shift raises concerns about the evolving structure of systemic risk. A central question is whether tighter bank regulation reduces overall risk or instead shifts intermediation toward the nonbank sector in ways that may increase systemic risk through greater interconnectedness between banks and NBFIs.

Recent policy discussions emphasize that regulation may have unintended consequences by pushing activity outside the traditional banking sector. For example, Michelle W. Bowman, the Vice Chair for Supervision of the Federal Reserve Board, argues that tighter requirements can constrain credit provision by banks and shift activity toward less-regulated intermediaries.[1] Recent empirical evidence supports the view that tighter bank regulation affects credit supply more broadly: using high-frequency identification, Drechsel and Miura (2026) show that regulatory tightening reduces bank risk but also leads to a contraction in economic activity by increasing banks' funding costs and tightening loan supply. Despite its prominence in both policy discussions and recent empirical work, there is limited evidence on the mechanisms through which regulation affects bank-nonbank intermediation and the resulting implications for systemic risk.

This paper studies the interaction between bank regulation, nonbank financial intermediation, and systemic risk using a structural approach. We develop a network model consisting of three types of agents: banks, NBFIs, and non-financial firms, which are linked through credit and funding relationships. Banks and NBFIs both provide credit to non-financial firms, while banks are additionally connected to NBFIs through funding exposures. Figure 1 illustrates the structure of the model. In this network, banks allocate balance-sheet capacity across direct loan to non-financial firms and funding provided to NBFIs, subject to convex costs—where the marginal cost increases with the level of balance-sheet usage—reflecting regulatory constraints and internal balance-sheet frictions. NBFIs, in turn, provide credit to non-financial firms while relying in part on bank funding, facing costs that increase with their reliance on such funding. Banks and NBFIs choose their balance-sheet allocations to maximize net returns, while equilibrium NBFI funding from banks and pricing are jointly determined through these interconnected balance-sheet linkages. We analyze in particular bank-NBFI linkages, defined as the funding provided by banks to NBFIs. Our model yields a decomposition of changes in bank-NBFI connectedness into two distinct components: a capacity channel, reflecting variation in effective bank balance-sheet capacity, and a reliance channel, capturing how much NBFI funding relies on banks.

We take the model to confidential supervisory data from the Federal Reserve's Y-14 dataset and recover key structural parameters governing bank constraints, which captures balance-sheet capacity, and NBFI fragility, which captures the tightness of funding conditions faced by NBFIs. Our empirical results yield three main findings. First, fluctuations in

[1] Speech on March 12, 2026 at the Cato Institute Policy Forum: Basel III and Bank Capital Rules, Washington, D.C. Transcript available at `https://www.federalreserve.gov/newsevents/speech/bowman20260312a.htm`

bank funding to NBFIs are primarily driven by the reliance channel, that is, by changes in how much NBFIs depend on bank financing. Greater reliance strengthens bank–NBFI linkages and shifts intermediation toward the nonbank sector. Second, we further decompose these fluctuations into their underlying drivers. We find that variation in NBFI fragility is the dominant driver, while other factors play a more limited role. Fragility captures how sensitive NBFIs are on bank financing, so increases in fragility compress NBFI funding from banks. Third, the time series of estimated structural parameters reveals economically meaningful variations: the marginal cost of expanding bank balance sheets rises markedly in the post-2021 period, while NBFI fragility exhibits a pronounced spike during the pandemic. Together, these findings suggest that while bank balance-sheet constraints shape the scale of financial intermediation, fluctuations in observed funding volumes are largely governed by NBFI funding composition—i.e., the share of NBFI funding sourced from banks.

We further use the model to study how bank–NBFI linkages affect shock propagation in a stress framework with liquidation frictions. This yields a simple amplification condition linking NBFI reliance on bank funding to their liquidation capacity. When reliance exceeds liquidation capacity, bank–NBFI linkages magnify losses relative to bank direct lending to non-financial firms, generating endogenous amplification through the network. The mechanism is straightforward: if NBFIs cannot liquidate assets sufficiently, they are unable to fully repay bank funding, reducing recoveries relative to direct lending to non-financial firms. This result shows that systemic risk depends not only on the scale of intermediation, but also on its composition and on the interaction between leverage and liquidation frictions in the nonbank sector.

Our results also show that when banks' lending to NBFIs is bounded by their liquidation capacity, the network structure facilitates risk sharing. When NBFIs are able to fully repay their obligations to banks, there is no amplification of losses relative to direct lending by banks. These findings contribute to a long-standing debate on the role of financial networks as mechanisms of amplification versus risk sharing. Allen and Gale (2000) show that a complete network (high interconnectedness) can dampen the effects of shocks, whereas Acemoglu et al. (2015) demonstrate that the overall impact depends on the size of the shock. Our framework complements this literature by delivering a simple condition that determines when bank-NBFI linkages amplify losses in stress scenarios.

Our paper contributes to several strands of the literature. First, we contribute to the literature on systemic risk, financial interconnectedness, and financial networks, including Adrian and Brunnermeier (2016), Brunnermeier and Oehmke (2013), Acemoglu et al. (2015), Allen and Gale (2000), and Glasserman and Young (2016). This literature emphasizes that network linkages can either amplify or mitigate shocks, depending on the structure of exposures and the nature of frictions. We contribute by developing a tractable structural framework that links bank-NBFI interconnectedness to underlying balance-sheet constraints and funding frictions, and by deriving a simple amplification condition that characterizes when intermediation through these networks amplifies losses rather than facilitates risk sharing. Our framework also relates to the literature on fire sales and funding liquidity (e.g., Brunnermeier and Pedersen (2009)) by incorporating liquidation frictions into the propagation mechanism in a reduced-form way and showing how they interact with funding structure.

Second, the paper contributes to the literature on bank regulation and its unintended consequences. Prior work documents that tighter capital requirements can affect lending behavior and the allocation of credit (e.g., Aiyar et al. (2014); Jiménez et al. (2017)). More recently, studies have highlighted the migration of financial intermediation to the nonbank sector (e.g., Abad et al. (2017); Albuquerque et al. (2026); Buchak et al. (2018); Irani et al. (2021)). While this literature provides reduced-form evidence of shifts in credit supply, we develop a structural framework that decomposes these effects into distinct capacity and reliance channels.

Third, our paper relates to the growing literature on NBFIs and shadow banking (e.g., Acharya et al. (2024a, 2026); Adrian and Ashcraft (2012); Pozsar et al. (2010)). This literature emphasizes the expansion of nonbank intermediation and its close linkages with the banking sector. Building on this view, we develop a structural framework that decomposes intermediation into a capacity component and a funding reliance component. This decomposition allows us to quantify how bank-NBFI interactions shape the allocation of credit and the propagation of shocks.

Finally, our approach contributes to the empirical structural literature in finance by combining a tractable equilibrium model with supervisory data to recover economically meaningful parameters. This allows us to move beyond reduced-form correlations and provide a quantitative assessment of the mechanisms linking regulation, intermediation, and systemic risk.

The remainder of the paper is organized as follows. Section 2 describes the institutional setting and data. Section 3 presents the model. Section 4 outlines the identification strategy. Section 5 presents the empirical results and policy analysis. Section 6 studies how NBFI intermediation affects systemic risk. Section 7 concludes. Appendices A and B contain supplementary theoretical results and empirical information.

2 Institutional Background and Data

2.1 Institutional Background

The structure of financial intermediation in the United States has evolved substantially since the Global Financial Crisis. Post-crisis regulatory reforms, including the Dodd-Frank Act and subsequent Basel III implementation, strengthened capital and liquidity requirements for banks, particularly for globally systemically important banks (GSIBs). These reforms increased the resilience of the banking sector but also altered the incentives governing balance-sheet allocation and risk-taking.

Over the same period, NBFIs have expanded their role in credit intermediation. While NBFIs are not subject to the same regulatory framework as banks, they remain closely interconnected with the banking sector through a range of funding and trading relationships, including secured lending, derivatives exposures, and liquidity provision. As a result, changes in bank regulation may affect not only the level of credit provision but also its allocation across institutions and the structure of intermediation.

A key feature of this environment is that regulatory constraints apply asymmetrically across activities. Capital requirements on bank loan holdings and exposures to nonbanks affect the marginal cost of balance-sheet usage, while NBFIs face distinct frictions related to funding structure and liquidity risk. These differences create scope for substitution between banks and NBFIs in equilibrium, motivating a framework that distinguishes between changes in aggregate intermediation and changes in its composition.

2.2 Data Sources

Our empirical analysis is based on confidential supervisory data from the Federal Reserve's Y-14 dataset, which is part of the Comprehensive Capital Analysis and Review and the Dodd-Frank Act Stress Test reporting framework. The Y-14 data provide granular information on the exposures of large U.S. banking organizations, including detailed loan-level and counterparty-level information.

We focus on data covering bank exposures to nonbank financial institutions and corporate borrowers. The dataset includes, at a quarterly frequency, information on loan holdings, committed and utilized exposures, and measures of borrower risk such as probability of default. This level of granularity allows us to construct measures of bank-counterparty exposures and to aggregate them into economically meaningful categories.

We classify counterparties into banks and nonbank financial institutions based on institutional type and industry classification. NBFIs include, among others, insurance companies, investment funds, broker-dealers, and other financial intermediaries outside the traditional banking sector. We further group exposures into loan *categories* based on borrower characteristics, such as sector or risk profile, which allows us to map the data into the model structure.

In addition to supervisory data, we use public data sources to measure key market variables. These include the risk-free rate, proxies for deposit convenience yields, and estimates of risk premia relevant for banks and NBFIs. Regulatory parameters, such as capital requirements on loan exposures and inter-institutional claims, are based on prevailing regulatory frameworks and supervisory guidance.

2.3 Construction of Model Variables

The empirical implementation requires mapping observed data into the objects of the model. We begin with quantities directly observed in supervisory data. These include bank loan holdings and bank-NBFI funding exposures, denoted by f. Loan returns are proxied using observed interest rates and performance measures in the Y-14 data.

We construct measures of NBFI activity using supervisory data and external sources. In particular, we proxy NBFI loan holdings t using information on funding relationships and aggregate balance-sheet data. The reliance ratio, defined as the share of NBFI funding obtained from banks, is constructed as $\rho = f/t$, and serves as a key variable capturing the reliance of NBFIs on bank funding. Using these inputs, we construct equilibrium objects implied by the model.

Bank balance-sheet usage is measured as the sum of loan holdings and exposures to NBFIs. Funding prices are inferred from observed spreads and model-implied relationships. Unit costs of intermediation are constructed from regulatory parameters and market variables.

A central feature of our approach is that key structural parameters can be recovered from equilibrium relationships. In particular, the bank balance-sheet convexity parameter and the NBFI fragility parameter are identified from observed quantities and prices using model-implied conditions. This allows us to quantify the role of bank constraints and NBFI funding frictions in shaping intermediation.

3 Model and Theoretical Results

We consider an economy with B banks, N NBFIs, and L loan cells with exogenously given amounts $a_1, a_2, \ldots, a_L$ and returns $r_1, r_2, \ldots, r_L$. Banks and NBFIs jointly intermediate credit to borrowers.

3.1 Banks

Banks allocate balance-sheet capacity across direct loans and funding provided to NBFIs. Let $s_{b\ell}$ denote bank b's holdings of loans in cell ℓ, and let f_{bn} denote funding provided by bank b to NBFI n. Total balance-sheet usage of bank b is given by

$$X_b = \sum_{\ell=1}^{L} s_{b\ell} + \sum_{n=1}^{N} f_{bn},$$

defined as the sum of loan holdings and funding exposures to NBFIs. Using a similar decomposition as in Acharya et al. (2024b), we define the (per-unit) bank loan cost by

$$c_{b\ell} := (1 - w_{b\ell})(\beta r_f - y) + w_{b\ell}(r_f + \pi_b), \tag{1}$$

and the (per-unit) bank cost of funding exposure to NBFI n by

$$\tilde{c}^F_{bn} := (1 - v_{bn})(\beta r_f - y) + v_{bn}(r_f + \pi_b), \tag{2}$$

where

- r_f: risk-free rate
- β: deposit beta or sensitivity to the risk-free rate
- y: convenience yield
- π_b: equity risk premium for bank b
- $w_{b\ell} \in (0, 1)$: regulatory equity capital requirement for bank b on loan ℓ
- $v_{bn} \in (0, 1)$: regulatory equity capital requirement for bank b on net exposure $f_{bn} \geq 0$ to NBFI n.

The net return of bank b is

$$\sum_{\ell=1}^{L} s_{b\ell}(r_\ell - c_{b\ell}) + \sum_{n=1}^{N} f_{bn}\big(p_{bn} - \tilde{c}^F_{bn}\big) - \Phi_b(X_b), \tag{3}$$

which it maximizes over $(s_{b\ell})_{\ell=1,2,\ldots,L}$ and $(f_{bn})_{n=1,2,\ldots,N}$. Here, Φ_b is a convex, differentiable, and increasing function, reflecting stress buffers, GSIB surcharge, or internal limits.

3.2 NBFIs

NBFIs extend credit to borrowers and rely in part on funding from banks. Let $t_{n\ell}$ denote lending by NBFI n to loan cell ℓ, and define the reliance ratio as

$$\rho_n = \frac{\sum_{b=1}^{B} f_{bn}}{\sum_{\ell=1}^{L} t_{n\ell}} \mathbb{1}_{\{\sum_{\ell=1}^{L} t_{n\ell} > 0\}},$$

which measures the reliance of NBFI n on bank funding. Let the marginal cost of funds for NBFI n be given by $d_n := r_f + \theta_n$, where θ_n denotes an NBFI-specific funding spread reflecting risk, liquidity, and investor return requirements.

The net return of NBFI n is given by

$$\sum_{\ell=1}^{L} t_{n\ell}(r_\ell - r_f - \theta_n) + \sum_{b=1}^{B} f_{bn}(r_f + \theta_n - p_{bn}) - \Psi_n(\rho_n) \sum_{\ell=1}^{L} t_{n\ell} - \frac{\xi_n}{2} \sum_{\ell=1}^{L} t_{n\ell}^2, \tag{4}$$

which is maximized over $(t_{n\ell})_{\ell=1,2,\ldots,L}$ and $(f_{bn})_{b=1,2,\ldots,B}$. Here, Ψ_n is a convex, differentiable, and increasing function that captures the private costs associated with reliance on fragile funding structures. These costs may arise from higher funding spreads, tighter constraints, and exposure to financial distress, including bankruptcy risk and associated reputational costs. In the model, such effects enter in reduced form through equilibrium funding conditions and constraints, rather than through an explicit default decision. The term $\frac{\xi_n}{2} \sum_{\ell=1}^{L} t_{n\ell}^2$ captures reduced-form diversification frictions or concentration risk across loans. Throughout, we allow for general $\xi_n \geq 0$. In the one-cell case $L = 1$, we set $\xi_n = 0$, since there is no portfolio-composition margin across loan cells.

We abstract from differences in loan-specific intermediation costs across banks and NBFIs. Instead, heterogeneity across loan cells is captured by loan-dependent returns r_ℓ, while differences across intermediaries are reflected in their respective funding costs and balance-sheet or funding frictions.

Figure 1 presents a stylized representation for a single bank-NBFI pair; in the model, this structure extends to a network of banks and NBFIs connected through funding links f_{bn}.

3.3 Equilibrium

An equilibrium consists of allocations $\{s_{b\ell}, t_{n\ell}, f_{bn}\}$ and prices p_{bn} such that:

1. Banks and NBFIs solve their respective optimization problems under the constraints

$$\sum_{b=1}^{B} f_{bn} \leq \sum_{\ell=1}^{L} t_{n\ell} \;\forall n, \quad s_{b\ell} \geq 0,\; t_{n\ell} \geq 0,\; f_{bn} \geq 0 \;\forall b, n, \ell.$$

2. Credit markets clear in each loan cell ℓ:

$$\sum_{b=1}^{B} s_{b\ell} + \sum_{n=1}^{N} t_{n\ell} = a_\ell. \tag{5}$$

3. The prices p_{bn} are determined in equilibrium so that the markets clear: bank supply equals NBFI demand for each (b, n).

Because of the first condition, the reliance ratio ρ_n is between 0 and 1.

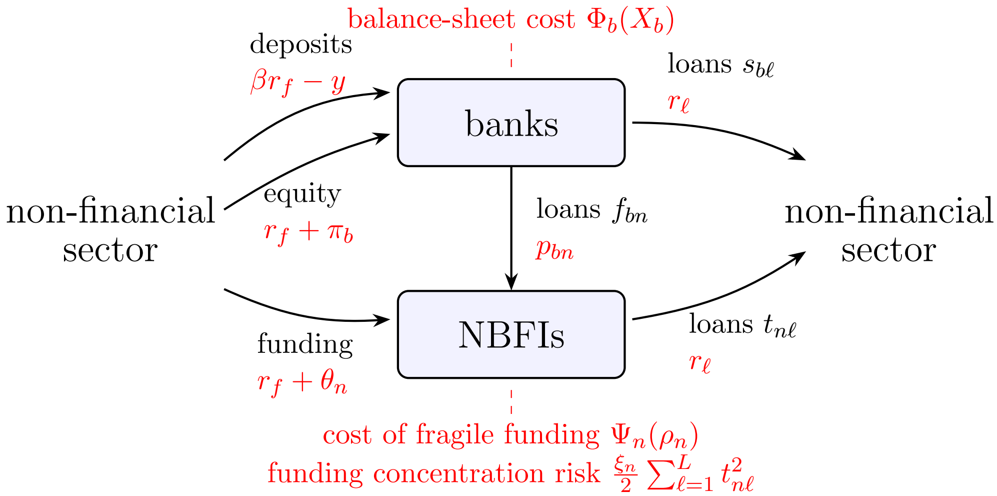


Figure 1: Stylized model structure with funding streams (black) and related costs (red). Banks allocate balance-sheet capacity between direct lending and funding to NBFIs, which in turn intermediate credit while relying on bank funding. The non-financial sector appears on both sides, as it provides funding to intermediaries (left) and receives credit (right).

3.4 Characterization

The model yields a tractable characterization of equilibrium intermediation. In Appendix A, we derive the general solution. Here, we present a fully explicit equilibrium under a simple but economically transparent symmetry assumption. While the model allows for multiple loan cells, we focus on the single-cell case ($L = 1$) to abstract from cross-sector heterogeneity and study intermediation at an aggregate level. In this case, equilibrium is characterized by the bank optimality conditions together with loan-market clearing. Given that the relevant loan return r is observed on the bank side in the data, we use the bank-side conditions to pin down equilibrium prices, and recover NBFI loan holdings from the market-clearing condition. We assume:

- A single loan cell ($L = 1$) with demand $a > 0$ and payoff r. Since there is no diversification consideration across loans, we set $\xi_n = 0$ for all n.
- B banks with identical funding costs and quadratic convexity costs (with bank-specific parameters)
$$c_{b1} = c, \qquad \tilde{c}_{bn}^F = \tilde{c}, \qquad \Phi_b(x) = \frac{\gamma_b}{2}x^2.$$
- N NBFIs with identical funding costs and quadratic fragility costs (with NBFI-specific parameters)
$$d_n = d, \qquad \Psi_n(\rho) = \frac{\eta_n}{2}\rho^2.$$

Bank optimality. For any active bank b, the first-order condition implies $r = c + \gamma_b X_b$ so that
$$X_b = \frac{r - c}{\gamma_b}. \tag{6}$$

Thus, banks differ in their balance-sheet usage depending on γ_b.

Funding price. For any active funding link (b, n), bank optimality implies $p = \tilde{c} + \gamma_b X_b$. Using (6), we obtain

$$p = \tilde{c} + r - c, \tag{7}$$

which is independent of b. Hence, a common funding price clears the market.

NBFI optimality. If the NBFI funding constraint is slack ($\rho_n < 1$), the NBFI funding first-order condition implies $p = d - \eta_n \rho_n$. Combining this with (7) gives an explicit expression for the equilibrium reliance ratio:

$$\rho_n = \frac{d - \tilde{c} - r + c}{\eta_n}. \tag{8}$$

An interior equilibrium requires $0 < \rho_n < 1$.

Loan allocation. Let t_n denote lending by NBFI n and s_b denote lending by bank b. Total balance-sheet usage satisfies $X_b = s_b + \sum_{n=1}^{N} f_{bn}$. Summing across banks,

$$\sum_{b=1}^{B} X_b = \sum_{b=1}^{B} s_b + \sum_{n=1}^{N} \sum_{b=1}^{B} f_{bn}. \tag{9}$$

Using market clearing (5) and $\sum_{b=1}^{B} f_{bn} = \rho_n t_n$, we obtain

$$\sum_{b=1}^{B} X_b + \sum_{n=1}^{N} (1 - \rho_n) t_n = a.$$

Solving for NBFI lending yields

$$\sum_{n=1}^{N} (1 - \rho_n) t_n = a - \sum_{b=1}^{B} X_b. \tag{10}$$

This equation determines the aggregate allocation of lending to NBFIs.

Funding flows. Total funding to each NBFI is

$$\sum_{b=1}^{B} f_{bn} = \rho_n t_n. \tag{11}$$

Funding allocations across banks are indeterminate up to the equalization of marginal costs across active banks. Any bank with $\tilde{c} + \gamma_b X_b = p$ can supply funding in equilibrium.

Summary. In equilibrium, equations (6)–(11) jointly describe:

- the scale of bank balance-sheet usage X_b,
- the equilibrium funding price p,
- the NBFI reliance ratio ρ_n,
- aggregate loan allocations and funding flows.

Interior sharing across banks and NBFIs arises whenever $\sum_{b=1}^{B}(r-c)/\gamma_b < a < \frac{1}{\rho}\sum_{b=1}^{B} X_b$, $r > c$, and $0 < \rho_n < 1$. While the reliance ratios ρ_n are uniquely determined, the allocation of lending across NBFIs is identified only up to the aggregate constraint, reflecting the absence of heterogeneity in loan returns across NBFIs in the single-cell setting. In our empirical implementation, this indeterminacy is not restrictive, as we directly observe t_n, s_b, and f_{bn} in the data and use the model to recover structural parameters from equilibrium relationships.

3.5 Comparative Statics

In an equilibrium with quadratic costs, the regulatory parameters w and v affect distinct margins of bank behavior and therefore have sharply different general-equilibrium effects.

An increase in the capital requirement on bank loan holdings w raises banks' marginal cost of holding loans,

$$c = (1-w)(\beta r_f - y) + w(r_f + \pi),$$

and reduces equilibrium bank balance-sheet usage $X = (r-c)/\gamma$. In equilibrium, banks reallocate balance-sheet capacity away from loan holding and toward NBFI funding activities. This lowers the equilibrium funding price charged to NBFIs,

$$p = \tilde{c} + r - c,$$

increases NBFIs' reliance on bank funding,

$$\rho_n = \frac{d - \tilde{c} - r + c}{\eta_n},$$

and shifts loan holdings from banks to NBFIs. As a result, bank-NBFI funding volumes and interconnectedness increase following a rise in w.

By contrast, an increase in the capital requirement on bank exposures to NBFIs v raises the marginal cost of bank funding,

$$\tilde{c} = (1-v)(\beta r_f - y) + v(r_f + \pi),$$

without directly affecting the marginal cost of bank loan holding. Equilibrium bank balance-sheet usage X_b therefore remains unchanged, but the funding price p increases. Higher funding prices reduce NBFIs' reliance on bank funding (ρ_n falls), leading to lower funding volumes between banks and NBFIs and a reduction in interconnectedness. Loan holdings shift away from the NBFI channel and back toward banks in order to clear the loan market.

Taken together, these comparative statics highlight a key asymmetry of regulatory tools: tightening capital requirements w on bank assets can increase bank-NBFI interconnectedness through general-equilibrium substitution, whereas tightening capital requirements v on bank-NBFI exposures directly dampens such interconnections.

Table 1 gives an overview of the comparative statics. Note that these relations hold only in interior equilibria. The behavior at the boundary can be different.

Table 1: Comparative statics in the symmetric quadratic equilibrium.

Parameter ↑	c	$\tilde{c}$	X_b	p	ρ_n	t_n	s_b	f_{bn}
w (capital on bank loans)	↑	→	↓	↓	↑	↑	↓	↑
π (bank equity risk premium)	↑	↑	↓	↓*	↑	↑	↓	↑
v (capital on bank-NBFI exposures)	→	↑	→	↑	↓	↓	↑	↓
θ (NBFI equity risk premium)	→	→	→	→	↑	↑	↓	↑
γ_b (bank convexity)	→	→	↓	→	→	↑	↓	↑
η_n (NBFI fragility)	→	→	→	→	↓	↓	↑	↓
r (loan return)	→	→	↑	↑	↓	↓	↑	↓
a (loan demand)	→	→	→	→	→	↑	↓	↑
β (deposit beta)	↑	↑	↓	↑*	↓*	ambiguous		
y (convenience yield)	↓	↓	↑	↓*	↑*	ambiguous		
r_f (risk-free rate)	↑	↑	↓	↓*	↑	↑	↓	↑

Notes. Arrows indicate the direction of change in the interior equilibrium ($r > c$, $0 < \rho_n < 1$, $a > \sum_{b=1}^{B}(r-c)/\gamma_b$). c is the bank loan cost, $\tilde{c}$ the bank funding cost to NBFIs, X_b bank b's total balance-sheet usage, p the funding price, ρ_n NBFI n's reliance on bank funding, t_n NBFI n's loan holdings, s_b bank b's loan holdings, and f_{bn} bank-NBFI funding volumes. * assumes $w > v$; the arrows would be inverted for $w < v$.

To illustrate this point, consider B identical banks ($\gamma_b = \gamma$), N identical NBFIs ($\eta_n = \eta$), and equilibria as a function of the aggregate loan demand a, starting from $a = 0$. For small values of a, only banks are active lenders, and supply is demand-constrained. In this region, the NBFIs do not participate in loan holding ($t = 0$), and the entire loan demand is absorbed by banks. Hence bank loan holdings increase linearly with a, with

$$s = \frac{a}{B}, \qquad t = 0, \qquad f = 0.$$

As a increases further, a threshold is reached at which the marginal valuation of NBFIs equals that of banks and an interior equilibrium emerges in which both sectors are active. Beyond this point, bank balance-sheet usage is pinned down by the first-order condition

$$X = \frac{r-c}{\gamma},$$

so that additional loan demand cannot be absorbed by banks without raising their marginal balance-sheet cost above the loan return. The adjustment therefore must occur through higher NBFI loan holdings. This boundary between the corner solution and the interior equilibrium occurs when

$$a^* = BX = \frac{B(r-c)}{\gamma}.$$

The threshold $a^* = BX$ admits a natural economic interpretation. The term $X = \frac{r-c}{\gamma}$ represents the optimal balance-sheet usage of an individual bank, determined by the trade-off between loan returns and the marginal cost of expanding the balance sheet. Aggregating across banks, BX therefore captures the total balance-sheet capacity of the banking sector. The boundary a^* corresponds to the point at which banks fully utilize their balance-sheet capacity. For $a \leq a^*$, banks can absorb all loan demand without increasing marginal balance-sheet costs beyond returns, and intermediation is carried out entirely within the banking sector. For $a > a^*$, bank balance-sheet constraints bind, and additional loan demand must be intermediated by NBFIs. In this sense, a^* separates a regime in which banks are the marginal providers of credit from a regime in which NBFIs become essential intermediaries due to binding balance-sheet constraints in the banking sector.

In the interior equilibrium, the loan-market clearing condition

$$Bs + Nt = a$$

together with the fixed level of X implies that t increases with a, while bank loan holdings

$$s = \frac{a}{B} - \frac{N}{B}t = -\frac{\rho}{B(1-\rho)}a + \frac{r-c}{(1-\rho)\gamma}$$

decline as NBFIs take a more active role in intermediation. Funding volumes f rise in parallel, reflecting greater bank-NBFI interconnectedness.

Economically, this pattern reflects two regimes that can be linked to fluctuations in economic activity. For low levels of loan demand (corresponding to periods of weak economic activity), banks are the primary intermediaries and scale up lending proportionally with demand. As economic activity strengthens and loan demand increases, bank balance-sheet constraints begin to bind, limiting further expansion in bank lending. Beyond this point, additional credit demand is increasingly intermediated by NBFIs rather than banks. This implies that NBFIs play a disproportionately important role in high-demand states of the economy, when bank balance-sheet capacity is scarce. As a result, expansions in economic activity are associated not only with higher overall intermediation, but also with a shift in its composition toward the nonbank sector.

3.6 Funding Decomposition

To obtain an explicit decomposition, we specialize in this section to the symmetric case with B identical banks ($\gamma_b = \gamma$) and N identical NBFIs ($\eta_n = \eta$). Because of (10) and (11), funding per bank-NBFI pair can be written as

$$f = \frac{a - BX}{BN} \cdot \frac{\rho}{1-\rho}, \tag{12}$$

where

$$X = \frac{r - c}{\gamma}, \qquad \rho = \frac{d - \tilde{c} - r + c}{\eta}.$$

This representation highlights that aggregate funding is the product of two distinct components: a *capacity term*, $a - BX$, and a *reliance term*, $\rho/(1-\rho)$.

Taking logarithms of (12) yields

$$\log f = \log(a - BX) + \log\left(\frac{\rho}{1-\rho}\right) - \log(BN).$$

From this, we immediately obtain the following result.

Proposition 1 *Changes in funding can be decomposed as*

$$\Delta \log f = \underbrace{\Delta \log(a - BX)}_{\textit{capacity channel}} + \underbrace{\Delta \log\left(\frac{\rho}{1-\rho}\right)}_{\textit{reliance channel}}. \tag{13}$$

Capacity channel. The term $\Delta \log(a - BX)$ captures changes in effective bank balance-sheet capacity. Since $X = (r - c)/\gamma$, this channel reflects variation in loan returns r, bank costs c, balance-sheet convexity γ, and aggregate capacity a. Economically, it measures how changes in bank-side constraints affect the total amount of intermediation that can be supported by the banking sector: an increase in capital requirements increases the marginal cost of the loan and reduces the ability of the banking sector to intermediate.

Reliance channel. The term $\Delta \log(\rho/(1-\rho))$ captures changes in the composition of funding between banks and NBFIs. Since $\rho = (d - \tilde{c} - r + c)/\eta$, this channel is driven by changes in NBFI funding costs d, bank funding costs to NBFIs $\tilde{c}$, bank loan costs c, loan returns r, and the elasticity parameter η. Economically, it measures shifts in the reliance on NBFIs in providing credit relative to banks.

The decomposition in (13) provides a transparent separation between two distinct margins of adjustment:

- a *capacity margin*, governing how much intermediation the system can support in aggregate;
- a *reliance margin*, governing how intermediation is allocated between banks and NBFIs.

Importantly, bank-side parameters (such as c) affect both channels, as they influence both balance-sheet usage X and the relative attractiveness of bank versus NBFI funding. By contrast, other parameters (such as $\tilde{c}$) affect only the reliance channel, as they do not directly enter bank balance-sheet constraints.

Differential decomposition. A first-order approximation further decomposes the two channels into primitive drivers. For the capacity channel,

$$\Delta \log(a - BX) \approx \frac{1}{a - BX}\Delta a - \frac{B}{a - BX}\Delta X,$$

with

$$\Delta X \approx \frac{1}{\gamma}\Delta r - \frac{1}{\gamma}\Delta c - \frac{r - c}{\gamma^2}\Delta \gamma.$$

For the reliance channel,

$$\Delta \log\left(\frac{\rho}{1 - \rho}\right) \approx \frac{1}{\rho(1 - \rho)}\Delta \rho,$$

where

$$\Delta \rho \approx \frac{1}{\eta}\left(\Delta d - \Delta \tilde{c} - \Delta r + \Delta c\right) - \frac{\rho}{\eta}\Delta \eta.$$

This decomposition is particularly useful for empirical implementation. It allows us to attribute changes in funding either to shifts in bank balance-sheet capacity or to changes in the relative importance of NBFIs, and to further trace these changes back to underlying primitives.

To our knowledge, this is the first paper to provide a structural decomposition of bank-nonbank intermediation into capacity and reliance channels. The decomposition highlights two distinct margins of adjustment. Changes in bank balance-sheet constraints primarily affect the quantity of intermediation through the capacity channel, while changes in NBFI fragility affect the composition of intermediation through the reliance channel. In equilibrium, these channels may offset each other, reflecting substitution between bank and nonbank intermediation.

4 Identification and Mapping to Data

We implement the model presented in Section 3.4 in a setting with B banks, N NBFIs, and a single loan cell ($L = 1$). The empirical strategy exploits the equilibrium structure of the model to map observed quantities and externally calibrated inputs into structural parameters governing bank balance-sheet constraints and NBFI funding fragility.

Overview of identification strategy. The key idea is that, although several model primitives are not directly observed, the equilibrium conditions derived in Section 3.4 provide a set of restrictions that link these primitives to observable quantities. In particular, the first-order conditions for banks and NBFIs imply explicit relationships between prices, quantities, and structural parameters.

Our identification proceeds in three steps:

1. We construct model inputs from supervisory data, market data, and regulatory parameters.

2. We use equilibrium relationships to recover intermediate objects such as balance-sheet usage, funding prices, and reliance ratios.

3. We invert these relationships to identify the structural parameters γ_b and η_n.

Table 2 summarizes this mapping and classifies each variable according to whether it is directly observed, externally calibrated, or derived from the model.

Observed quantities and inputs. We begin with quantities directly observed in supervisory data. These include bank loan holdings s_b, bank-NBFI funding volumes f_{bn}, and loan returns r, which are constructed from the Federal Reserve Y-14 dataset. We proxy NBFI loan holdings t_n using supervisory data and external balance-sheet sources. Because the mapping between supervisory classifications and financial accounts data is not one-to-one, we construct an approximate concordance; details are provided in Appendix B.2. While this mapping is necessarily approximate, it captures the main balance-sheet exposures of each sector and is sufficient for the structural decomposition.

Using these quantities, we construct total loan demand as $a = \sum_{b=1}^{B} s_b + \sum_{n=1}^{N} t_n$. The NBFI reliance ratio is measured as $\rho_n = \frac{\sum_{b=1}^{B} f_{bn}}{t_n}$, which captures the reliance of each NBFI on bank funding.

In addition to supervisory data, we use public data sources to obtain market variables, including the risk-free rate r_f, the deposit convenience yield y, and risk premia π and θ. Regulatory parameters w and v are determined by prevailing capital requirements.

Construction of unit costs. Given these inputs, we construct the model-implied unit costs of intermediation. The cost c and $\tilde{c}$ of bank loan holdings and bank funding to NBFIs are given by (1) and (2). These expressions translate regulatory and market inputs into the marginal costs that govern bank behavior in equilibrium.

Recovery of equilibrium objects. We next recover equilibrium objects implied by the model. Bank balance-sheet usage is constructed from $X_b = s_b + \sum_{n=1}^{N} f_{bn}$. The equilibrium funding price is obtained from the model-implied relationship (7). Together, these quantities provide a complete mapping from observed data to the equilibrium objects that enter the structural equations.

Identification of structural parameters. The structural parameters γ_b and η_n are identified by inverting the equilibrium conditions.

From the bank first-order condition, $r = c + \gamma_b X_b$, we obtain $\gamma_b = \frac{r-c}{X_b}$. This equation identifies the bank convexity parameter γ_b using observed loan returns, constructed costs, and measured balance-sheet usage.

Similarly, from the NBFI funding condition, $p = r_f + \theta - \eta_n \rho_n$, we obtain $\eta_n = \frac{r_f + \theta - p}{\rho_n}$. This expression identifies the NBFI fragility parameter η_n from observed reliance ratios and the model-implied funding price.

This identification strategy highlights that the model is exactly identified at the level of structural parameters. Each parameter is recovered from a corresponding equilibrium condition that directly links it to observable quantities and externally calibrated inputs.

Table 2: Mapping of model variables to data sources.

Variable	Supervisory Observed	Market Estimated	Model Assumed	Formula Derived
Primitive parameters				
w (capital on bank loans)			✓	
π (bank equity risk premium)		✓		
v (capital on bank-NBFI exposures)			✓	
θ (NBFI equity risk premium)		✓		
γ_b (bank convexity)				$\gamma_b = (r - c)/X_b$
η_n (NBFI fragility)				$\eta_n = (r_f + \theta - p)/\rho_n$
r (loan return)	✓ (Y-14)			
a (loan demand)				$a = \sum_{b=1}^{B} s_b + \sum_{n=1}^{N} t_n$
β (deposit beta)			✓	
y (convenience yield)			✓	
r_f (risk-free rate)		✓		
Constructed unit costs				
c (bank loan cost)				$c = (1 - w)(\beta r_f - y) + w(r_f + \pi)$
$\tilde{c}$ (bank funding cost to NBFIs)				$\tilde{c} = (1 - v)(\beta r_f - y) + v(r_f + \pi)$
Equilibrium quantities				
X_b (bank balance-sheet usage)				$X_b = s_b + \sum_{n=1}^{N} f_{bn}$
p (funding price)				$p = r + \tilde{c} - c$
ρ_n (NBFI reliance ratio)				$\rho_n = \sum_{b=1}^{B} f_{bn}/t_n$
t_n (NBFI loan holdings)	✓			
s_b (bank loan holdings)	✓ (Y-14)			
f_{bn} (bank-NBFI funding volumes)	✓ (Y-14)			

Importantly, while the model does not uniquely pin down the allocation of lending across NBFIs in the single-cell setting, this indeterminacy does not affect identification. The quantities t_n, s_b, and f_{bn} are directly observed in the data, and the equilibrium conditions are used to recover structural parameters rather than to determine allocations.

Overall, the combination of supervisory data, external inputs, and equilibrium restrictions allows us to move from reduced-form observations to economically meaningful structural parameters that govern bank constraints and NBFI fragility.

5 Empirical Results and Policy Analysis

This section presents the empirical results obtained from the structural estimation of the model using supervisory data. We focus on estimates based on utilized exposures, which most closely reflect realized intermediation activity. Results based on committed exposures are reported in Appendix B.3 and are qualitatively similar.

We proceed in three steps. First, we describe the time-series behavior of the estimated structural parameters governing bank balance-sheet constraints and NBFI fragility. Second, we analyze the decomposition of bank-NBFI intermediation into capacity and reliance channels. Third, we discuss the implications for financial intermediation.

5.1 Time Series of Structural Parameters

We begin by examining the time-series behavior of the estimated structural parameters governing bank balance-sheet constraints and NBFI fragility. Figure 2 reports the evolution of bank convexity γ_b separately for GSIBs and non-GSIBs, while Figure 3 presents the evolution of NBFI fragility η_n across six NBFI sectors. To determine these parameters, we have applied the model of Section 3.4, along with the identification strategy presented in Section 4, to two bank groups (GSIBs and non-GSIBs) and six NBFI groups. The latter is based on the North American Industry Classification System (NAICS) and is consistent with the classification used by Acharya et al. (2024a).

Bank balance-sheet convexity. Figure 2 shows that bank convexity exhibits pronounced time variation and systematic differences across bank groups. Convexity is moderately lower for GSIBs (red line) than for non-GSIBs (blue line) throughout the sample, indicating that GSIBs operate with a relatively lower marginal cost of balance-sheet expansion.

One interpretation is that GSIBs are more efficient in their use of balance-sheet capacity, reflecting scale advantages, better access to funding markets, or more sophisticated risk management and internal capital allocation. At the same time, GSIBs are subject to tighter regulatory requirements, including GSIB surcharges and enhanced supervision. The lower estimated convexity therefore likely reflects a combination of structural advantages and differences in effective balance-sheet management.

Both groups display a clear cyclical pattern. Convexity increases steadily from 2015 to 2018–2019, consistent with heightened regulatory scrutiny of the banking sector following the Global Financial Crisis. It then declines sharply at the onset of the COVID-19 pandemic in 2020, as policy interventions and regulatory flexibility temporarily relax balance-

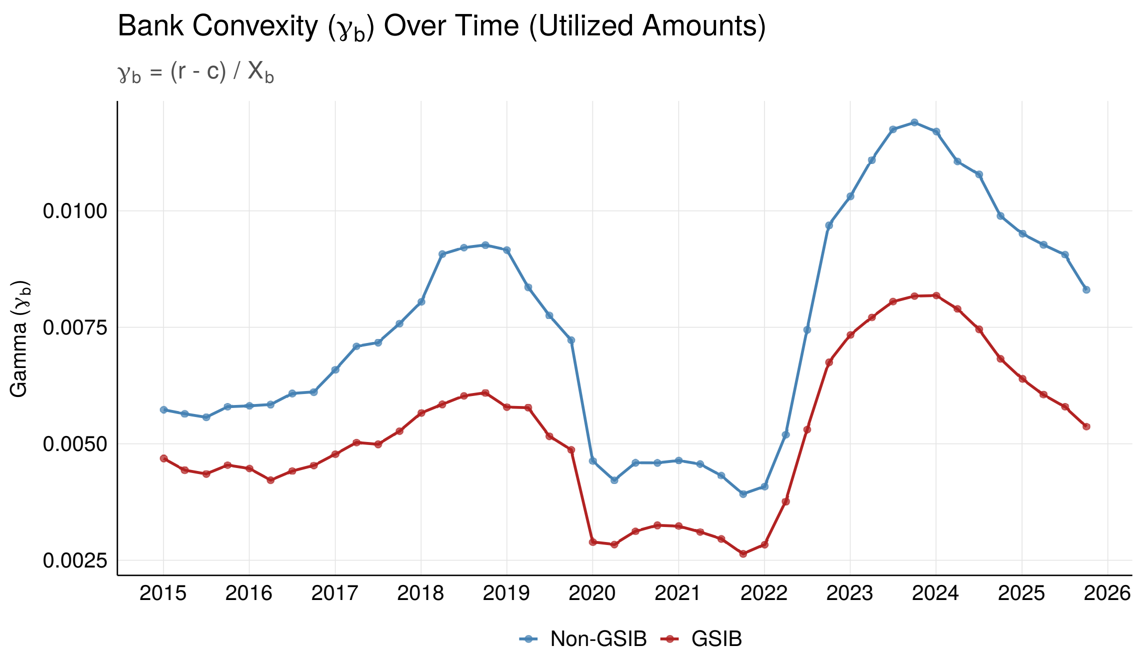


Figure 2: Bank convexity γ_b over time. The figure plots the estimated bank balance-sheet convexity parameter $\gamma_b = (r - c)/X_b$ at the quarterly frequency, separately for GSIBs and non-GSIBs. In the computation of γ_b, r and c are expressed as percentages and X_b in billions of dollars. Higher values of γ_b correspond to a higher marginal cost of balance-sheet usage and thus tighter effective balance-sheet constraints. *Source:* Authors' calculation based on Y-14 dataset, Z.1 Financial Accounts (see Appendix B.2), FRED 10Y rate (DGS10), FRED cpi (CPIAUCSL), and Bloomberg Finance LP, Bloomberg Per Security Data License.

sheet constraints, before rising markedly in the post-2021 period and reaching peak levels around 2023–2024, in line with tighter funding conditions and the normalization of regulatory regimes.

To better understand these dynamics, it is useful to decompose $\gamma_b = (r - c)/X_b$ into its components. The time-series variation in γ_b is primarily driven by changes in net lending margins $r - c$, which decline sharply during the COVID-19 period and increase markedly in the post-2021 period. Movements in balance-sheet usage X_b play a secondary but amplifying role, particularly during stress episodes when balance sheets expand.

Despite level differences, the time-series dynamics of GSIBs and non-GSIBs closely track each other, suggesting that common macro-financial factors drive much of the variation in effective balance-sheet tightness. Overall, the magnitude and persistence of these fluctuations suggest that bank convexity remains an economically meaningful determinant of intermediation through the capacity channel, even though the decomposition below shows that the reliance channel is quantitatively more important over our sample.

NBFI fragility. Figure 3 reports the evolution of the NBFI fragility parameter η_n across six sectors defined by NAICS classifications. The figure reveals substantial heterogeneity across sectors as well as strong time variation.

Fragility dynamics differ markedly across sectors. The insurance sector (pink line) ex-

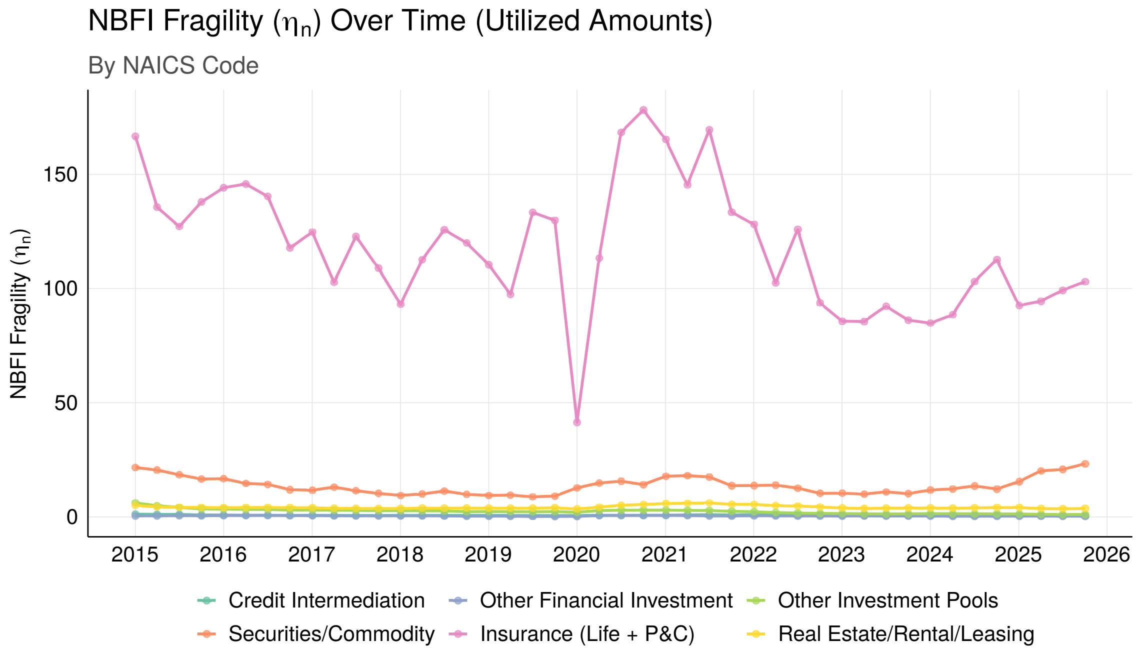


Figure 3: NBFI fragility η_n by sector over time. The figure plots the estimated NBFI fragility parameter η_n at the quarterly frequency across six NBFI sectors classified by NAICS codes. Higher values of η_n indicate greater sensitivity of NBFIs to funding reliance and thus higher effective fragility. *Source:* Authors' calculation based on Y-14 dataset, Z.1 Financial Accounts (see Appendix B.2), FRED 10Y rate (DGS10), FRED cpi (CPIAUCSL), and Bloomberg Finance LP, Bloomberg Per Security Data License.

hibits elevated values, consistent with funding conditions in this sector being more sensitive. Securities and commodities intermediaries display a smoother but steadily increasing trend, reaching elevated levels in the later part of our sample. Credit intermediation and real estate-related NBFIs exhibit relatively low levels of fragility throughout, with only modest cyclical variation.

Taken together, these results highlight that NBFI fragility is both time-varying and highly heterogeneous across sectors. Not surprisingly, the insurance sector exhibits the highest sensitivity of funding conditions to reliance. This is in line with recent evidence on the role of insurers in providing credit to risky firms—see Carlino et al. (2025). This heterogeneity is important for understanding the composition effects captured by the reliance channel in the subsequent analysis.

Bank-NBFI exposures. To complement the analysis of structural parameters, Figure 4 reports the evolution of bank exposures to NBFI sectors over time, while Figure 5 provides a complementary heatmap representation of these exposures. Figure 4 plots aggregate funding volumes f_{bn} from banks to each NBFI sector, separately for GSIBs and non-GSIBs. The heatmap highlights the concentration of exposures in a small number of sectors, persistent differences across bank types, and time variation in sectoral funding patterns.

Several patterns emerge from the combined evidence in the heatmap and the aggregate time-series plot. First, exposures are highly concentrated in a small number of sectors. In

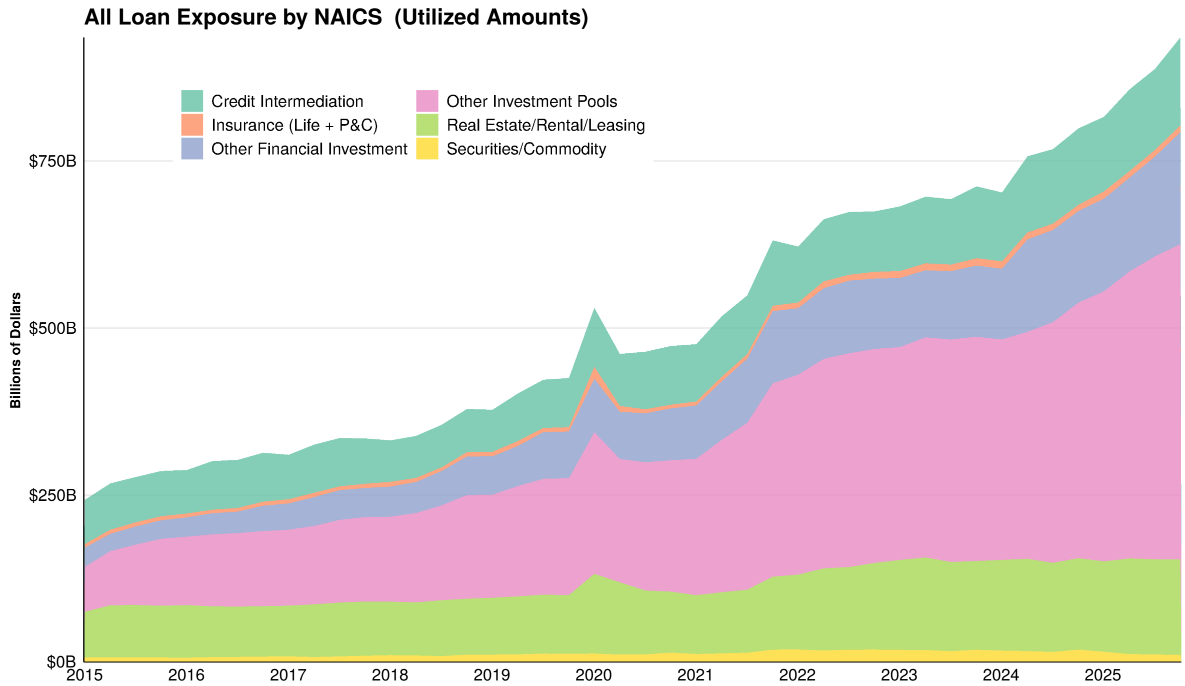


Figure 4: Bank exposures to NBFI sectors over time. The figure plots aggregate funding volumes f_{bn} from banks to NBFI sectors at the quarterly frequency. *Source:* Y-14 dataset.

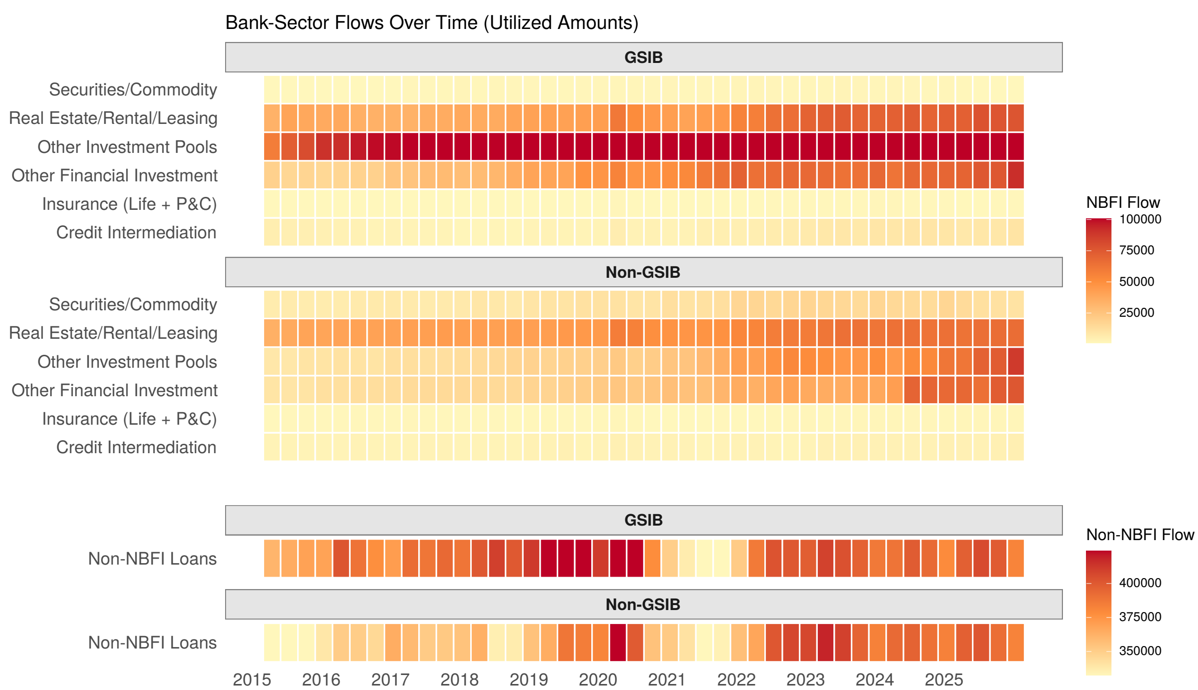


Figure 5: Heatmap of bank lending to NBFI sectors over time, separately for GSIBs and non-GSIBs. *Source:* Y-14 dataset.

particular, real estate (green), other financial investment (gray), and other investment pools (pink) consistently account for the largest shares of bank-NBFI funding, which is visible both in the darker intensity bands of the heatmap (indicating persistently high exposure levels across time) and in the dominant series in the aggregate exposure plot.

Second, exposures exhibit pronounced time variation. Both figures show a steady expansion with a marked increase during the pandemic when policy interventions provided funding opportunities to many sectors of the economy. Post-pandemic, bank lending to NBFIs continued to grow.

Third, there are systematic differences between GSIBs and non-GSIBs. The heatmap reveals that GSIB exposures are more persistent and more concentrated toward "other investment pools" whereas non-GSIB exposures appear more broadly distributed across sectors. These patterns align with differences in balance-sheet capacity and funding strategies across bank types and provide a reduced-form view of the intermediation dynamics that are structurally decomposed into capacity and reliance channels in the subsequent analysis.

Interestingly, the insurance sector, which showed the largest fragility in Figure 3, does not rely very much on bank funding. This is to be expected since insurance companies have stable sources of funding based on collecting policy premia and relying on nontraditional liabilities—see Foley-Fisher et al. (2022).

5.2 Decomposition of Intermediation

We now turn to the central empirical implication of the model: the decomposition of changes in bank-NBFI intermediation into the capacity channel (capturing bank balance-sheet capacity) and the reliance channel (capturing how intermediation is allocated between banks and NBFIs). For this analysis, we treat banks and NBFIs as representative entities by aggregating them, in line with the setting of Section 3.6.

As shown in Section 3.6, we can decompose the bank-NBFI funding changes into different channels and drivers. Figure 6 presents the empirical implementation of this decomposition for utilized exposures. Based on Proposition 1, Panel A reports the decomposition into capacity and reliance channels while Panel B further decomposes these components into underlying primitive drivers using the first-order approximation derived in Section 3.6.

Capacity and reliance channels. Panel A shows that the reliance channel is the primary driver of fluctuations in bank-NBFI intermediation: most of the variation in connectedness between banks and NBFIs (black line) is accounted for by movements in the reliance component (orange bars). Because the reliance channel reflects equilibrium behavior on both sides of the market, changes in both bank and nonbank conditions contribute to the evolution of f. By contrast, the capacity channel plays a more limited role.

This pattern is particularly pronounced during the COVID-19 period. The reliance channel exhibits sharp movements, consistent with large shifts in reliance on bank funding, while the capacity channel contributes only modestly. This suggests that fluctuations in bank-NBFI interconnectedness are driven primarily by changes in market conditions affecting both sectors, rather than by variation in bank balance-sheet capacity.

More generally, these results indicate that bank-NBFI linkages are shaped mainly by how credit is intermediated between the two sectors, rather than by the overall capacity of the banking system. While banking regulation remains an important determinant of aggregate credit supply, the structure of intermediation between banks and NBFIs plays an even more central role.

Underlying drivers. Panel B links these dynamics to the primitive drivers identified, using the decomposition and first-order approximation of Section 3.6. The figure attributes changes in intermediation to variation in loan demand a, loan returns r, bank convexity γ, NBFI fragility η, the risk-free rate r_f, and risk premia π and θ.

Two key patterns emerge. First, fluctuations in intermediation between banks and non-banks are primarily driven by NBFI-side factors, in particular variation in NBFI fragility η. This component accounts for the largest share of movements, indicating that changes in NBFI funding conditions are the dominant force behind the dynamics of bank-NBFI connectedness.

Second, bank-side factors, including bank convexity γ, play a more limited role. Other determinants—such as loan demand a, the risk-free rate r_f, and risk premia π and θ—contribute to fluctuations but are quantitatively smaller and more persistent over time.

Overall, the evidence highlights the central role of the reliance channel in shaping bank-NBFI intermediation. Variation in funding composition, rather than bank balance-sheet capacity, accounts for most of the observed dynamics. The decomposition further shows that these fluctuations are largely driven by changes in NBFI fragility, underscoring the importance of NBFI-side funding conditions.

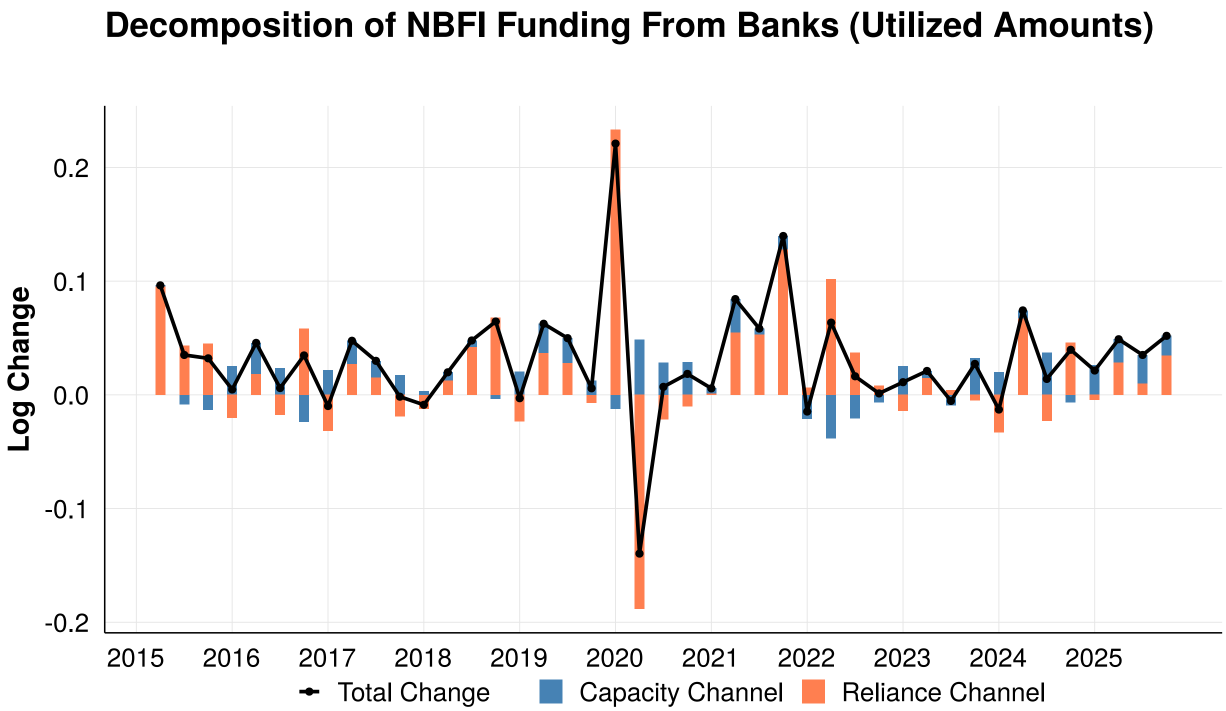
5.3 Economic Interpretation and Policy Implications

The decomposition in Section 5.2 provides a structural lens through which to interpret the interaction between bank regulation, nonbank intermediation, and systemic risk. By separating changes in intermediation into capacity and reliance channels, the model distinguishes between shifts in the *quantity* of intermediation and shifts in its *composition*.

Bank constraints and aggregate intermediation. The dominance of the reliance channel implies that NBFI-side conditions are the primary determinant of fluctuations in bank-NBFI intermediation. While bank balance-sheet constraints shape the feasible scale of intermediation, observed variation in funding volumes is largely driven by changes in funding composition and reliance on bank funding.

From a regulatory perspective, this highlights the central role of NBFI-side funding conditions, especially in sectors that are less tightly regulated and supervised than banks. It also shows that policies that affect bank balance sheets, including capital requirements, liquidity regulation, and funding conditions, directly influence the overall volume of credit intermediation, consistent with the comparative statics in Section 3.5.

Substitution between banks and NBFIs. At the same time, the reliance channel reveals a systematic substitution between banks and NBFIs. Periods of increased bank capacity are often accompanied by declines in NBFI reliance on bank funding, and vice versa. This



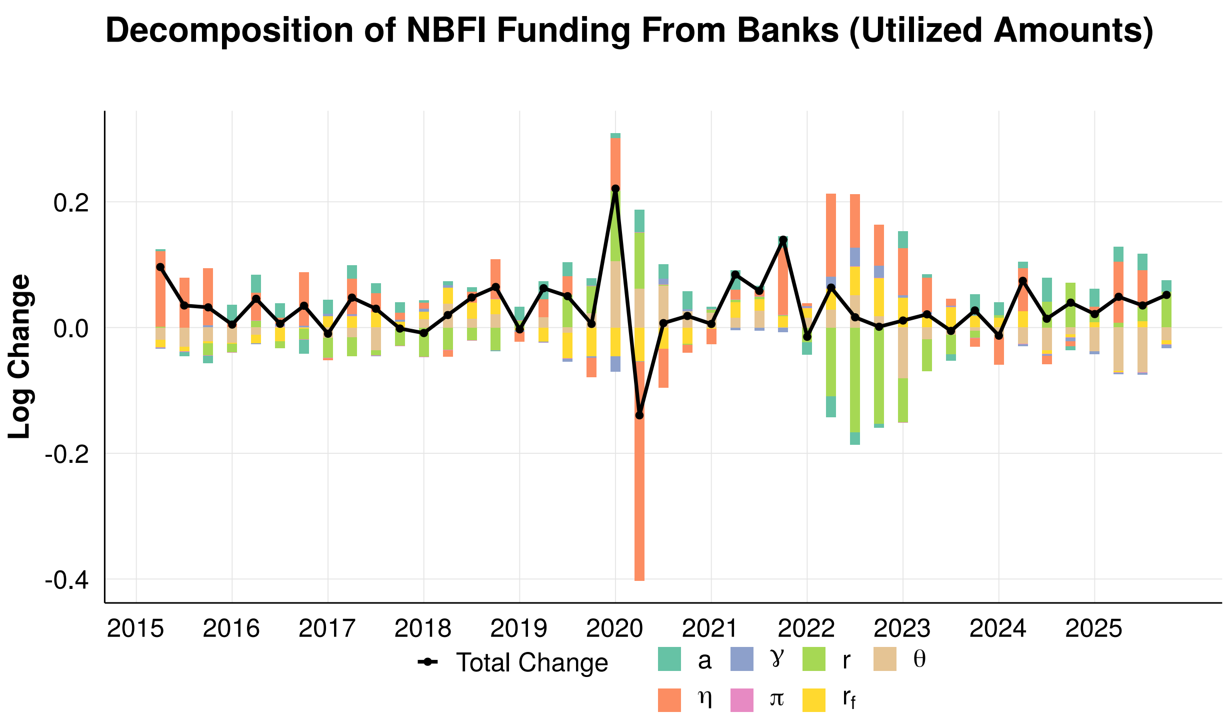


Figure 6: Decomposition of changes in NBFI funding from banks. Panel A shows the decomposition of funding changes into capacity and reliance channels, as derived in Section 3.6. Panel B further decomposes these changes into underlying drivers. *Source:* Authors' calculation based on Y-14 dataset, Z.1 Financial Accounts (see Appendix B.2), FRED 10Y rate (DGS10), FRED cpi (CPIAUCSL), and Bloomberg Finance LP, Bloomberg Per Security Data License.

reflects a general equilibrium reallocation implied by the model: changes in bank balance-sheet costs affect both the feasible scale of intermediation and the relative attractiveness of bank versus NBFI funding, generating an endogenous substitution between the two sectors.

As a result, regulatory interventions targeting banks may have indirect effects on the nonbank sector. Tightening bank constraints may tend to increase reliance on NBFIs, while loosening constraints may reduce such reliance. The net effect on intermediation therefore depends on the interaction between the capacity and reliance channels.

Fragility and funding composition. The results highlight NBFI fragility as the central driver of intermediation dynamics, as shown in Panel B of Figure 6. Increases in fragility, η, reduce the equilibrium reliance ratio ρ, leading to a contraction in bank-NBFI funding even in periods of strong aggregate intermediation.

This mechanism is particularly evident during the COVID-19 episode, where a sharp increase in NBFIs' fragility coincides with a decline in reliance, alongside a large expansion in bank balance-sheet capacity. More generally, shocks to NBFI funding conditions can materially affect the structure of intermediation without necessarily reducing its overall level.

Banks as stabilizing intermediaries in stress periods. An important implication of the decomposition is that adjustments in intermediation during stress periods operate primarily through changes in funding composition. In particular, during the COVID-19 episode, large movements in the reliance channel reflect shifts in NBFI funding conditions, while changes in bank balance-sheet capacity play a more limited role.

This pattern suggests that banks can still play a stabilizing role along the capacity margin, absorbing a larger share of intermediation when NBFI funding conditions deteriorate. At the same time, the decomposition shows that the dominant source of variation in observed bank-NBFI funding volumes depends on NBFIs' fragility.

Importantly, the banks' stabilizing role operates along the capacity margin and does not eliminate underlying fragility in the nonbank sector. Rather, it reflects a reallocation of intermediation toward banks when nonbank funding becomes more constrained. As a result, aggregate intermediation remains resilient, even as its structure adjusts.

Policy implications. Taken together, the findings imply that regulatory policies should account for both margins of adjustment identified by the model. Policies that focus solely on bank balance-sheet resilience may overlook the endogenous response of the nonbank sector, while policies targeting nonbank fragility may have limited effects on aggregate intermediation if bank capacity remains unconstrained.

The structural decomposition developed in this paper provides a tractable framework to quantify these interactions. By separately identifying capacity and reliance channels, it allows policymakers to distinguish between policies that affect the scale of intermediation and those that affect its composition, and to assess how these margins jointly determine the distribution of risk in the financial system.

6 Systemic Risk and NBFI Intermediation

The empirical results in Section 5 show substantial heterogeneity in reliance ratios ρ_n across sectors and over time. In particular, several NBFI sectors exhibit persistently high reliance on bank funding. In this section, we study how such reliance interacts with liquidation frictions to determine the amplification of shocks. We exploit the structure of the model to compare equilibria with different degrees of bank-NBFI intermediation and quantify how these differences affect the transmission of shocks.

Stress framework. We consider the one-cell setting ($L = 1$) and fix an equilibrium allocation

$$\{s_b\}_{b=1}^{B}, \quad \{t_n\}_{n=1}^{N}, \quad \{f_{bn}\}_{b,n}.$$

We impose a common adverse shock to loan payoffs. Let $\alpha \in [0, 1]$ denote the recovery rate on loans. After the shock, loan values become

$$\tilde{s}_b = \alpha s_b, \qquad \tilde{t}_n = \alpha t_n.$$

NBFIs are subject to funding fragility. Recall that the reliance ratio is $\rho_n = \frac{\sum_{b=1}^{B} f_{bn}}{t_n}$. An NBFI defaults if its post-shock asset value cannot cover its funding obligations toward the banking sector:

$$\alpha t_n < \sum_{b=1}^{B} f_{bn} \quad \Longleftrightarrow \quad \alpha < \rho_n.$$

Upon default, NBFI n liquidates its assets under fire-sale conditions. We introduce a parameter $\kappa_n \in [0, 1]$, which captures the fraction of post-shock asset value that can be realized in liquidation. The total value available to creditors (banks) is therefore $\kappa_n \alpha t_n$. The parameter κ_n is conceptually distinct from the fragility parameter η_n. While η_n governs the sensitivity of NBFI funding demand to reliance in equilibrium, κ_n captures ex post liquidation efficiency under stress.

Bank claims on NBFIs are repaid proportionally. Hence, the repayment rate on bank-NBFI funding is

$$\phi_n = \begin{cases} 1, & \alpha \geq \rho_n, \\ \frac{\kappa_n \alpha}{\rho_n}, & \alpha < \rho_n. \end{cases}$$

The post-shock asset value of bank b is therefore

$$A_b^{\text{post}} = \alpha s_b + \sum_{n=1}^{N} \phi_n f_{bn}.$$

Benchmark without NBFI intermediation. To assess the role of NBFIs, we compare this outcome to a counterfactual benchmark in which banks hold all exposures directly. In this case, bank b holds total exposure

$$s_b + \sum_{n=1}^{N} f_{bn},$$

which is subject to the same recovery rate α. The corresponding post-shock value is

$$A_b^{\text{direct}} = \alpha \left(s_b + \sum_{n=1}^{N} f_{bn} \right).$$

The difference between the two scenarios is

$$A_b^{\text{post}} - A_b^{\text{direct}} = \sum_{n=1}^{N} (\phi_n - \alpha) f_{bn}.$$

Aggregating across banks, the difference in post-shock asset values is given by

$$\sum_{b=1}^{B} (A_b^{\text{post}} - A_b^{\text{direct}}) = \sum_{n=1}^{N} (\phi_n - \alpha) \sum_{b=1}^{B} f_{bn},$$

so that amplification operates through NBFIs with both large overall funding volumes and high reliance of NBFIs on bank credit.

The expression above yields the following characterization of when NBFI intermediation amplifies losses.

Proposition 2 *Suppose $\alpha < \rho_n$ so that NBFI n defaults. Then bank-NBFI intermediation amplifies losses relative to direct lending if and only if*

$$\kappa_n < \rho_n. \tag{14}$$

To see this, note that under default, $\phi_n = \kappa_n \alpha / \rho_n$. Hence,

$$\phi_n < \alpha \quad \iff \quad \frac{\kappa_n \alpha}{\rho_n} < \alpha \quad \iff \quad \kappa_n < \rho_n.$$

Condition (14) has a natural economic interpretation. The reliance ratio ρ_n captures the degree of leverage of NBFI n, while κ_n captures its liquidation efficiency. Amplification arises when reliance exceeds liquidation capacity, so that recoveries on funding claims are further reduced under distress.

More broadly, this condition highlights that the systemic implications of financial interconnectedness depend on the interaction between leverage and liquidity. In particular, the same network structure can either facilitate risk sharing or generate amplification, depending on whether funding reliance remains aligned with liquidation capacity. This provides a simple way to assess when bank-nonbank linkages are likely to amplify losses rather than absorb shocks.

Interpretation of the liquidation parameter. The parameter κ_n summarizes the fraction of post-shock asset value that can be realized under forced liquidation. It captures several well-documented mechanisms:

- *Fire-sale discounts:* Forced asset sales depress prices below fundamental values.

- *Margin and funding constraints:* Deleveraging amplifies price impact.
- *Asset encumbrance:* Not all assets are available to repay creditors.

In this sense, κ_n plays a role analogous to a recovery rate in network models, but incorporates endogenous liquidity effects. Empirical evidence from fire-sale episodes and repo haircuts suggests that this parameter can be substantially below one, particularly for market-based intermediaries in stress situations.

The framework highlights a key trade-off. Increased NBFI intermediation can expand credit supply through the capacity channel, but may also increase systemic risk if it raises reliance on fragile bank funding structures. The net effect depends on the interaction between leverage (captured by ρ_n) and liquidation capacity (captured by κ_n). This provides a structural link between regulation, intermediation, and systemic risk: policies that shift activity toward NBFIs may increase fragility if they lead to highly leveraged intermediaries with limited liquidation capacity.

The amplification condition highlights that systemic risk is particularly sensitive to sectors with high reliance ratios ρ_n. Empirically, we find in Figure 7 that reliance ratios ρ_n are elevated in sectors such as credit intermediation and other financial intermediation, which includes venture capital firms and private equity funds. These sectors account for a substantial share of bank-NBFI funding exposures (see Figure 4), and their high reliance implies that they are especially prone to amplification effects when subject to adverse shocks. According to the amplification condition, such sectors are more likely to transmit losses to the banking system when liquidation capacity is limited (i.e., when κ_n is sufficiently low).

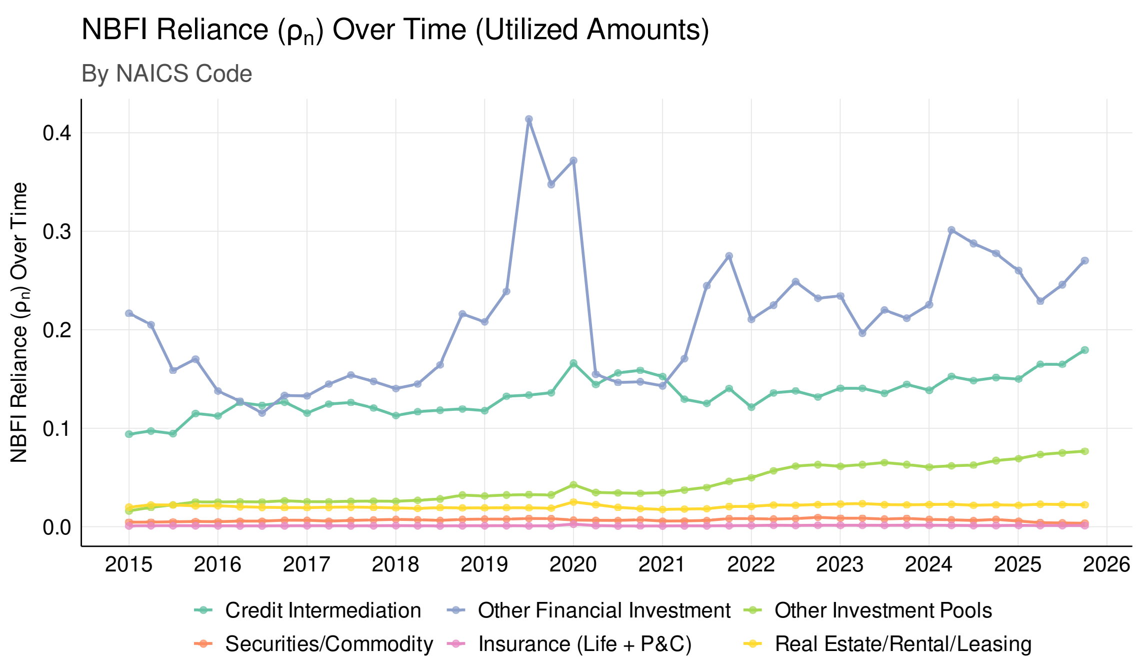


Figure 7: NBFI reliance levels ρ_n for the different NBFI sectors. Nondepository credit intermediation and other financial investment have elevated ρ_n. *Source:* Authors' calculation based on Y-14 dataset and Z.1 Financial Accounts (see Appendix B.2.)

7 Conclusion

This paper develops a structural framework to analyze bank-nonbank financial intermediation and to quantify how changes in bank balance-sheet constraints and NBFI fragility jointly shape funding dynamics. A central contribution is a tractable decomposition of intermediation into two channels: a capacity channel, which governs the overall scale of intermediation, and a reliance channel, which governs its composition between the banking and the nonbanking sectors.

Using supervisory data and a transparent mapping from model primitives to observed variables, we estimate time-varying measures of bank convexity and NBFI fragility and implement the decomposition empirically. The results show that fluctuations in intermediation are primarily driven by changes in funding composition through the reliance channel, with NBFI fragility emerging as the dominant underlying driver.

A key insight of the paper is that the systemic risk implications of nonbank intermediation depend critically on its composition. Embedding the equilibrium allocation into a stress framework with liquidation frictions, we derive a simple amplification condition: intermediation through NBFIs amplifies losses when their reliance on bank funding exceeds their liquidation capacity. This condition provides a structural link between funding interconnectedness and shock propagation, and highlights that systemic risk cannot be inferred from the scale of intermediation alone.

Our empirical results also suggest that these two channels can behave differently during periods of stress. In particular, during the COVID-19 episode, the reliance channel exhibited sharp swings—rising at the onset of the stress episode before reversing as NBFI fragility increased—while bank balance-sheet capacity expanded. This pattern indicates a shift in the composition of intermediation and suggests that banks can help stabilize overall activity even as the structure of funding adjusts.

From a policy perspective, these findings highlight that the effects of regulation operate along both channels. Policies that affect bank balance-sheet constraints shape the aggregate supply of credit, while conditions in the nonbank sector determine how that credit is intermediated and how shocks propagate through the system. As a result, effective regulation must account not only for the resilience of banks, but also for the interaction between leverage and liquidation frictions in the nonbank sector.

The framework developed in this paper provides a basis for further analysis of these interactions. Extensions to heterogeneous loan markets, richer network structures, and dynamic policy interventions offer promising directions for future research. More broadly, the decomposition between capacity and reliance channels offers a useful lens for understanding the evolving role of banks and nonbanks in the financial system and highlights that financial stability depends not only on who intermediates credit, but on how that intermediation is funded.

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A Optimization Solution in the General Model

A.1 Solution via KKT Conditions

Bank KKT Conditions. Define the bank marginal balance-sheet cost

$$m_b := \Phi_b'(X_b). \tag{15}$$

The KKT conditions for (3) are:
Loans. For each ℓ,

$$r_\ell - c_{b\ell} - m_b \le 0, \quad s_{b\ell} \ge 0, \quad s_{b\ell}\big(r_\ell - c_{b\ell} - m_b\big) = 0. \tag{16}$$

Equivalently,

$$s_{b\ell} > 0 \implies r_\ell = c_{b\ell} + m_b.$$

Funding. For each n,

$$p_{bn} - \tilde{c}_{bn}^F - m_b \le 0, \quad f_{bn} \ge 0, \quad f_{bn}\big(p_{bn} - \tilde{c}_{bn}^F - m_b\big) = 0. \tag{17}$$

Equivalently,

$$f_{bn} > 0 \implies p_{bn} = \tilde{c}_{bn}^F + m_b. \tag{18}$$

NBFI KKT conditions. Let $\mu_n \ge 0$ denote the multiplier on the constraint $F_n \le T_n$ in (4). For $T_n > 0$, let $\psi_n(\rho) := \Psi_n'(\rho)$ and $\rho_n = F_n/T_n$.

Useful derivatives (for $T_n > 0$):

$$\frac{\partial}{\partial f_{bn}}\big[T_n \Psi_n(\rho_n)\big] = \psi_n(\rho_n), \qquad \frac{\partial}{\partial t_{n\ell}}\big[T_n \Psi_n(\rho_n)\big] = \Psi_n(\rho_n) - \rho_n \psi_n(\rho_n).$$

Funding. For each b,

$$(d_n - p_{bn}) - \psi_n(\rho_n) - \mu_n \le 0, \quad f_{bn} \ge 0, \quad f_{bn}\big((d_n - p_{bn}) - \psi_n(\rho_n) - \mu_n\big) = 0. \tag{19}$$

Equivalently,

$$f_{bn} > 0 \implies p_{bn} = d_n - \psi_n(\rho_n) - \mu_n. \tag{20}$$

Loans. For each ℓ,

$$(r_\ell - d_n) - \big(\Psi_n(\rho_n) - \rho_n \psi_n(\rho_n)\big) + \mu_n - \xi_n t_{n\ell} \le 0, \quad t_{n\ell} \ge 0, \tag{21}$$

$$t_{n\ell}\Big((r_\ell - d_n) - \big(\Psi_n(\rho_n) - \rho_n \psi_n(\rho_n)\big) + \mu_n - \xi_n t_{n\ell}\Big) = 0. \tag{22}$$

Equivalently,

$$t_{n\ell} > 0 \implies r_\ell = d_n + \Psi_n(\rho_n) - \rho_n \psi_n(\rho_n) - \mu_n + \xi_n t_{n\ell}.$$

Constraint complementarity.

$$\mu_n \ge 0, \quad F_n \le T_n, \quad \mu_n(T_n - F_n) = 0. \tag{23}$$

Funding-price equalization on active links. Combining (18) and (20), any active edge (b, n) with $f_{bn} > 0$ satisfies

$$\tilde{c}^F_{bn} + m_b = d_n - \psi_n(\rho_n) - \mu_n.$$

Inactive edges satisfy the inequality version implied by (16)–(19).

Loan allocation and market clearing. Loan allocations satisfy the complementarity conditions (16) and (21)–(22), together with market clearing (5). In equilibrium, active holdings satisfy the corresponding effective marginal valuation conditions; on the NBFI side, these include the cell-specific portfolio-allocation term $\xi_n t_{n\ell}$.

A.2 Quadratic Specification

As an example, we consider

$$\Phi_b(x) = \frac{\gamma_b}{2}x^2, \qquad \Psi_n(\rho) = \frac{\eta_n}{2}\rho^2, \tag{24}$$

with $\gamma_b > 0$ and $\eta_n > 0$.

Explicit marginal costs. From (15) and (24),

$$m_b = \Phi'_b(X_b) = \gamma_b X_b = \gamma_b\left(\sum_{\ell=1}^{L} s_{b\ell} + \sum_{n=1}^{N} f_{bn}\right).$$

Also,

$$\psi_n(\rho) = \Psi'_n(\rho) = \eta_n\rho.$$

Moreover,

$$\Psi_n(\rho) - \rho\psi_n(\rho) = \frac{\eta_n}{2}\rho^2 - \eta_n\rho^2 = -\frac{\eta_n}{2}\rho^2. \tag{25}$$

Bank optimality. Bank loan conditions (16) become

$$r_\ell - c_{b\ell} - \gamma_b X_b \le 0, \quad s_{b\ell} \ge 0, \quad s_{b\ell}\big(r_\ell - c_{b\ell} - \gamma_b X_b\big) = 0. \tag{26}$$

Funding conditions (17) become

$$p_{bn} - \tilde{c}^F_{bn} - \gamma_b X_b \le 0, \quad f_{bn} \ge 0, \quad f_{bn}\big(p_{bn} - \tilde{c}^F_{bn} - \gamma_b X_b\big) = 0. \tag{27}$$

In particular, if $f_{bn} > 0$, then

$$p_{bn} = \tilde{c}^F_{bn} + \gamma_b X_b. \tag{28}$$

NBFI optimality. For $T_n > 0$, the reliance ratio is $\rho_n = F_n/T_n$ and (19) become

$$(d_n - p_{bn}) - \eta_n\rho_n - \mu_n \le 0, \quad f_{bn} \ge 0, \quad f_{bn}\big((d_n - p_{bn}) - \eta_n\rho_n - \mu_n\big) = 0. \tag{29}$$

Hence, if $f_{bn} > 0$,

$$p_{bn} = d_n - \eta_n\rho_n - \mu_n. \tag{30}$$

Loan conditions (21)–(22) use (25) and become

$$(r_\ell - d_n) + \frac{\eta_n}{2}\rho_n^2 + \mu_n - \xi_n t_{n\ell} \le 0, \quad t_{n\ell} \ge 0, \quad t_{n\ell}\Big((r_\ell - d_n) + \frac{\eta_n}{2}\rho_n^2 + \mu_n - \xi_n t_{n\ell}\Big) = 0. \tag{31}$$

Equivalently, if $t_{n\ell} > 0$,

$$r_\ell = d_n - \frac{\eta_n}{2}\rho_n^2 - \mu_n + \xi_n t_{n\ell}.$$

If $\xi_n > 0$, this can be written as

$$t_{n\ell} = \frac{1}{\xi_n}\left[r_\ell - d_n + \frac{\eta_n}{2}\rho_n^2 + \mu_n\right]_+ .$$

Constraint complementarity remains (23):

$$\mu_n \ge 0, \quad F_n \le T_n, \quad \mu_n(T_n - F_n) = 0.$$

Active-edge equalization. Combining (28) and (30), any active funding edge (b, n) with $f_{bn} > 0$ satisfies

$$\tilde{c}^F_{bn} + \gamma_b X_b = d_n - \eta_n\rho_n - \mu_n.$$

This equation highlights the new smooth mechanism:

- bank marginal cost rises in total usage X_b through $\gamma_b X_b$;
- NBFI willingness to pay falls in reliance ρ_n through $\eta_n\rho_n$ and (possibly) through the binding constraint multiplier μ_n.

System to be solved. An equilibrium is any collection (s, t, f, p) satisfying:

1. Bank KKT conditions (26)–(27) for all b;
2. NBFI KKT conditions (29)–(31) and (23) for all n;
3. Market clearing (5) for all ℓ and the consistency of aggregates $X_b = \sum_{\ell=1}^{L} s_{b\ell} + \sum_{n=1}^{N} f_{bn}$ and (T_n, F_n, ρ_n) as defined above.

Given smooth convexity, one can compute equilibrium by iterating on the low-dimensional fixed point

$$m_b = \gamma_b X_b, \qquad \rho_n = F_n/T_n, \qquad \mu_n \ge 0,\ \mu_n(T_n - F_n) = 0,$$

using the KKT equalities on active sets together with market clearing.

B Data Appendix

B.1 Summary Statistics

NBFI Time Series Summary Stats (Utilized Amounts)

Summary Statistics

Variable	N	Mean	Std. Dev.	Min	25th Pctl	Median	75th Pctl	Max	Skewness	Kurtosis
π (%)	44	0.065	0.008	0.046	0.059	0.063	0.072	0.077	−0.03	−0.56
θ (%)	44	0.083	0.015	0.063	0.069	0.079	0.098	0.112	0.23	−1.53
γ	44	0.003	0.001	0.001	0.002	0.003	0.003	0.004	0.24	−1.00
η	44	4.343	1.134	2.650	3.337	4.269	5.104	7.814	0.76	0.48
r (%)	44	4.034	1.775	2.116	2.505	3.459	5.908	7.191	0.60	−1.21
a ($Bn)	44	24,141	3,464	19,323	21,028	24,146	26,709	31,007	0.21	−1.28
r_f(%)	44	2.585	1.048	0.879	1.914	2.336	3.420	4.338	0.36	−1.04
c (%)	44	0.520	0.369	-0.069	0.264	0.406	0.906	1.180	0.42	−1.11
$\tilde{c}$ (%)	44	0.520	0.369	-0.069	0.264	0.406	0.906	1.180	0.42	−1.11
X ($Bn);	44	1,280	230	933	1,081	1,214	1,485	1,699	0.28	−1.39
p (%)	44	2.149	1.910	0.090	0.417	1.631	4.275	5.424	0.51	−1.31
ρ	44	0.021	0.005	0.013	0.016	0.020	0.027	0.031	0.24	−1.47
t ($Bn)	44	23,376	3,452	18,614	20,284	23,350	26,022	30,243	0.22	−1.29
s ($Bn)	44	765	64.389	655	736	763	795	1,058	1.87	7.41
f ($Bn);	44	515	200	243	334	469	685	935	0.40	−1.22

Note: N = number of observations.
We preset the value of model parameters as follows: $\beta = 0.3$, w = v = 0.08, y = 0.01

B.2 Data Source: Mapping Loan Holdings to Parameters

The Federal Reserve Z.1 Financial Accounts report loan holdings by institutional sector, whereas the Y-14 Schedule H data classify loans by the borrower's NAICS industry code. These two taxonomies were not designed to align, and no official concordance exists between them. Constructing the variable t_n, which captures NBFI loan holdings in the model, thus requires an approximate mapping from Z.1 sectors to NAICS industry groups. The table below reports the specific series assignments; we summarize the key identification choices here.

NAICS to Financial Accounts Data Matching

NAICS Code	Financial Accounts ID	Financial Accounts Series Name
53	FL893065405.Q	All sectors; multifamily residential mortgages; asset
53	FL893065505.Q	All sectors; commercial mortgages; asset
5222	FL613066005.Q	Finance companies; consumer credit; asset
5222	FL673066000.Q	Issuers of asset-backed securities; consumer credit; asset
5231	FL663069005.Q	Security brokers and dealers; other loans and advances; asset
5239	FL503069005.Q	Other financial business; other loans and advances; asset
5239	FL503069013.Q	Other financial business; loans to nonfinancial corporate business from the Main Street Facilities LLC; asset
5239	FL503069023.Q	Other financial business; loans to nonfinancial noncorporate business from the Main Street Facilities LLC; asset
5239	FL503069033.Q	Other financial business; loans to nonprofit organizations from the Main Street Facilities LLC; asset
5239	FL503069075.Q	Other financial business; loans from Federal Reserve funding, credit and liquidity facility special purpose vehicles; asset
5239	FL503069805.Q	Other financial business; syndicated loans to nonfinancial corporate business; asset
5241	FL514004005.Q	Property-casualty insurance companies; debt securities and loans; asset
5241	FL543069075.Q	Life insurance companies; other loans and advances; asset
5241	FL543069405.Q	Life insurance companies; policy loans; asset
5241	FL543069873.Q	Life insurance companies, general accounts; syndicated loans to nonfinancial corporate business; asset
5241	FL544004005.Q	Life insurance companies; debt securities and loans; asset
5259	FL654022005.Q	Mutual funds; debt securities and loans; asset
5259	FL673065403.Q	Issuers of asset-backed securities; multifamily residential mortgages, including REIT securitized multifamily residential mortgages; asset
5259	FL673069005.Q	Issuers of asset-backed securities; securitized other loans and advances; asset
5259	FL733069013.Q	Holding companies; other loans and advances due from U.S. addressees; asset

The mappings for brokers and dealers (NAICS 5231) and insurance carriers (NAICS 5241) are straightforward, as the Z.1 sector definitions closely mirror the NAICS descriptions. We consolidate NAICS 5242 (insurance-related intermediaries) into 5241 and NAICS 5223 (credit-related intermediaries) into 5222, as both comprise fee-based businesses with negligible balance-sheet loan exposure that cannot be separately identified in the Z.1.

For NAICS 5259 (Other Investment Pools and Funds), we assign the Z.1 mortgage REIT, mutual fund, and ABS issuer sectors. Because the Z.1 does not record the originating finance company as the loan holder, we assign ABS issuers to 5259 and finance companies to 5222, which avoids mechanical double-counting. The least precise mapping is NAICS 5239 (Other Financial Investment Activities), where we rely on the "holding companies" and "other financial business" residual categories. This mapping is necessarily imperfect, as the Z.1 does not separately identify investment banks, which account for a substantial share of activity in this NAICS category.

All series are measured on the asset side of Table L.214. The one exception is NAICS 53 (Real Estate and Rental and Leasing), where the relevant quantity is the sector's mortgage indebtedness. Because the Z.1 does not isolate real estate firms as a distinct financial sector, we use loan liabilities as a proxy, using the multifamily residential and commercial mortgage instrument totals. This approach likely overstates the true NAICS 53 figure, as it attributes all multifamily and commercial mortgage debt to real estate firms, whereas some portion is owed by non-real-estate borrowers such as manufacturers and retailers occupying owner-occupied properties.

Despite these limitations, the mapping captures the primary balance-sheet exposures of each sector and is sufficient for the structural decomposition, which relies on relative variation across sectors rather than precise level measurement.

B.3 Plots based on Committed Amounts

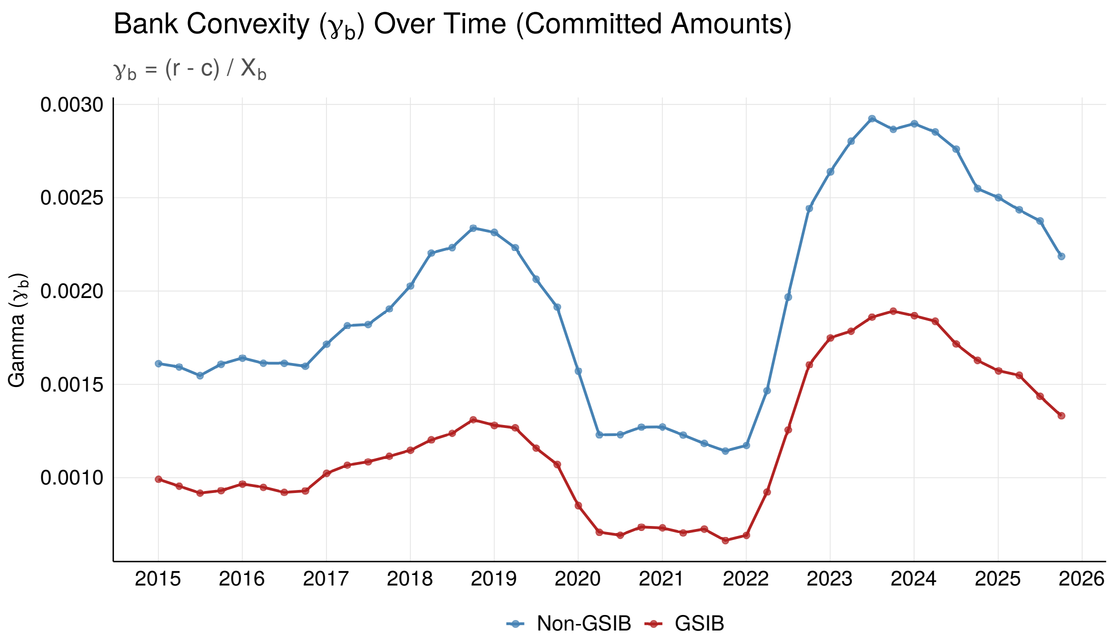


Figure 8: Bank convexity γ_b over time based on committed amounts. In the computation of $\gamma_b = (r-c)/X_b$, r and c are expressed as percentages and X_b in billions of dollars. *Source:* Authors' calculation based on Y-14 dataset, Z.1 Financial Accounts (see Appendix B.2), FRED 10Y rate (DGS10), FRED cpi (CPIAUCSL), and Bloomberg Finance LP, Bloomberg Per Security Data License.

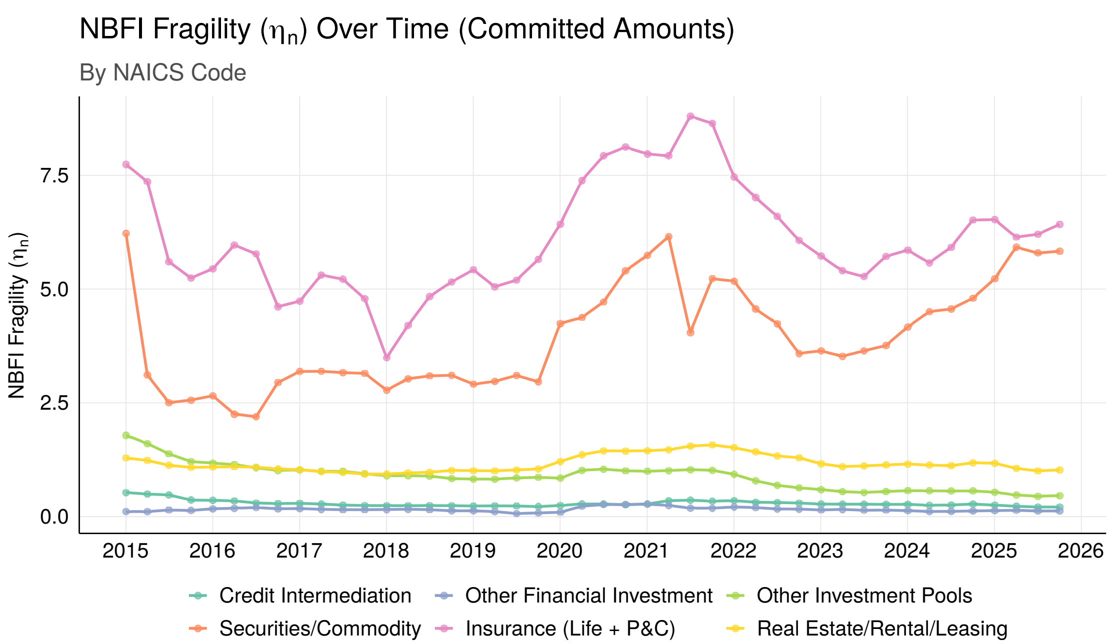


Figure 9: NBFI fragility η_n by sector over time based on committed amounts. *Source:* Authors' calculation based on Y-14 dataset, Z.1 Financial Accounts (see Appendix B.2), FRED 10Y rate (DGS10), FRED cpi (CPIAUCSL), and Bloomberg Finance LP, Bloomberg Per Security Data License.

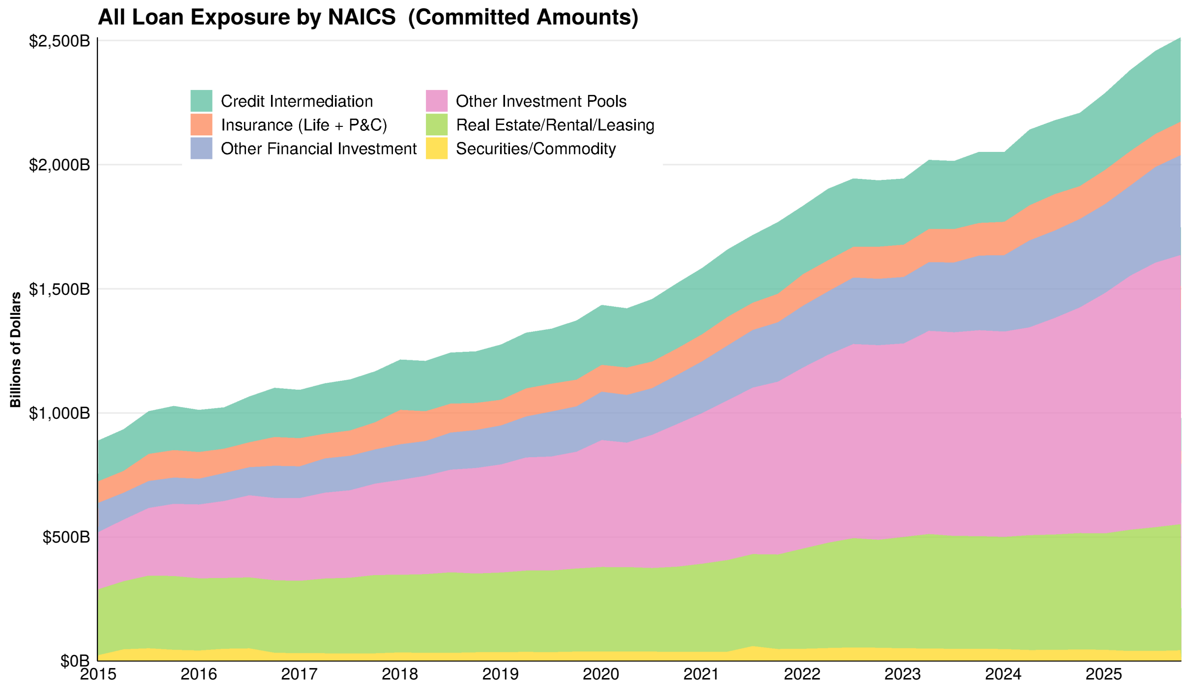


Figure 10: Bank exposures to NBFI sectors over time. The figure plots aggregate funding volumes f_{bn} from banks to NBFI sectors at the quarterly frequency based on committed amounts. *Source:* Y-14 dataset.

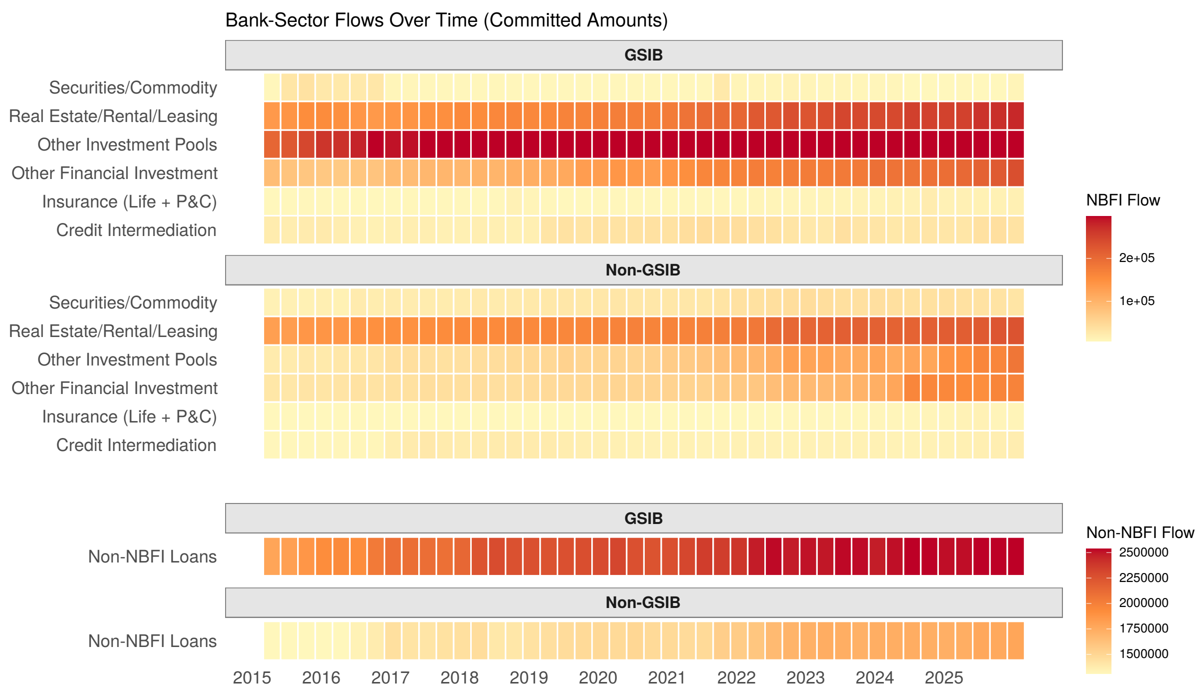
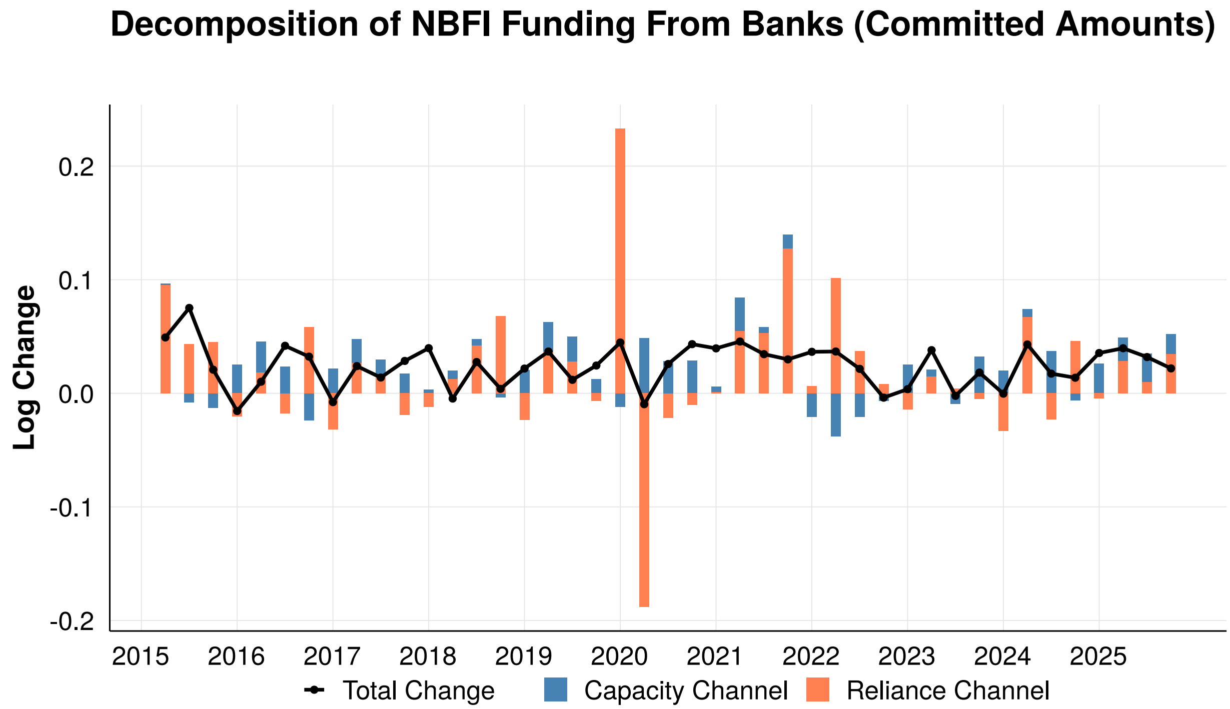


Figure 11: Heatmap of bank lending to NBFI sectors over time, separately for GSIBs and non-GSIBs, based on committed amounts. *Source:* Y-14 dataset.



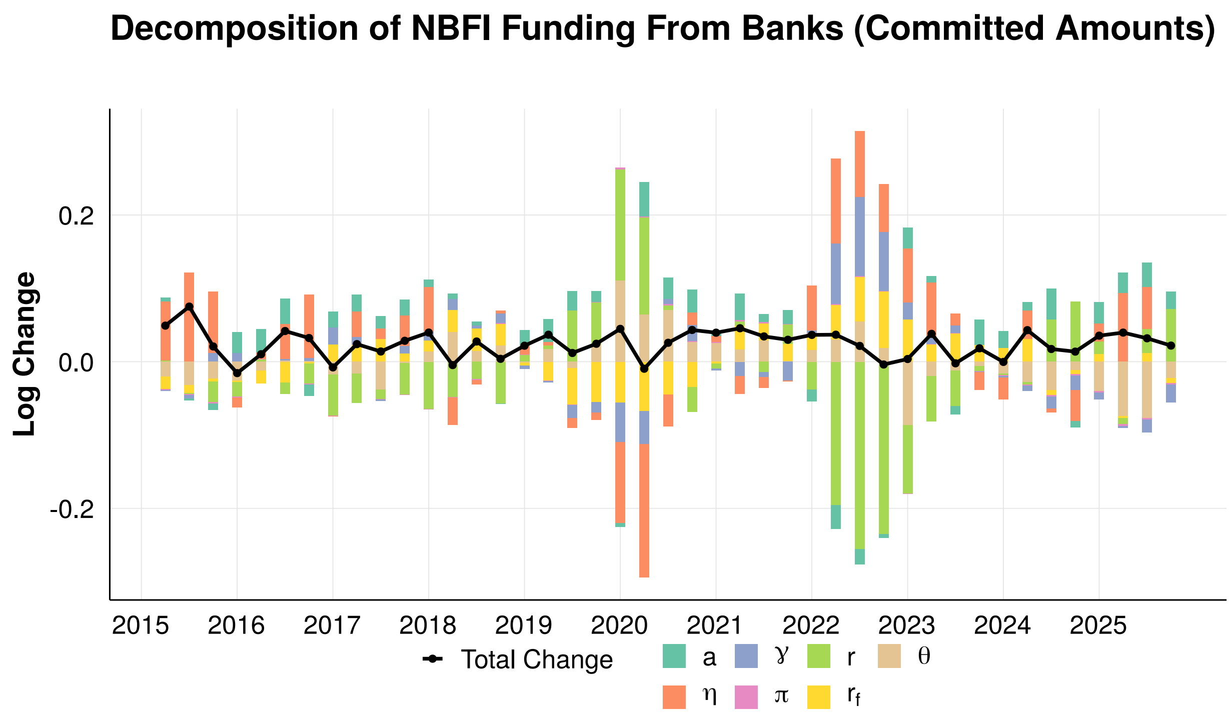


Figure 12: Decomposition of changes in NBFI funding from banks based on committed amounts. Panel A shows the decomposition of funding changes into capacity and reliance channels, as derived in Section 3.6. Panel B further decomposes these changes into underlying drivers. *Source:* Authors' calculation based on Y-14 dataset, Z.1 Financial Accounts (see Appendix B.2), FRED 10Y rate (DGS10), FRED cpi (CPIAUCSL), and Bloomberg Finance LP, Bloomberg Per Security Data License.

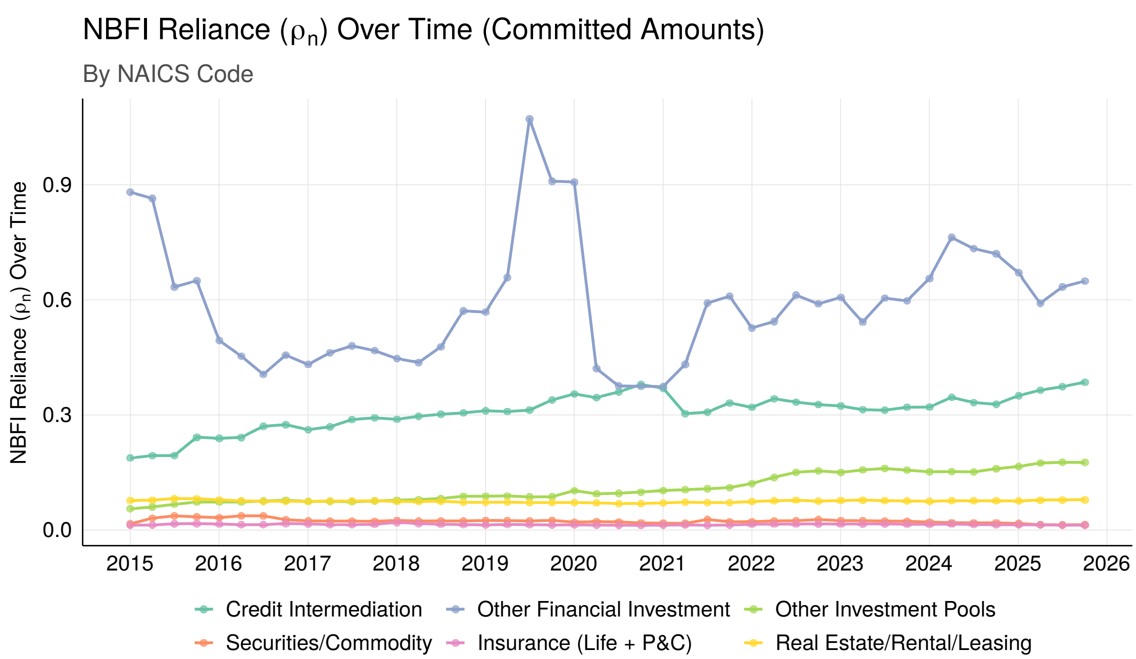


Figure 13: NBFI reliance levels ρ_n for the different NBFI sectors. *Source:* Authors' calculation based on Y-14 dataset and Z.1 Financial Accounts (see Appendix B.2.)