The Value of Contingent Liquidity from Banks to Nonbank Lenders

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Abstract

This paper shows that the contractual arrangement between banks and nonbank lenders (NBLs) is a key source of financial stability. I document that credit lines account for 90% of bank funding to NBLs. NBLs use credit lines to manage investment uncertainties and gain liquidity support, while banks' liquidity advantage makes them natural insurers. I develop a dynamic model of financial intermediation with endogenous credit limits and fees to study the financial stability implications of bank–NBL credit lines. Credit lines allow NBLs to finance uncertain investments and endogenously affect their commercial paper funding costs. Therefore, NBLs trade off liquidity support and asset value gains against higher default risk from increased leverage. As large providers of credit lines, when extending limits, banks internalize NBLs' price schedule for credit line insurance. In addition, banks also account for costly drawdown exposures in bad states. Banks trade off NBLs' decreasing marginal willingness to pay for each extra limit and the regulatory costs of undrawn commitments against upfront fee revenues and net risk-sharing gains. Credit lines' contingent features make them cheaper than cash, and safer but costlier than loans. Quantitatively, credit lines raise welfare by 1.83% relative to loans. Partial guarantee to NBL debt reduces welfare by weakening banks' liquidity advantage and restricting credit line supply.

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1 Introduction

Nonbank financial intermediaries have grown rapidly since the 2008 financial crisis. A major concern is their connection to banks. As banks fund nonbanks, one view is that these connections threaten financial stability. However, I argue that this view is incomplete. The exact way banks lend to nonbanks matters. In this paper, I show that the contractual features governing bank lending to nonbanks can strengthen financial stability.

I document that credit lines account for 90% of bank lending to nonbank lenders (non-depository financial institutions that provide debt financing to firms in the syndicated loan market[1]; henceforth NBLs) (Figure 1). Why, then, do banks supply and NBLs demand credit lines? I find that NBLs use credit lines to manage investment opportunities and secure liquidity, while banks' low-cost deposits give them a liquidity advantage that makes them natural insurers. What remains unclear is how this individually desirable arrangement impacts financial stability and welfare more generally.

I develop a general-equilibrium model in which banks provide NBLs with credit lines featuring endogenous limits and fees. Raising the limit increases future drawdowns while lowering NBLs' marginal willingness to pay. Banks are large players in credit line provision, and credible commitment requires them to make profits. They therefore internalize the decreasing marginal return on additional limits. This intermediation structure shapes credit line contracts in ways that partially offset the risk-taking incentives created by deposit insurance and produces a stabilizing mechanism.

I use the model to decompose the value of contingent liquidity by comparing credit lines to simpler non-contingent contracts. Relative to NBLs holding cash at banks, credit lines defer most funding costs until investment opportunities arise. Relative to direct bank loans to NBLs, credit lines' insurance feature provides state-contingent liquidity. Taken together, credit lines are cheaper but riskier than cash and safer but costlier than loans. In welfare terms, credit lines dominate both.

Finally, I use the model to evaluate three policies: (i) overall capital requirements, which limit the scale of bank risk-taking; (ii) off-balance-sheet regulation through credit conversion factors (CCFs), which set relative capital charges for drawn and undrawn credit lines versus loans; and (iii) partial guarantees to NBL debt. Tightening bank capital requirements reduces banks'direct lending

[1] Acharya et al. (2024b) also use syndicated loan data to study bank lending to REITs. With annual flows of $2-3 trillion, the syndicated loan market (SLM) is a key source of financing for major U.S. corporations and provides the most comprehensive public data. While this paper is motivated by the SLM, the model also applies broadly to nonbank direct lending. Nonbanks that lend directly to firms face similar asset-side volatility, as their borrowers are riskier (Chernenko et al., 2022). Major U.S. NBLs, finance companies and investment funds, account for 90% of nonbank lending to firms and 70% of bank funding to nonbanks. (Appendix A.1.5).

and credit line provision. When requirements become sufficiently tight, credit lines turn scarce and more profitable, inducing banks to shift from firm lending toward lending to NBLs; the resulting expansion of NBL intermediation, funded by costly commercial paper, reduces efficiency and lowers welfare. Tighter off-balance-sheet regulation reduces banks' liquidity provision by shrinking credit line limits and deposit issuance. While this lowers default risk and improves financial stability, it constrains investment and reduces welfare. Overall effects are modest, highlighting that bank–NBL credit lines are driven by fundamental comparative advantages and endogenous contract design rather than regulation alone. Providing partial guarantees to NBL debt is suboptimal not only because they create moral hazard, but also because government-backed commercial paper weakens NBLs demand for bank credit lines as liquidity backstops. Through the bankNBL link, this weakens banks' relative debt advantage and lowers credit line supply. Intermediation shifts from banks—where credit lines impose contractual discipline—to NBLs funded by partially-guaranteed commercial paper, increasing financial fragility and reducing welfare.

Having outlined the main insights, I now turn to the specific results. This paper has two parts: an empirical analysis and a quantitative model. The empirical analysis combines DealScan, Loan Connector, and CapitalIQ with textual evidence from SEC prospectuses to establish three findings. First, credit lines account for 90% of bank funding to NBLs, with half maturing within 364 days to avoid higher capital charges on longer maturities under Basel rules. While regulation shapes the maturity, credit lines themselves are not merely artifacts of regulation. My second empirical finding, based on SEC prospectus data, shows that credit lines help NBLs manage investment uncertainty and funding needs. From 585 filings, I manually[2] review 95 to train a few-shot large language model (LLM) classifier (Wei et al., 2022). Results are consistent across two LLM models: 80% of filings cite investment opportunities and 40% liquidity management. The second finding underpins the model's investment shocks and funding frictions. Third, I show that NBL lending is correlated with their credit line availability. Therefore, in the model, banks take into account that higher credit limits *ex ante* induce higher drawdown exposures *ex post*.

The model is designed to incorporate these empirical findings. In the model, both banks and NBLs hold long-term defaultable debt claims on firms with exogenous endowments. They differ in two key ways: (i) banks issue deposits and face capital requirements that cap bank leverage, while NBLs are non-depository and unregulated; and (ii) bank deposits carry a higher convenience

[2] Examples include phrases such as "we will use the credit lines to fund our origination and purchase of a diverse pool of loans" and "we use credit lines as backup support for our commercial paper."

yield, which lowers bank funding costs relative to NBLs that rely on commercial papers. Capital regulation prevents banks from monopolizing firm credit, giving rise to NBLs. Yet, even if capital regulation segments banks from NBLs, credit lines, due to their option-like nature, help complete markets by providing state-contingent liquidity. In my model, the endogenous fee and credit line limit together price the NBL's option to draw down. Two key internalizations characterize credit line contracts. First, banks recognize that higher credit limits reduce the marginal value of additional commitment. This is because to credibly commit, banks have to sustain profits in the continuation value. This makes banks not atomistic in credit line pricing. Second, banks internalize how higher credit limit *ex ante* raises drawdown exposure *ex post*—a feature unique to credit lines. Crucially, the market structure of intermediaries shapes credit line design in a way that partially offsets the risk-taking incentives induced by deposit insurance.

I calibrate the model to match key moments in credit risk and intermediary dynamics in the U.S. economy from 1990 to 2023. The model reproduces patterns in credit lines, funding structures, credit risk, defaults, loan loss severities, and convenience yields on deposits and commercial paper. The calibrated model makes three key contributions.

First, the model challenges the view that lending to NBLs merely shifts risk to banks. Instead, it shows that credit lines can enhance financial stability. When unpredictable investment shocks raise demand for flexible funding, NBLs are willing to pay more for credit lines. The resulting increase in upfront fees allows banks to extract greater rents and strengthen bank equity, enabling greater loan origination to non-financial firms. In turn, banks can support a larger volume of deposits (Figure 7). The key innovation here is to take the contractual mechanism of lending seriously. In the credit line contract, banks optimally choose their risk exposure, while the upfront fee endogenously adjusts. This endogenous pricing is essential for accurately assessing risks within the financial system.

Second, I decompose the value of contingent liquidity by benchmarking credit lines against simpler, non-contingent contracts, such as the cash or the loan contract. In the model, credit lines are best understood as insurance contracts with two unique contingent features: *flexibility* relative to cash and *optionality* relative to loans. These two features make credit lines cheaper than cash and safer than loans (Figure 8). First, *flexibility* arises because they defer most funding costs until uncertain investment opportunities actually occur, making them preferable to cash. Second, *optionality* arises from the endogenous credit limit and upfront fee, which together price the NBL's option to draw in the future. This optionality is costly. Different from credit lines, many financial institutions can offer direct loans. In standard defaultable debt contracts, it is the borrower (NBL) that internalizes how borrowing more increases funding costs through higher default risk. In contrast, few institutions can provide credit lines. Among them, banks are large players, and much like large sovereigns that internalize their price impact, banks internalize how extending a higher limit reduces their marginal profit per additional limit. Banks' large role in credit line provision leads them to ration credit, which partially offsets the risk-taking incentives created by deposit guarantees. This result rationalizes current regulation through credit conversion factors that put lower capital charges on committed credit lines versus loans. Overall, welfare comparisons show that credit lines dominate both cash and loans. Relative to cash, credit lines raise consumption-equivalent welfare by 0.02%. But relative to non-contingent loans, the welfare gain is larger at 1.83%.

Finally, I provide a framework for assessing policies in an interconnected financial system. Capital and off-balance-sheet regulation have non-linear but modest effects: excessive tightening shifts intermediation from banks to inefficient, commercial-paper-funded NBL lending, reducing welfare despite lower default risk. Partial guarantees further weaken bank credit lines by crowding out their liquidity backstop role, increasing financial fragility and lowering welfare.

Literature Review. My paper contributes to the literature in three key ways.

My work is related to models of credit lines (Holmström and Tirole, 1998; Acharya et al., 2013, 2014; Choi, 2022; Greenwald et al., 2023; Donaldson et al., 2024). I develop a model in which both the credit limit and the upfront option fee are endogenous. Earlier work often abstracts from endogenizing these features explicitly—and rightly so, given their different objectives. But for understanding how bank-NBL credit lines affect financial stability, credit lines' limits and fees are not cosmetic; I show that they are the exact margins that drive systemic outcomes. The key intuition, consistent with the seminal paper by DeMarzo and Fishman (2007), is that an intermediary can credibly commit to absorbing future losses only if it has sufficiently high expected future profits. In my model, banks must therefore be non-atomistic: they internalize how expanding the credit limit reduces marginal profitability. This internalization of higher drawdown exposure and lower marginal profits provides the stabilizing mechanism. Whereas Acharya et al. (2024a,b) emphasize the transfer of risks back to banks as they lend to nonbanks, I show that the contractual design of credit lines governing bank–NBL relationships can enhance stability. Consistent with DeMarzo and Sannikov (2006), I find that greater cash-flow volatility increases the value of flexible and state contingent financing relative to rigid long-term debt. Unlike earlier theoretical work that characterizes an optimal allocation and then implements it through contracts, my model focuses on the design features of credit lines and quantifies their implications for financial stability and welfare in a connected financial system. Finally, in relation to Kashyap et al. (2002), who show that imperfect correlation between credit and deposit draws enables banks to provide credit lines, I demonstrate that even when these draws become correlated under aggregate shocks, credit lines remain superior to loans in stabilizing intermediation. Relative to a counterfactual in which banks lend to NBLs through loans, credit lines allow banks to deleverage more effectively in crises, mitigating the "double-run" problem (Ippolito et al., 2016). The model also generates heterogeneity in limits and fees (Chodorow-Reich et al., 2022) and reproduces the screening property documented by Berg et al. (2016), where high spreads are paired with lower fees for likely non-drawers.

My paper also relates to models of financial intermediation and regulation, with two main contributions. First, I develop a quantitative macro-finance model linking banks and NBLs through credit lines with endogenous features. This connects to the literature on financial intermediation (He and Krishnamurthy, 2013; Brunnermeier and Sannikov, 2014; Moreira and Savov, 2017; Quarles, 2020; Elenev et al., 2021; Begenau, 2020; Begenau and Landvoigt, 2022; Elliott et al., 2023; dAvernas et al., 2023; Lee et al., 2023). I define banks as liquidity producers as in Begenau and Landvoigt (2022). Consistent with Plantin (2015); Huang (2018); Xiao (2020); Farhi and Tirole (2021), NBLs arise from bank capital regulation. My focus, however, is on the linkages between banks and NBLs: banks' liquidity advantage makes them natural insurers for NBLs facing investment uncertainty and liquidity shortages. Second, I contribute to the literature on banking regulation (Davydiuk, 2017; Begenau, 2020; Elenev et al., 2021; Corbae and D'Erasmo, 2021; Begenau and Landvoigt, 2022) by developing the first framework to evaluate policies when banks and NBLs are connected via credit lines. I evaluate the spillover of bank regulation on NBLs through their credit line link, and the effect of off-balance-sheet regulation on undrawn credit lines. Moreover, I show that backstopping NBLs can unintentionally weaken banks' liquidity advantage and increase systemic risk.

I contribute to the growing empirical and theoretical literature on nonbank intermediation. Related to the empirical literature (Cetorelli et al., 2012; Blickle et al., 2020; Berg et al., 2021; Aldasoro et al., 2022; Gopal and Schnabl, 2022; Berg et al., 2022; Ghosh et al., 2022; Benson et al., 2023; Buchak et al., 2024; Acharya et al., 2024a,b; Beaumont et al., 2025), I provide the first textual evidence on NBLs' use of bank credit lines to manage investment opportunities and liquidity. Few papers provide an economic rationale beyond regulation for why nonbanks exist. One exception is Diamond et al. (2025) that theorize the existence of CLOs as a tool to insulate banks from fire-sale discounts. My paper shows that the connection between banks and NBLs solves a different economic problem, namely, investment uncertainty. Using credit lines, banks leverage their liquidity advantage to insure NBLs against investment and funding shocks. In this way, my model incorporates the regulatory motives in Chernenko et al. (2025), while also uncovering the fundamental economic rationale for credit lines as an efficient contractual arrangement between banks and NBLs. My model enables counterfactual comparisons of credit lines with cash and loans, yielding insights into contractual arrangements that data alone cannot reveal. Consistent with evidence from Beaumont et al. (2025), I emphasize complementarity rather than competition between banks and NBLs (Jiang, 2023), showing that credit lines not only benefit each side individually but also enhance financial stability relative to simpler cash or loan contracts.

Roadmap. Section 2 documents empirical evidence. Section 3 presents the quantitative macro-finance model. Section 4 unpacks the economic mechanisms of credit lines. Section 5 details the calibration strategy. Section 6 conducts counterfacutal contract and policy comparisons and examines crisis dynamics under aggregate shocks. Section 7 concludes.

2 Empirical Evidence

2.1 Data

I draw on four main data sources: DealScan Legacy (1990-2020), LSEG Loan Connector (2020-2023), Capital IQ, and SEC prospectuses.

Facility-level data. DealScan, maintained by Refinitiv LPC, provides detailed facility-level data on syndicated, bilateral, and structured loans, including club deals and project finance. I merge the DealScan Legacy and LSEG Loan Connector ("New DealScan") datasets and refer to the combined dataset as "DealScan." In this dataset, a facility represents a loan and includes both syndicated and bilateral (direct) loans. The data include information on facility type (e.g., term loans, revolving credit facilities), pricing, covenants, and borrower and lender characteristics. In this paper, I group loans into two categories: (1) corporate loans from financial intermediaries (banks and NBLs) to non-financial corporations ("firms") and (2) intermediary-to-intermediary loans.

Drawdown data. Most bank funding to NBLs takes the form of credit lines (Figure 1). Because DealScan does not report utilization, I supplement it with Capital IQ drawdown data. Using the Roberts DealScan-Compustat Linking Database (Chava and Roberts, 2008), I map DealScan IDs to GVKEYs and then to Capital IQ firm IDs. From DealScan Legacy, I record each facility's total commitment amount for every quarter between its start and maturity, creating a panel with quarters as rows, NBLs as columns, and total available credit per NBL as values. Combining these total commitments with undrawn amounts from Capital IQ, I compute utilization ratios.

Textual data. While DealScan Legacy, LSEG Loan Connector, and Capital IQ provide numerical data, I also analyze textual information from prospectuses filed with the U.S. Securities and Exchange Commission (SEC). A prospectus is a formal disclosure associated with a registered public offering of securities. It details a firm's operations, financials, and risks. Both public and private firms must file one when offering securities to the public, unless they qualify for an exemption such as a private placement. I combine manual review with large language models to study these documents and understand why NBLs seek bank credit lines.

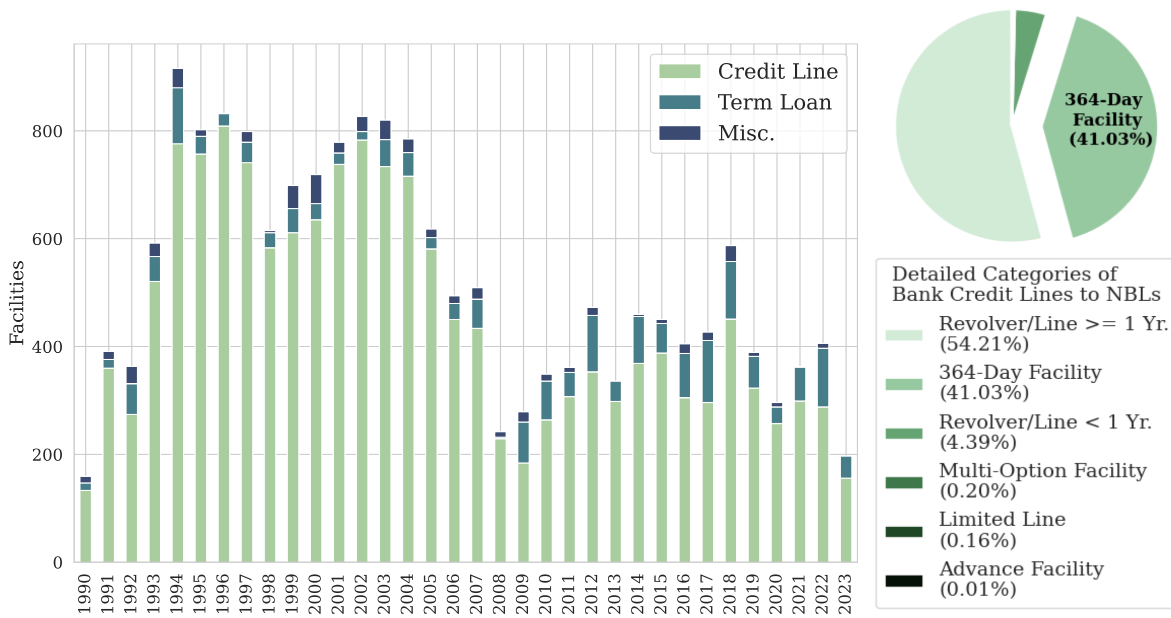
2.2 Empirical Findings

Major U.S. NBLs that both lend to non-financial firms and borrow from banks in the syndicated loan market are finance companies, investment funds, and institutional investors (Figure A.1.5). I identify 371 such NBLs. Finance companies and investment funds together account for about 90% of nonbank lending to firms and receive roughly 70% of bank funding to nonbanks. Bank funding to NBLs exhibits three key patterns. First, 90% of total bank lending to NBLs (by facility count) takes the form of credit lines, with notable bunching at 364-day maturities. Second, these credit lines are used to manage investment opportunities and liquidity needs. Third, NBL lending is positively correlated with available credit capacity. The following subsections elaborate on these three findings.

2.2.1 Credit Lines from Banks to NBLs

Figure 1 shows that credit lines account for 90% of bank funding to NBLs[3] by facility count[4] (94% by facility amount).

Figure 1: Types of Bank Funding to NBLs



Notes. This figure reports bank funding to NBLs by facility type. The left panel shows bank funding to NBLs by facility count, broken down into three broad categories: credit lines (green), term loans (blue), and miscellaneous (navy). The right panel uses different shades of green to decompose credit lines by facility count into revolvers and lines under one year, 364-day facilities, standby letters of credit, and revolvers or lines over one year. Appendix Figure A.1.1 plots the same figure but by facility amount.

A striking 41% of bank-issued credit lines to NBLs have maturities of exactly 364 days. This clustering is partly a regulatory artifact: under Basel rules (Basel Committee on Banking Supervision, 2020), commitments with maturities of up to one year are assigned a 20% credit conversion

[3]Appendix Figure A.1.3 reports the one-year moving average of quarterly flow of funds from banks to nonbanks, and from nonbanks to banks. The asymmetry—nonbanks depend on banks, but not vice versa—is consistent with Acharya et al. (2024a).

[4]Because facilities are not always fully drawn, figures by count are more conservative. Appendix Figure 1, based on facility amounts, confirms a similar pattern: credit lines make up 94% of bank funding to NBLs. Appendix Figure 1 based on facility amount confirms a similar pattern: credit lines make up 94% of bank funding to NBLs by facility amount.

factor (CCF), compared with 50% for longer maturities.[5] The CCF specifies the proportion of off-balance-sheet exposures—such as letters of credit or guarantees—that are converted into on-balance-sheet exposures for capital requirement calculations. The discrete jump at the one-year threshold creates a strong incentive for banks to set maturities just below it.

However, regulation alone does not explain the prevalence of credit lines. As shown in Section 3, banks have economic incentives to share risk with NBLs. Deposits give banks a low-cost, fully insured funding source with a high convenience yield, but deposit insurance also creates moral hazard, necessitating capital regulation to curb excessive risk-taking (Kareken and Wallace, 1978). Banks therefore enjoy a liquidity advantage but face capital constraints. NBLs, by contrast, are unregulated and rely on equity, giving them a capital advantage but no access to insured funding. Banks profit from combining their liquidity advantage with NBLs' capital advantage. While this complementarity applies to any form of bank lending to NBLs, credit lines are unique in combining flexibility and optionality. Counterfactuals in Sections 6.2.1 and 6.2.2 show that credit lines are cheaper than cash and safer than loans, and welfare-improving relative to these non-contingent contracts. On top these fundamental economic forces which will be discussed later, regulation that favors short-term maturities shapes the 364-day maturity of bank credit lines to NBLs. Together, they help explain the widespread use of short-term credit lines, especially 364-day facilities.

2.2.2 Credit Lines for Investment Opportunity and Liquidity Support

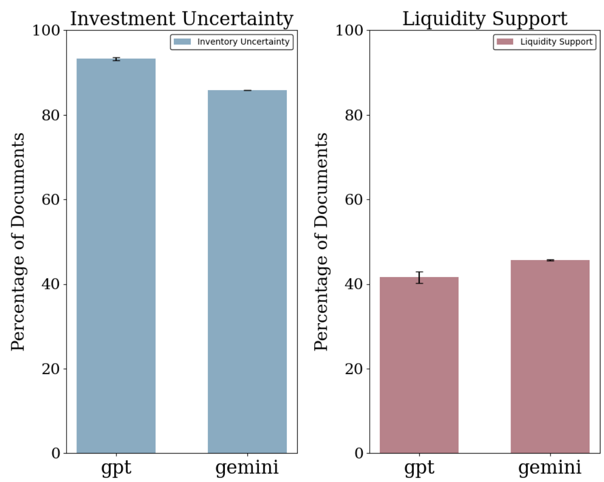
The previous section documents banks' incentives for offering credit lines. This section turns to the perspective of nonbank lenders (NBLs) and presents empirical and textual evidence on their motives for borrowing through credit lines. NBLs face both investment uncertainty and liquidity risk, and credit lines serve as insurance against these risks.

These asset- and liability-side challenges are documented in the SEC prospectuses. To conduct textual analysis, I start by manually reviewing 95 of 585 SEC prospectuses to identify indicative phrases such as "we will use credit lines to fund loan origination and purchases" or "we use credit lines as backup support for our commercial paper." These phrases serve as ground truth to train a few-shot large language model (LLM) classifier (Wei et al., 2022). Keywords include "revolving," "line of credit," "facility," and "credit agreement." Representative examples and word clouds are included in Appendix A.2. Results are consistent across two LLMs, GPT and Gemini. Figure 2

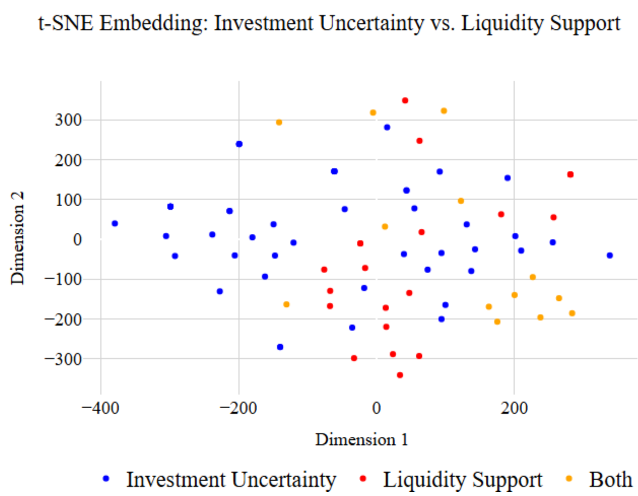
[5] Basel regulation assigns different CCFs to credit-line products than to loans, lowering the equity buffer required. See Basel regulations and an illustrative CCF calculation.

shows that 80% of prospectuses cite credit lines as flexible funding for uncertain investment demand, and 40% as liquidity backstops, especially for NBLs' commercial paper funding.

Figure 2: Textual Evidence



(a) Large Language Model Results



(b) Two-dimensional Embedding Graph

Notes. Panel (a) compares 2 LLMs by the share of documents citing credit lines for investment opportunity or liquidity support. Panel (b) shows a 2D-embedding of training sentences, revealing distinct semantic clusters.

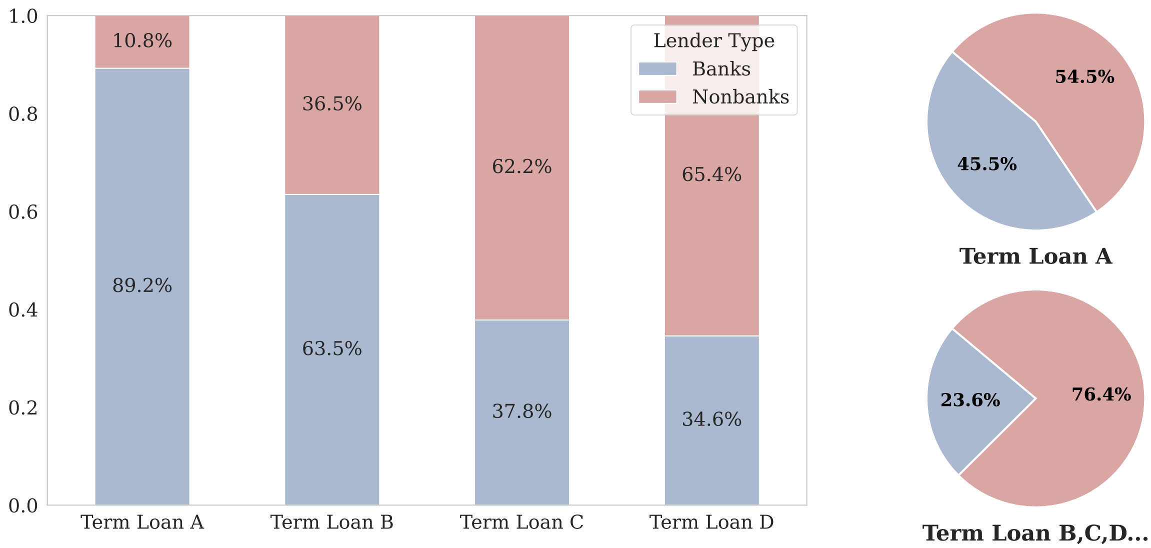
First, to understand NBLs' asset-side challenges, this paper draws on the syndicated loan market for motivation, given the availability of detailed large-scale data. As frequent participants rather than lead arrangers,[6] (Blickle et al., 2020) NBLs face volatile investment opportunities, whereas banks typically act as lead arrangers. I find that NBLs originate and hold a greater share of sub-A term loans than banks. Term loan A facilities are generally lower-yielding, amortizing regularly, and shorter in maturity (under seven years). In contrast, sub-A loans (B, C, D) carry higher interest rates, feature bullet repayments,[7] and have longer maturities (six to ten years). While covenants are largely standardized, variation emerges when NBLs act as sole lenders or originate sub-A loans. These loans often permit higher debt-to-EBITDA, debt-to-equity, and debt-to-net-worth thresholds (see Figure A.1.8 for a comparison of covenant metrics between loans originated by banks and NBLs).

[6]Lead arrangers structure, negotiate, and coordinate a syndicated loan, while participants provide funds under the agreed terms without managing the deal.

[7]Regular amortization repays both principal and interest in installments over the loan's life, whereas bullet payments defer the full principal repayment to a single lump sum at maturity.

Because DealScan reports only origination data, I rely on Blickle et al. (2020), who supplement holding-level information from Shared National Credit (SNC) data, which I do not have access to. They estimate that banks sell most loans to NBLs within 10 days. Using their regression coefficients, I infer that banks retain 45.51% of Term Loan A facilities, with NBLs holding the remaining 54.49%. For sub-A loans, banks retain 23.60%, while NBLs hold 76.40%. The fact that NBLs originate and hold a larger share of sub-A term loans makes their asset side more volatile. Beyond the syndicated loan market, empirical evidence from the literature also shows that nonbank direct lending is highly volatile (Chernenko et al., 2022).

Figure 3: Share of Corporate Term Loans by Banks and Nonbanks



(a) Origination share (b) Holding share

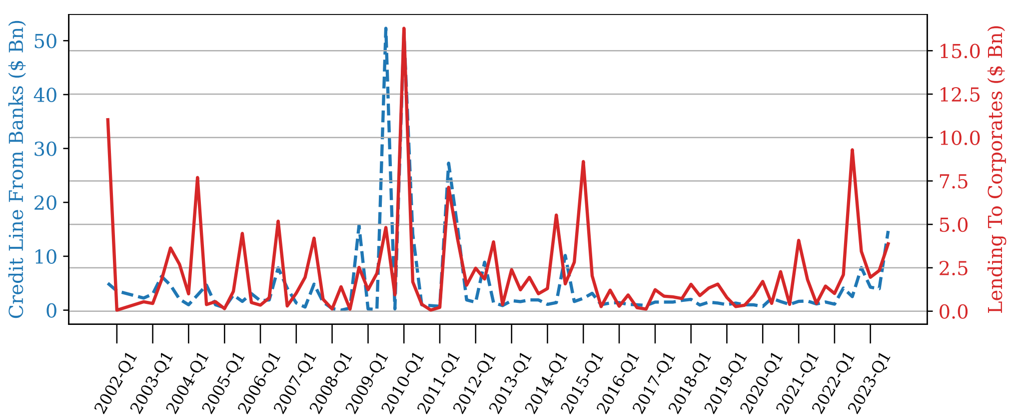
Notes. Panel (a) plots the origination share by term loan type (A, B, C, D). Panel (b) plots the approximate holding-period share, using estimates from Blickle et al. (2020); details are provided in Appendix D.2.

Turning to the liability side, NBLs do not have access to deposits. Unlike banks, which issue deposits that earn a high convenience yield, NBLs rely on commercial paper with a lower convenience yield, creating a greater need for liquidity support. In textual disclosures, NBLs often state, for example, "our primary credit facility backs our commercial paper facility," "the revolving credit facilities provide 100% backstop support for our commercial paper program," or "we use credit lines as backup support for our commercial paper programs." Such language underscores the need for liquidity sources beyond short-term market funding. Applying machine learning to the full prospectus set, I find that about 40% reference credit lines as liquidity buffers, consistent empirical evidence on NBL funding instability(Blickle et al., 2020). These motives underpin two model ingredients: an investment opportunity shock and a funding structure difference between banks and NBLs, reflecting NBLs' lack of insured deposits (Section 3).

2.2.3 Credit Line Drawdown and Pricing

The preceding evidence explains why banks supply—and NBLs demand—credit lines. In this section, I examine how NBLs use them. Because DealScan does not report drawdowns, I use Capital IQ data on undrawn amounts. Using the Roberts DealScan-Compustat Linking Database (Chava and Roberts, 2008), I match about 25% of DealScan NBLs to Capital IQ. Figure 4 shows the behavior of the median NBL by lending volume, while Appendix Figure A.1.6 reports the relationship between total lending and credit line funding for this matched subset. A time-series analysis reveals correlation between undrawn credit availability and lending activity, with availability typically leading lending. This pattern suggests that NBLs secure credit lines preemptively to preserve flexibility for uncertain investment opportunities.

Figure 4: NBL Lending Vs. Credit Line Funding



Notes. The solid red line shows quarterly lending by the representative median NBL (ranked by lending volume) within the 25% of DealScan NBLs matched to Capital IQ. The blue dotted line shows undrawn credit lines for the same median NBL. Appendix Figure A.1.6 reports total lending and credit line funding for this matched subset.

Appendices A and D.1 provide additional information on the cost of credit line usage. When

NBLs draw on their credit lines, they pay a fixed spread over a floating risk-free rate. In DealScan, the all-in spread includes an upfront option premium per committed dollar, a fixed spread, and a risk-free base rate (typically LIBOR or SOFR), along with possible annual or utilization fees. When undrawn, NBLs pay an all-in undrawn spread.

Together, this section establishes the empirical foundation for the quantitative model that follows. First, the data show that both banks and NBLs lend directly to firms. Banks have a liquidity advantage but face capital constraints, whereas NBLs lack a liquidity advantage yet benefit from more flexible capital structures. This difference in their relative advantage allows both to coexist in equilibrium in the model. Second, in the data, 90% of bank funding to NBLs takes the form of credit lines. Hence, my model incorporates these institutional features by endogenously determining limits and option fees. Endogenizing credit line design enables analysis of how contractual features shape financial stability. Third, textual evidence indicates that NBLs face investment uncertainty and liquidity needs. These are precisely the two forces that motivate their demand for credit lines in the model. Finally, the data reveal that credit line availability is positively correlated with investment. Therefore, in the model, banks take into account that higher credit limits *ex ante* increases drawdown exposure *ex post*. A quantitative model disciplined by these empirical facts is therefore the appropriate tool to evaluate the economic mechanisms of credit lines and their implications for financial stability and policy.

3 Quantitative Model

This section develops a quantitative macro-finance model to study how the design of credit line contracts affects financial stability. The model features firms, financial intermediaries, households and the government. Firms are modeled as Lucas trees with exogenous endowments. Financial intermediaries, banks and NBLs, hold debt claims on these Lucas trees and transform them into short-term liabilities. Low-cost deposit funding gives banks a liquidity advantage, enabling them to extend credit lines—with endogenous upfront fees and limits—to liquidity-constrained NBLs. Capital regulation segments banks and NBLs, yet credit lines allow banks to tap into NBLs' balance-sheet capacity. In equilibrium, this structure reallocates liquidity, helps complete markets, and shares risk across agents. This section first specifies preferences, technology, and timing; then describes the bank-NBL credit-line contract; next solves the NBL and bank problems, highlighting the endogenous credit-line mechanisms; and finally incorporates households and equilibrium conditions that clear markets.

3.1 Preferences, Technology, Market Structure and Timing

Preferences. The model features a representative household with Epstein-Zin preferences:

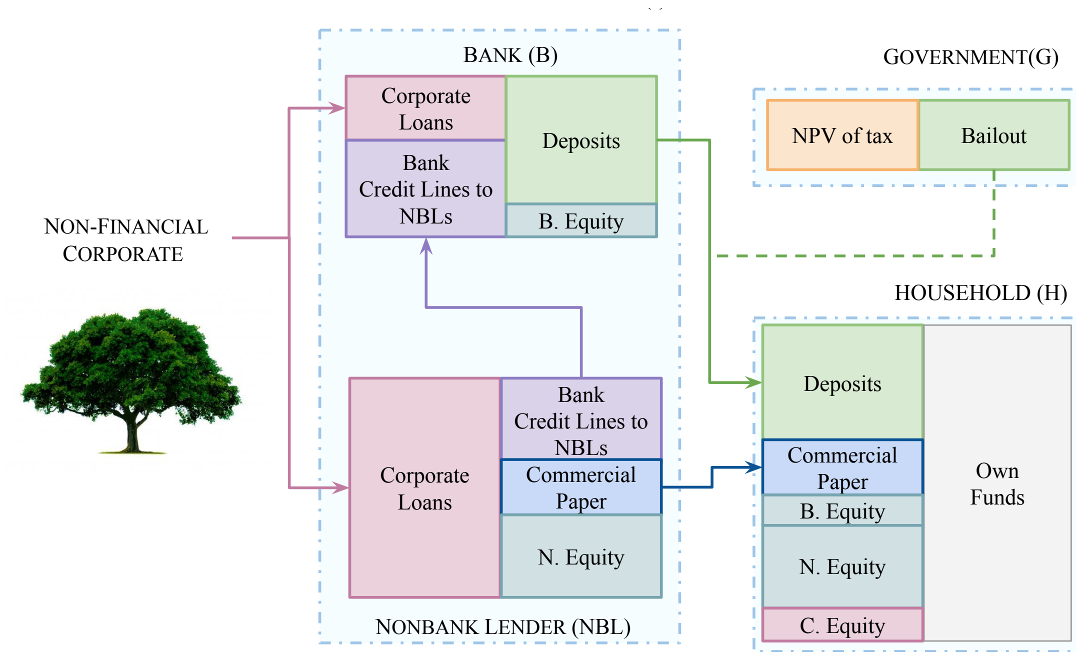
$$U_t^H = \left\{ (1-\beta_H)(u_t^H)^{1-\frac{1}{\nu_H}} + \beta_H \left(\mathrm{E}_t \left[(U_{t+1}^H)^{1-\sigma_H} \right] \right)^{\frac{1-\frac{1}{\nu_H}}{1-\sigma_H}} \right\}^{\frac{1}{1-\frac{1}{\nu_H}}}, \tag{3.1}$$

where $\beta_H \in (0,1)$ is the subjective discount factor, $\nu_H > 0$ is the intertemporal elasticity of substitution, and $\sigma_H > 0$ represents risk aversion. Period utility $\left\{u_t^H\right\}_{t=0}^{\infty}$ combines consumption C_t^H and liquidity benefits obtained from holding bank deposits D_{t+1}^H and commercial paper issued by NBLs B_{t+1}^H: $u_t^H = \left(C_t^H\right)^{1-\varsigma} \left(\left(D_{t+1}^H\right)^{\theta} \left(B_{t+1}^H\right)^{1-\theta} \right)^{\varsigma}$, where $\varsigma \in (0,1)$ captures the household's preference for liquidity services relative to consumption, and $\theta \in (0,1)$ reflects the preference for deposits relative to commercial paper.

Technology. There is a unit measure of non-financial corporations (hereafter, "firms")—modeled as Lucas trees—indexed by $i \in [0,1]$. Each tree pays a dividend $f_t^i = \exp\left(Z_t + z_t^i + \zeta d_t\right)$, where Z_t is an aggregate productivity shock, z_t^i is an idiosyncratic shock, $d_t \in \{0,1\}$ indicates a disaster, and $\zeta < 0$ measures disaster severity. The aggregate shock follows an autoregressive (AR(1)) process $Z_t = \rho Z_{t-1} + (1-\rho)\mu + \sigma\varepsilon_t$, where $\varepsilon_t \sim \mathcal{N}(0,1)$, $\rho \in (0,1)$ denotes persistence, μ is the long-run mean, and $\sigma > 0$ denotes volatility. The idiosyncratic shock is $z_t^i = \sigma_i \varepsilon_t^i$, with $\varepsilon_t^i \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0,1)$ across firms. The disaster indicator d_t follows a two-state Markov chain with transition matrix $\Pi_d = \begin{pmatrix} 1-\pi_d & \pi_d \\ 1-\pi_s & \pi_s \end{pmatrix}$, where π_d is the probability of entering the disaster state and π_s is the probability of remaining there. Denote by $G\left(f_t^i \mid Z_t, d_t\right)$ firm i's dividend conditional on the aggregate state on the aggregate state (Z_t, d_t).

Motivated by empirical evidence in Section 2, NBLs face idiosyncratic investment opportunity shocks ι_t, which are i.i.d. across NBLs and follow a log-normal distribution $F(\iota_t)$ on $[0,\infty)$ with time-varying mean $\mathcal{I}_t$ and variance $\sigma_{\iota,t}$. The mean of ι_t is correlated with aggregate dividend risk: $\mathcal{I}_t = \bar{\mathcal{I}}\left(1 - \zeta_\iota Z_t\right)$. This is consistent with empirical findings where banks offload loans to nonbanks when they are close to the regulatory constraints (Irani et al., 2021) and during crises (CSBS, 2019).

Figure 5: Market Structure



Notes. This figure illustrates the market structure of the model economy. Arrows run from borrowers to lenders to indicate the direction of repayment. For visual clarity, bank credit lines to NBLs (purple block) are shown on the left-hand side of the balance sheet. In practice, only the drawn portion of a credit line appears on the balance sheet as a loan asset. The undrawn (committed but unused) portion is not a balance-sheet liability, but it constitutes an offbalance-sheet contingent liability for the bank. Banks must hold capital against undrawn credit lines according to credit conversion factors discussed in Section 3.3.2.

Market Structure. Banks and NBLs fund firms by holding their long-term debt A_{t+1}. Each corporate loan is modeled as a geometrically declining perpetuity, priced at q_t, paying coupon c^A, and declining at rate $\delta \in (0,1)$. Each period the firm repays a $(1-\delta)$ share of principal, while the remaining δ share rolls over and is valued at q_{t+1}. If its payoff satisfies $f_t^i \geq c^A + (1-\delta)$, the firm remits $c^A + (1-\delta) + \delta q_t$; otherwise it defaults, and the lender recovers $(1-\chi) f_t^i$. Because the economy contains a continuum of firms, idiosyncratic shocks are fully diversified, leaving aggregate risk the sole driver of firm default. By the law of large numbers, the aggregate firm loan payoff is

$$\mathscr{P}_t^A = \int_{c^A+(1-\delta)}^{\infty} \left(c^A + (1-\delta) + \delta q_t\right) dG + \int_{-\infty}^{c^A+(1-\delta)} (1-\chi) f_t^i dG. \tag{3.2}$$

Aggregate firm dividends distributed to households consist of cash flow after servicing debts, plus proceeds from new debt issuance:

$$Div_t^A = \int_{c^A+(1-\delta)}^{\infty} \left[f_t^i - \left(c^A + (1-\delta) + \delta q_t\right)\right] dG(f_t^i \mid Z_t, d_t) + q_t. \tag{3.3}$$

Banks and NBLs both hold long-term defaultable corporate debt claims that pay $\mathscr{P}_t^A$, but they differ in two respects. First, banks face capital requirements, whereas NBLs do not. Second, while banks can access household deposits, NBLs instead rely on commercial paper. These differences are two sides of the same coin. As depository institutions, banks transform long-term risky assets into short-term safe liabilities. Deposit insurance gives banks a funding advantage but also creates moral hazard, necessitating capital requirements (Kareken and Wallace, 1978). Thus, the very policies that grant banks a liquidity edge also constrain them from monopolizing corporate loan markets, leading to coexistence with NBLs. Capital requirements segment markets, yet bank-provided credit lines to NBLs, L_t, serve as contingent contracts that facilitate risk sharing despite regulatory frictions.

Figure 5 summarizes the market structure. Sections 3.3 - 3.5 below describe each agent's problems and aggregation assumptions in detail. I consider a recursive competitive equilibrium (Prescott and Mehra, 2005). Let $\mathcal{S}_t$ denote the state vector, which in principle must include the entire cross-sectional distribution of household wealth and intermediary net worth, along with exogenous states. In the model, households are represented by a stand-in household with wealth W_t^H. Intermediaries, banks and NBLs, aggregate such that their net worths are summarized by N_t^B and N_t^N. Hence, I work with $\mathcal{S}_t = \left(N_t^B,\, N_t^N,\, W_t^H,\, L_t,\, Z_t,\, d_t\right)$.

Timing. At the start of period t, events unfold as follows:

1. Aggregate shocks are realized.

2. Idiosyncratic NBL investment opportunities are realized. Each NBL decides how much to draw from its credit line negotiated in the previous period.

3. Idiosyncratic profit shocks for banks and NBLs are realized. Each intermediary decides whether to declare bankruptcy. The government insures depositors of failed banks, while households assume ownership of failed intermediaries and firms, recovering their liquidation values under the aggregation assumptions in Section 3.4.

4. Agents make portfolio choices. Banks and NBLs negotiate next period's credit-line limits. Markets clear and households consume.

3.2 Credit Line Contract between Banks and NBLs

Before analyzing the bank and NBL problems, I describe the credit line contract. A credit line is the triplet $\left(l_t, q_t^L, s^C\right)$, where l_t is the credit limit, q_t^L the upfront fee, and s^C the spread over a floating benchmark rate. As in practice, lenders grant borrowers a discretionary right—not an obligation—to draw up to l_t.

The limit l_t is endogenously set through bank–NBL negotiation and pinned down by their first-order conditions (equations (4.5) and (4.1)), where the supply and demand of credit lines equate in equilibrium. Banks internalize two effects. First, a higher limit increases the likelihood of ex-post drawdowns when NBLs face investment shocks (Section 3.3.1). Second, because banks must earn profits to credibly commit, they are not atomistic price-takers and instead must internalize NBLs' decreasing marginal willingness to pay per unit of credit line option q_t^L.

The upfront fee q_t^L, paid *ex ante* per dollar on the credit limit, compensates banks for the option-like flexibility of credit lines and varies with NBL risk. Borrower heterogeneity is primarily reflected in fees, which drive variation in the all-in-spread-undrawn (AISU) and all-in-spread-drawn (AISD), and serve a screening role: borrowers with lower AISU and higher AISD are less likely to draw (Berg et al., 2016).[8]

A fixed spread s^C over the floating risk-free rate r_t^{rf}, set at inception and unchanged at drawdown, implies that NBLs pay

$$R_t^C = s^C + r_t^{rf}, \tag{3.4}$$

per unit of drawn credit, where $r_t^{rf} = \frac{1}{\mathrm{E}[\mathcal{M}_{t,t+1}]}$ and $\mathcal{M}_{t,t+1}$ is the household stochastic discount factor from equation (B.24). Importantly, the model also predicts a fee–spread tradeoff: lower fixed spreads are paired with higher fees (Figure B.6.1 in Appendix Section B.6), consistent with

[8] The DealScan glossary defines AISD as the basis points over the risk-free rate per dollar drawn, combining the loan spread with facility fees. DealScan does not separate the fixed margin, and fee itemization is too inconsistent to isolate it. Empirically, upfront fees typically range from 0.25% to 1% of undisbursed amounts, with greater variation for smaller facilities and more stable levels for larger ones (see Corporate Finance Institute; AFSVision). Fees can be volatile: subscription line upfront fees rose by 32% in 2023 before stabilizing in early 2024 (Haynes Boone). By contrast, spreads are more standardized, reflecting market norms and performance-pricing provisions.

evidence that the fee–spread menu screens borrowers. Borrowers with private information that they are unlikely to draw prefer contracts with low fees and high spreads, while those expecting to draw choose the opposite (Berg et al., 2016).

As shown in Section 3.3.1, NBLs usually participate rather than lead in syndicated loans, and their deal flow is more uncertain. Therefore, NBLs value credit lines as flexible funding options, with the upfront fee as the option price. Anticipating larger drawdowns under investment shocks, NBLs want higher limits *ex ante*. The credit limit and the upfront fee are determined in equilibrium by both banks and NBLs. For the purpose of studying financial stability, it is important to endogenize these design features of the credit line contract. Banks take into account for how a marginal increase in limit provision affects NBL drawdown and their marginal willingness to pay, which helps mitigate the transmission of credit risk and discourages NBLs from excessive risk-taking.

Bank deposits carry a higher convenience yield than commercial paper, making bank debt cheaper than NBL debt. At the same time, NBLs—typically operating with about $2:1$ leverage[9]—issue more equity. By lending to NBLs, banks effectively combine their deposit advantage with NBLs' capital advantage. Moreover, as shown in the following sections, the endogenous design of credit line contracts—including their limits and option fees—allows banks to profit from risk-sharing with NBLs while capping their exposure. In addition to the design features of credit lines, Basel's lighter capital charge on credit lines further strengthens this incentive: lower credit conversion factors (CCFs) reduce the equity capital banks must hold relative to term loans (see Section 2.2.1).

I now present the full problems of banks and NBLs and their joint determination of the credit-line contract in equilibrium.

3.3 Financial Intermediaries

Two intermediary types, banks and NBLs, invest in long-term risky corporate loans whose payoff $\mathscr{P}_t^A$, defined in (3.2), accounts for the possibility of firm default. I first describe NBLs, then banks.

[9]Business development companies (BDCs) were originally subject to a $1:1$ leverage cap under the Investment Company Act of 1940. The 2018 SBCAA relaxed this constraint by relaxing it to a 150% asset-coverage requirement—equivalent to $2:1$ debt-to-equity—subject to board or shareholder approval.

3.3.1 NBLs

I analyze the optimization problem of a representative NBL facing idiosyncratic investment and default risk, with aggregation assumptions discussed below.

Each period, the NBL chooses holdings of Lucas tree debt a^N_{t+1}, credit line limit l_{t+1}, commercial paper issuance b^N_{t+1}, and equity issuance e^N_t subject to issuance costs $\Psi^N(e^N_t)$. When investment opportunity shocks hit, NBLs draw funds from their pre-negotiated credit lines, subject to the available credit limit. Thus, the individual NBL's drawdown amount is $c_{t,\iota_t} = \min(\iota_t, l_t)$.

In addition to corporate credit risk from long-term loan portfolios, NBLs face idiosyncratic profit shocks ϵ^N_t. These i.i.d., mean-zero shocks follow the CDF F^N_ϵ and cause default in only a subset of NBLs. As in Elenev et al. (2021), they capture cross-portfolio heterogeneity in credit quality: only the fraction F^N_ϵ of NBLs with sufficiently adverse shocks defaults, generating fractional rather than systemic failure. Since ϵ^N_t is revealed after investment decisions, it affects current dividends but leaves next-period net worth unchanged. An individual NBL's net worth n^N_t evolves as

$$n^N_t = \mathscr{P}^A_t[a^N_t + c(l_t)] - R^C_t c(l_t) - b^N_t, \tag{3.5}$$

where the first term is the asset payoff; the second is repayment on drawn credit; and the third is commercial paper debt. Each period, the NBL distributes a fraction ϕ^N_0 of book equity as dividends, but may adjust by issuing equity e^N_t subject to issuance cost $\Psi^N(e^N_t) = \frac{\phi^N_1}{2}(e^N_t)^2$. The budget constraint states that retained earnings $(1-\phi^N_0)n^N_t$, net equity issuance $e^N_t - \Psi^N(e^N_t)$, and commercial paper b^N_{t+1}—issued at price q^r_t—finance next-period loan holdings $q_t a^N_{t+1}$ and total credit line upfront fee $q^L_t l_{t+1}$:

$$q_t a^N_{t+1} + q^L_t l_{t+1} \leq (1-\phi^N_0)n^N_t + e^N_t - \Psi^N(e^N_t) + q^r_t(a^N_{t+1}, b^N_{t+1}, l_{t+1}; \mathcal{S}_t)b^N_{t+1}, \tag{3.6}$$

where NBLs internalize that the price of their commercial paper debt q^r_t is a function of their default risk and thus their capital structure. NBLs are also subject to non-negativity constraints

$$0 \leq a^N_{t+1}, \quad 0 \leq l_{t+1}, \tag{3.7}$$

which require that NBLs can extend only non-negative amounts of debt to firms or negotiate non-negative credit limits, but cannot sell loans back to corporates or credit lines back to banks. NBLs operate under limited liability and maximize net present value of dividends. Using $\mathcal{M}^N_{t,t+1}$ to denote the NBL stochastic discount factor, the recursive problem of an individual NBL is

$$V^N(\mathcal{S}_t, \epsilon^N_t, n^N_t) = \max_{\substack{a^N_{t+1}, l_{t+1}, \\ e^N_t, b^N_{t+1}}} \phi^N_0 n^N_t - e^N_t + \epsilon^N_t + \mathrm{E}_t \left[\mathcal{M}^N_{t,t+1} \max\{V^N(\mathcal{S}_{t+1}, \epsilon^N_{t+1}, n^N_{t+1}), 0\} \right], \tag{3.8}$$

subject to (3.5)–(3.7).

3.3.2 Banks

Having outlined the problem of NBLs, I now turn to banks. Banks finance themselves through deposits d_t and equity e^B_t, extend credit lines to nonbanks, and also lend directly to firms. Unlike NBLs, banks are subject to regulatory capital requirements.

Access to short-term deposits d_t gives banks a liquidity advantage over NBLs. This allows them to extend credit lines l_t and charge an endogenous upfront fee q^L_t per unit of credit limit (see Section 3.2). When NBLs draw, banks honor requests $c(l_t)$ up to the pre-negotiated limit l_t. An individual bank's net worth evolves according to:

$$n^B_t = \mathscr{P}^A_t a^B_t - d_t + \mathscr{P}^L_t c\left(l_t\right) - c\left(l_t\right), \tag{3.9}$$

where the first term represents payoff from banks' corporate loan investments; the second term represents deposit liabilities; the third term represents credit-line payoff (where $\mathscr{P}^L_t$ is defined in (3.20)); and the fourth term represents cash outflow from NBL drawdowns. Deposits d_t are priced at q^f_t, for which banks pay a deposit insurance fee κ per unit. Bank equity issuance cost takes quadratic form: $\Psi^B(e^B_t) = \frac{\phi^B_1}{2}(e^B_t)^2$. This gives us an individual bank's budget constraint:

$$q_t a^B_{t+1} - \left(q^f_t - \kappa\right) d_{t+1} \leq (1 - \phi^B_0) n^B_t + e^B_t - \Psi^B(e^B_t) + q^L_t(l_{t+1}; \mathcal{S}_t) l_{t+1}, \tag{3.10}$$

where banks take into account that the size of the credit limit influences the marginal willingness to pay per unit of credit line upfront fee.

Unlike NBLs, banks face Basel-style risk-weighted capital requirements. They must hold total equity $e^{B,tot}_{t+1}$ equal to at least a fraction ξ^E of risk-weighted assets. Basel assigns different risk weights to corporate loans and credit lines; $\omega^{CCF}_{\text{drawn}}$ and $\omega^{CCF}_{\text{undrawn}}$ denote the credit conversion factors

(CCFs) for drawn and undrawn exposures, which translate the capital charges on credit lines into equivalent capital charges on loans. The institutional details on regulation are discussed previously in Section 2.2.1 previously and specific CCF numbers will be presented in Section 5 on calibration. Together, these rules[10] imply that banks must maintain minimum equity of:

$$e_{t+1}^{B,tot} \geq \xi^E (a_{t+1}^B + \omega_{drawn}^{CCF} \mathrm{E}[c(l_{t+1})] + \omega_{undrawn}^{CCF}(l_{t+1} - \mathrm{E}[c(l_{t+1})])), \tag{3.11}$$

where there is an expectation on drawdown because it is correlated with aggregate risk.

Proposition 1 (Collateral benefits and regulatory buffer requirements)**.** *Suppose the bank faces a capital requirement in* (3.11)*. Then, this is equivalent to the deposit ceiling*

$$d_{t+1} \leq \xi \Big(a_{t+1}^B + \omega^C \ \mathrm{E}[c(l_{t+1})] + \omega^U \Big(l_{t+1} - \mathrm{E}[c(l_{t+1})] \Big) \Big) , \tag{3.12}$$

where $\xi \equiv 1 - \xi^E$ governs maximum leverage, $\omega^C \equiv (1 - \xi^E \omega_{drawn}^{CCF})/\xi$ captures the extra deposits the bank can back per unit of drawn credit line, and $\omega^U \equiv -\xi^E \omega_{undrawn}^{CCF}/\xi$ captures the deposit reduction required per unit of undrawn credit line to preserve buffer space for potential drawdowns.

See proof in Appendix B.3.1. Moreover, ω^C is positive because a drawn credit line functions like a loan and therefore helps banks back deposits. I later refer to this mechanism as the *collateral benefit* of credit lines to banks in Section 4. By contrast, ω^U is negative because undrawn credit commitments require banks to maintain capacity for potential utilization, thereby limiting the amount of deposits they can issue. I later refer to this mechanism as the *buffer cost* in Section 4.

Similar to NBLs, banks face idiosyncratic profit shocks ϵ_t^B, i.i.d. with mean zero and CDF F_ϵ^B, which capture fractional default à la Elenev et al. (2021). Bank's long-term debt to firms a_t^B is also subject to a no-shorting constraint:

$$a_t^B \geq 0, \tag{3.13}$$

which reflects that banks cannot finance themselves by selling corporate loans back to firms. Similar to NBLs, banks distribute a target fraction ϕ_0^B of net worth as dividends and may issue equity e_t^B at convex cost Ψ^B (see Section 3.4). They operate under limited liability and maximize the net present value of dividends to shareholders. Using $\mathcal{M}_{t,t+1}^B$ to denote bank stochastic discount factor,

[10]Capital requirements are expressed in book-value terms, consistent with regulatory practice.

an individual bank's recursive optimization problem is:

$$V^B(\mathcal{S}_t, \epsilon_t^B, n_t^B) = \max_{a_{t+1}^B, d_{t+1}, l_{t+1}, e_t^B} \phi_0^B n_t^B - e_t^B + \epsilon_t^B + \mathrm{E}_t \left[\mathcal{M}_{t,t+1}^B \max\{V^B(\mathcal{S}_{t+1}, \epsilon_{t+1}^B, n_{t+1}^B), 0\} \right], \tag{3.14}$$

subject to (3.10), (3.12) and (3.13).

3.4 Aggregation and Bailouts

Aggregation to a representative bank or NBL relies on three assumptions: (i) objectives are linear in idiosyncratic profit shocks, $\epsilon_{i,t}^B$ and $\epsilon_{i,t}^N$, (ii) shocks affect only current payouts without altering future net worth, and (iii) defaulting intermediaries are replaced by new entrants with equity equal to survivors.

Proposition 2 (Aggregation, credit line drawdowns and intermediary defaults)**.** *Under assumptions (i)–(iii), the distribution of idiosyncratic shocks across intermediaries does not affect aggregate outcomes. In particular:*

1. *Banks and NBLs can each be represented by a single intermediary with net worth N_t^B and N_t^N, respectively. Their value functions satisfy $\tilde{V}_t^B = V_t^B - \epsilon_{i,t}^B$ and $\tilde{V}_t^N = V_t^N - \epsilon_{i,t}^N$, where $\epsilon_{i,t}^B$ and $\epsilon_{i,t}^N$ denotes idiosyncratic profit shocks to banks and NBLs.*

2. *Aggregate drawdowns across all NBL credit lines are given by*

$$C(L_t) = \int_0^\infty \min(\iota, l_t) dF(\iota), \tag{3.15}$$

3. *Aggregate bank and NBL default probabilities depend only on representative net worth:*

$$F_{\epsilon,t}^B = F_\epsilon^B \left(-\tilde{V}^B(N_t^B, \mathcal{S}_t) \right), \tag{3.16}$$

$$F_{\epsilon,t}^N = F_\epsilon^N \left(-\tilde{V}^N(N_t^N, \mathcal{S}_t) \right). \tag{3.17}$$

Proof is in Appendix Section B.1. Defaulted banks are recapitalized by the government to the same equity level as survivors. Instead, defaulted NBLs are recapitalized by the households. This implies aggregate bank and NBL dividends

$$Div_t^B = \phi_0^B N_t^B - e_t^B + \left(1 - F_{\epsilon,t}^B\right) \epsilon_t^{B,+} - F_{\epsilon,t}^B N_t^B, \tag{3.18}$$

$$Div_t^N = \phi_0^N N_t^N - e_t^N + \left(1 - F_{\epsilon,t}^N\right) \epsilon_t^{N,+} - F_{\epsilon,t}^N N_t^N, \tag{3.19}$$

where $\epsilon_t^{B,+} = \mathrm{E}_{\epsilon^B}\left[\epsilon^B \mid \epsilon^B \geq -\tilde{V}^B\left(N_t^B, \mathcal{S}_t\right)\right], \epsilon_t^{N,+} = \mathrm{E}_{\epsilon^N}\left[\epsilon^N \mid \epsilon^N \geq -\tilde{V}^N\left(N_t^N, \mathcal{S}_t\right)\right]$ are the expected idiosyncratic profit shocks conditional on intermediaries not defaulting. The last terms in the aggregate dividends represent the costs to shareholders of recapitalizing defaulted intermediaries, from zero net worth post-bailout to the same positive net worth of the non-defaulted intermediaries.

A defaulted bank loses ζ^B per unit of asset. When defaulting banks are liquidated by the government, the bailout transfer from the government to the banks is

$$bailout_t = F_{\epsilon^B,t}\left[\zeta^B(\mathscr{P}_t^A A_t^B + \mathscr{P}_t^L C(L_t)) - N_t^B - \epsilon_t^{B,-}\right],$$

where the conditional expectation, $\epsilon_t^{B,-} = \mathrm{E}_{\epsilon^B}\left[\epsilon^B \mid \epsilon^B \leq -\tilde{V}^B(N_t^B, \mathcal{S}_t)\right]$, is the expected idiosyncratic profit of defaulting banks. Government funds bailouts using lump-sum taxes T_t on households and deposit-insurance fees levied on banks such that the budget constraint holds:

$$bailout_t = T_t + \kappa D_{t+1}^B.$$

In contrast, defaulting NBLs receive no government support. Their default lowers the returns banks earn on outstanding credit lines. The payoff on credit lines is:

$$\mathscr{P}_{t+1}^L(L_{t+1}) = \underbrace{(1 - F_{\epsilon,t+1}^N) R_{t+1}^C}_{\text{Non-defaulting NBL repayment}} + \underbrace{F_{\epsilon,t+1}^N RV^N + \frac{F_{\epsilon,t+1}^N \epsilon_{t+1}^{N,-}}{C(L_{t+1}) + B_{t+1}^N}}_{\text{Default recovery on credit lines}}, \tag{3.20}$$

where the conditional expectation $\epsilon_t^{N,-} = \mathrm{E}_{\epsilon^N}\left[\epsilon^N \mid \epsilon^N \leq \tilde{V}^N\left(N_t^N, \mathcal{S}_t\right)\right]$ is the expected idiosyncratic profit of defaulting NBLs. Recovery value[11] RV^N if NBL default occurs is:

$$RV^N = (1-\zeta^N)\frac{\mathscr{P}^A_{t+1}\left(A^N_{t+1}+C(L_{t+1})\right)}{C(L_{t+1})+B^N_{t+1}}. \tag{3.21}$$

3.5 Households

Households own equity in firms, banks, and NBLs, receiving aggregate dividends Div_t^A, Div_t^B, and Div_t^N. Each period they allocate wealth across consumption C_t^H, bank deposits D_{t+1}^H, and NBL commercial paper B_{t+1}^H, deriving liquidity services from deposits and commercial paper. They choose C_t^H, D_{t+1}^H, and B_{t+1}^H to maximize utility (equation (3.1)) subject to the following household budget constraint:

$$C_t^H + q_t^f D_{t+1}^H + q_t^r B_{t+1}^H + T_t + O_t \leq W_t^H, \tag{3.22}$$

where O_t denotes the additional funding—beyond rollover of existing assets and credit line proceeds—required to originate and service these investment opportunity shocks (see Appendix B.4 for detailed derivations). Household wealth W_t^H consists of dividends from firms, banks, and NBLs, plus risk-free deposits paying 1 and risky commercial paper paying $\mathscr{P}_t^B$ per unit:

$$W_t^H = Div_t^A + Div_t^B + Div_t^N + D_t^H + B_t^H \mathscr{P}_t^B. \tag{3.23}$$

Commercial paper payoff $\mathscr{P}_t^B$ takes into account default risk of NBLs:

$$\mathscr{P}_t^B = \underbrace{1 - F_{\epsilon,t}^N}_{\text{No default}} + \underbrace{F_{\epsilon,t}^N\left((1-\zeta^N)\frac{\mathscr{P}_t^A\left(A_t^N + C(L_t)\right)}{B_t^N + C(L_t)}\right) + F_{\epsilon,t}^N\frac{\epsilon_t^{N,-}}{B_t^N + C(L_t)}}_{\text{Default recovery on commercial paper}}, \tag{3.24}$$

where non-defaulting NBLs remit full payments, defaulting NBLs liquidate assets subject to haircut ζ^N per unit of asset. To satisfy the aggregate resource constraint, any loan demand generated by investment shocks that exceeds NBLs' credit limits is absorbed by households.

[11] In practice, undrawn commitments are terminated at default, so only the drawn amount $C(L_{t+1})$ is treated as outstanding senior debt, ranking *pari passu* with term loans and other senior secured obligations. If credit lines enjoyed seniority in repayment, the stabilizing effect of credit lines relative to loan contracts would be even stronger. Assuming equal seniority of credit lines and commercial paper is therefore more conservative.

3.6 Equilibrium

Given aggregate state $\mathcal{S}_t$, a competitive equilibrium is an allocation $\{A^B_{t+1}, L_{t+1}, e^B_t, D_{t+1}\}$ for banks, $\{A^N_{t+1}, L_{t+1}, e^N_t, B^N_{t+1}\}$ for NBLs, and $\{C^H_t, B^H_{t+1}, D^H_{t+1}\}$ for households, such that, given prices $\{q_t, q^L_t, q^f_t, q^r_t\}$ and taxes/transfers, households maximize lifetime utility, banks and NBLs maximize shareholder value, the government budget holds, and markets clear:

$$\text{Deposits:} \quad D_{t+1} = D^H_{t+1}, \tag{3.25}$$

$$\text{NBL Commercial Paper:} \quad B^N_{t+1} = B^H_{t+1}, \tag{3.26}$$

$$\text{Corporate Loans:} \quad 1 = A^B_{t+1} + A^N_{t+1} + \mathcal{I}_{t+1}, \tag{3.27}$$

$$\text{ARC:} \quad \exp(Z_t - \zeta d_t) = C^H_t + \Psi^B\left(e^B_t\right) + \Psi^N\left(e^N_t\right) + DWL_t, \tag{3.28}$$

where the aggregate resource constraint (ARC) equates total output to aggregate consumption plus equity-issuance costs and default dead-weight loss (DWL):

$$\begin{aligned} DWL_t =& \zeta^B F^B_{\epsilon,t}\big(\mathscr{P}^A_t A^B_t + \mathscr{P}^L_t C(L_t)\big) + \zeta^N F^N_{\epsilon,t}\, \mathscr{P}^A_t\big(A^N_t + C(L_t)\big) \\ &+ \int_{-\infty}^{c^A+(1-\delta)} \chi\, f^i_t\, dG\big(f^i_t \mid Z_t, d_t\big). \end{aligned} \tag{3.29}$$

4 The Economics of the Credit Line Contract

The previous sections establish the general-equilibrium framework for the maximization problems of banks and NBLs. This section unpacks the trade-offs embedded in the credit line contract, analyzing the private incentives of both parties. Full derivations are provided in Appendix B.

Private value of credit lines to NBLs. Credit lines allow NBLs to manage investment shocks. When choosing the credit limit, they weigh upfront fees and leverage costs—against the benefit of seizing investment opportunities. This tradeoff is captured by their first-order condition with respect to the credit line limit L_{t+1}:

$$\underbrace{q^L_t}_{\text{Upfront fee}} \underbrace{- \frac{\partial q^r_t}{\partial L_{t+1}} B^N_{t+1}}_{\substack{\text{potential debt, default} \uparrow \\ \text{Vs. asset value} \uparrow}} = \underbrace{\mathrm{E}_t\left[\mathcal{M}^N_{t,t+1}\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right)\frac{\partial C(L_{t+1})}{\partial L_{t+1}}\right]}_{\text{Net investment benefit of credit line}} \tag{4.1}$$

Two costs appear on the left-hand side of equation (4.1). The first, q_t^L, is the upfront fee paid to banks, akin to an option premium. The second, $-\frac{\partial q_t^r}{\partial L_{t+1}} B_{t+1}^N$ (derived in Appendix B.4.5), captures how access to credit lines affects the funding cost of NBLs' commercial paper. NBLs' commercial paper price schedule is

$$q_t^r = \frac{(1-\theta)\varsigma C_t^H}{(1-\varsigma)B_{t+1}^H} + \mathrm{E}_t \left\{ \mathcal{M}_{t,t+1} \left[1 - F_{\epsilon,t+1}^N + \frac{F_{\epsilon,t+1}^N \left((1-\zeta^N) \mathscr{P}_{t+1}^A (A_{t+1}^N + C(L_{t+1})) + \epsilon_{t+1}^{N,-} \right)}{B_{t+1}^N + C(L_{t+1})} \right] \right\}, \tag{4.2}$$

with full derivation in Appendix B.4, leading to equation (B.26). Taking the derivative of (4.2) with respect to the credit line limit L_{t+1} shows the impact of getting a credit line on NBLs' commercial paper funding cost.

Proposition 3 (Liquidity support Vs. default risk—impact of credit line on NBL commercial paper pricing)**.** *The sensitivity of the commercial paper price q_t^r to the credit line limit L_{t+1} is given by*

$$\frac{\partial q_t^r}{\partial L_{t+1}} = \mathbb{E}_t \left\{ \mathcal{M}_{t,t+1} \left[(\mathcal{A}_{t+1}^H - 1) \frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}} + F_{\epsilon,t+1}^N \frac{\partial \mathcal{A}_{t+1}^H}{\partial L_{t+1}} + \frac{\partial \mathcal{B}_{t+1}^H}{\partial L_{t+1}} \right] \right\}, \tag{4.3}$$

where I define $\mathcal{A}_{t+1}^H \equiv (1-\zeta^N) \mathscr{P}_{t+1}^A \frac{A_{t+1}^N + C(L_{t+1})}{B_{t+1}^N + C(L_{t+1})}$, $\mathcal{B}_{t+1}^H \equiv \frac{\epsilon_{t+1}^{N,-} F_{\epsilon,t+1}^N}{B_{t+1}^N + C(L_{t+1})}$ as in (B.27)- (B.28)*, and*

$$\frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}} = -f_{\epsilon,t+1}^N(-\tilde{V}_{t+1}^N) \left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N} \right) \left(\mathscr{P}_{t+1}^A - R_{t+1}^C \right) \frac{\partial C(L_{t+1})}{\partial L_{t+1}},$$

$$\frac{\partial \mathcal{A}_{t+1}^H}{\partial L_{t+1}} = \left(1-\zeta^N\right) \mathscr{P}_{t+1}^A \frac{\left[B_{t+1}^N + C_{t+1}\right] \frac{\partial C(L_{t+1})}{\partial L_{t+1}} - \left[A_{t+1}^N + C_{t+1}\right] \frac{\partial C(L_{t+1})}{\partial L_{t+1}}}{\left(B_{t+1}^N + C(L_{t+1})\right)^2},$$

$$\frac{\partial \mathcal{B}_{t+1}^H}{\partial L_{t+1}} = \frac{1}{\left(B_{t+1}^N + C(L_{t+1})\right)^2} \left(\frac{\partial \left(\epsilon_{t+1}^{N,-} F_{\epsilon,t+1}\right)}{\partial L_{t+1}} \left(B_{t+1}^N + C\left(L_{t+1}\right)\right) - \epsilon_{t+1}^{N,-} F_{\epsilon,t+1} \frac{\partial C(L_{t+1})}{\partial L_{t+1}} \right).$$

This derivative reflects a trade-off between higher default risk from increased potential drawdowns and improved asset and recovery values from credit-line–financed investment.

Proof is in Appendix B.4.6. The sign of $\frac{\partial q_t^r}{\partial L_{t+1}}$ reflects a trade-off between liquidity support and default risk and depends on which force dominates in equilibrium. On the one hand, undrawn credit lines constitute an option asset for NBLs. Moreover, investment financed through credit line drawdowns increases NBLs'asset values, thereby improving the recovery value of commercial paper in default. By raising asset values, access to a credit line reduces the funding cost of NBLs'commercial paper programs through the *liquidity support channel*.

On the other hand, drawn credit is a liability for NBLs. A higher credit limit increases potential drawdowns and effective leverage, raising default risk and thus elevating the cost of commercial paper funding. This constitutes the *default risk channel*. Consequently, even though NBLs often emphasize the liquidity support role of credit lines in their prospectuses—potentially to facilitate access to other forms of funding such as commercial paper—the equilibrium effect of credit lines on commercial paper funding costs depends on effective leverage conditional on access to a credit line and is determined in general equilibrium, taking into account increase in both assets and potential liabilities when drawn. When the liquidity support effect dominates, credit lines lower NBL funding costs; when the default risk effect dominates, credit lines increase NBL funding costs.

The right-hand side of equation (4.1) captures the marginal benefit. As L_{t+1} rises, expected utilization C_{t+1} increases, i.e. $\frac{\partial C(L_{t+1})}{\partial L_{t+1}} > 0$ (equation (4.4)). NBLs fund corporate loans that pay $\mathscr{P}^A_{t+1}$, while repaying drawn credit R^C_{t+1} specified in equation (3.4). To sum up, NBLs weigh the costs of upfront fees and potential default risk against the benefits of seizing investment opportunities and obtaining liquidity support.

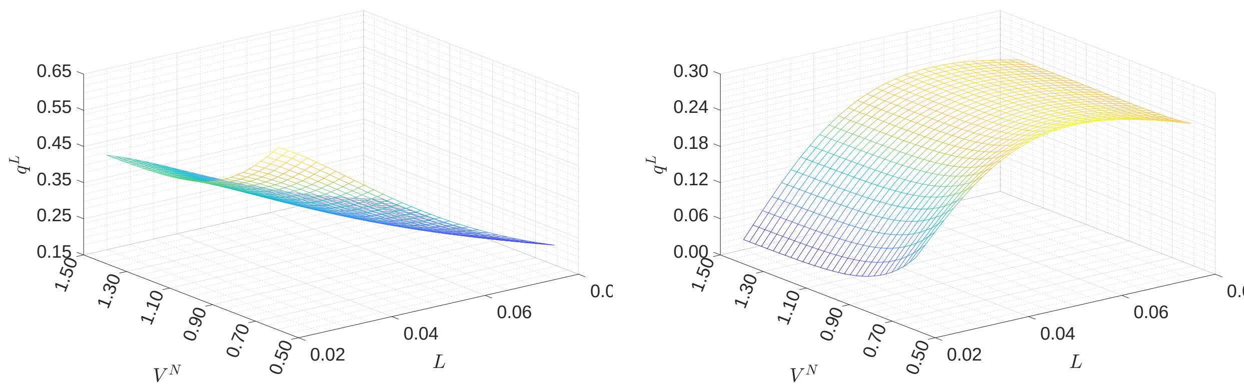
To visualize NBLs' price schedule, Figure 6(a) plots NBLs' first-order condition with respect to the credit limit L_{t+1}. For NBLs, the upfront fee q^L—their marginal willingness to pay for the limit—declines as L_{t+1} increases. This reflects that each extra dollar of liquidity provides diminishing insurance value.

Private value of credit lines to banks. The endogenous design features of the credit line contracts allow banks to risk-share with NBLs while capping their own risk exposure. Preferential regulatory treatment provides an added incentive. When choosing the credit limit, banks weigh marginal benefits—risk-sharing with NBLs and regulatory advantage—against marginal costs, mainly higher NBL default risk. This risk reaches bank balance sheets only if the line is drawn. Thus, a key issue is how drawdowns respond to the committed limit. From the aggregate NBL drawdown in equation 3.15, we study how the size of credit line drawdown responds to a change in the credit limit:

$$\frac{\partial C(L_t)}{\partial L_t} = \frac{\partial}{\partial L_t}\left(\int_0^{l_t} \iota_t\, dF(\iota_t) + \int_{l_t}^{\infty} l_t\, dF(\iota_t)\right) = 1 - F(L_t), \tag{4.4}$$

which shows that the marginal drawdown from raising the credit limit L_t equals the probability that the investment shock exceeds the current limit. The limit is set through bilateral negotiation,

Figure 6: Credit Line Pricing Schedule



(a) Surface of NBL first-order condition (b) Surface of bank first-order condition

Notes. Panel (a) plots the NBL's first-order condition (4.1) with respect to credit limit L from the calibrated model with calibration details in Section 5. The surface shows q^L (z-axis, the NBL's willingness to pay per unit of credit) against the credit limit (x-axis) and the NBL value function (y-axis). Panel (b) plots the bank's first-order condition (4.5) with respect to credit limit L against the credit limit and the NBL value function.

but actual drawdowns are chosen by NBLs alone and lie outside banks' control. This lack of control makes banks cautious: a higher limit today raises future exposure. Banks therefore internalize NBLs' expected response when setting L_{t+1}. This acts as an endogenous check against offering excessively large limits *ex ante*. The mechanism enters the bank's optimization problem, summarized by the first-order condition for credit line extension in equation (4.5):

$$\underbrace{-\overbrace{\frac{\partial q_t^L}{\partial L_{t+1}}}^{<0} L_{t+1}}_{\text{MWTP (NBL)}\downarrow} \quad \underbrace{-\tilde{\lambda}_t^B \xi \overbrace{\omega^U}^{<0} \left(1 - \frac{\partial \mathrm{E}[C(L_{t+1})]}{\partial L_{t+1}}\right)}_{\text{regulatory buffer for undrawn line}}$$
$$= \underbrace{q_t^L}_{\text{premium}} \underbrace{+ \tilde{\lambda}_t^B \xi \omega^C \frac{\partial \mathrm{E}[C(L_{t+1})]}{\partial L_{t+1}}}_{\text{collateral benefit on drawn credit}} \underbrace{+ \mathrm{E}\left[\mathcal{M}_{t,t+1}^B \frac{\partial}{\partial L_{t+1}} \left(\left(\mathscr{P}_{t+1}^L - 1\right) C\left(L_{t+1}\right)\right)\right]}_{\text{MB on risk-sharing}}, \tag{4.5}$$

The left-hand side of equation (4.5) captures the expected marginal cost to banks from extending credit lines. Banks internalize how changes in the limit affect the per-unit price of credit. In particular, the derivative $\frac{\partial q_t^L}{\partial L_{t+1}}$ follows from the NBLs' first-order condition for the optimal credit limit in equation (4.1):

$$\frac{\partial q_t^L}{\partial L_{t+1}} = -\mathrm{E}\left[\mathcal{M}^N_{t,t+1}\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right) f(L_{t+1})\right]. \tag{4.6}$$

As shown in Figure 6(a), NBLs' willingness to pay per unit of credit limit falls with an additional dollar on the limit, i.e. $\frac{\partial q_t^L}{\partial L_{t+1}} < 0$. Banks internalize this decline in NBLs' marginal willingness to pay, which deters them from offering excessively high limits. Lemma 1 in Appendix B.3.6 provides sufficient conditions for $\frac{\partial q_t^L}{\partial L_{t+1}} < 0$.

Second, credit lines are option assets for NBLs but contingent liabilities for banks when drawn. When a bank provides a credit line, it commits to lending to NBLs in states of the world where they choose to draw down. Regulation therefore requires an *ex ante* cost by tying up balance-sheet capacity, since credit lines commit banks to providing potentially risky loans *ex post*. This cost is purely derived from the capital requirement, not an exogenous cost.

Banks weigh these two costs against three benefits on the right-hand side in equation (4.5). First, they earn the upfront fee q_t^L, which serves as an insurance premium. Second, they gain a regulatory benefit: $\tilde{\lambda}_t^B$ is the shadow cost of capital and ξ represents the leverage cap. Drawn commitments are equivalent to loans that can be used to back deposits, with a regulatory conversion parameter ω^C discussed above in Section 3.3.2. Third, banks benefit from risk-sharing. Funded by cheap deposits, they gain exposure to NBL investments by tapping into NBLs' balance-sheet capacity. I further decompose this term to study the good and bad sides of credit lines' flexibility.

$$\mathrm{E}\left[\mathcal{M}^B_{t,t+1}\right]\Bigg\{\underbrace{\mathrm{E}\left[\frac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}^L_{t+1}-1\right)C\left(L_{t+1}\right)\right)\right]}_{\text{average marginal benefit}} + \underbrace{\mathrm{Cov}_t\left(\widehat{\mathcal{M}}^B_{t,t+1}, \frac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}^L_{t+1}-1\right)C\left(L_{t+1}\right)\right)\right)}_{\text{bad-state cost}}\Bigg\}, \tag{4.7}$$

where $\widehat{\mathcal{M}}^B_{t,t+1} \equiv \frac{\mathcal{M}^B_{t,t+1}}{E\left[\mathcal{M}^B_{t,t+1}\right]}$. The first expectations term in expression (4.7) is the average positive benefit of extending credit lines. The second term turns negative in bad times. On average, higher limits let NBLs absorb shocks more efficiently—the *good* side of risk-sharing, which also generates bank profit. The same flexibility is costly when bank balance-sheet space is most valuable. In bad states, the bank's SDF $\widehat{\mathcal{M}}^B$ is high, while two forces push the derivative down. First, drawdowns rise when funding is tight, i.e. $\frac{\partial C}{\partial L}$ increases. Second, default risk worsens and the credit line payoff compresses, i.e. $\frac{\partial \mathscr{P}^L}{\partial L} < 0$ or $\mathscr{P}^L - 1$ shrinks. When both occur, the covariance term becomes more negative and subtracts from the average benefit.

Proposition 4 (Downside of flexibility)**.** *In bad aggregate states, when either the net payoff $\mathscr{P}^L - 1$ on the credit line is small or the marginal default sensitivity $\left|\frac{\partial \mathscr{P}^L}{\partial L}\right|$ is large, then*

$$\mathrm{Cov}_t\left(\widehat{\mathcal{M}}^B_{t,t+1}, \frac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}^L_{t+1} - 1\right) C\left(L_{t+1}\right)\right)\right) < 0.$$

Proof is in Appendix B.3.7. In bad states, as the covariance term subtracts from total benefit and is more negative precisely when balance-sheet space is most valuable. Therefore, credit lines' flexibility delivers risk-sharing in general, but can be costly in bad states.

To visualize the banks' price schedule, Figure 6(b) plots banks' first-order condition with respect to the credit limit L_{t+1} As L_{t+1} rises from 0.02 to 0.05, the option premium q_t^L increases. Here the dominant force behind pricing is default risk. A higher limit implies larger expected drawdowns, which raise NBL default risk and lead banks to charge a higher premium *ex ante*. Beyond $L_{t+1} = 0.05$, the derivative $\frac{\partial q_t^L}{\partial L_{t+1}}$ falls in magnitude, flattening the surface. The figure also shows that q_t^L declines with NBL value V^N. Higher V^N lowers default risk and reduces the required upfront premium. Overall, credit lines let NBLs pay a premium to enjoy partial funding flexibility, while banks adjust limits to balance risk-sharing profit and risk exposure.

5 Calibration

The model is calibrated to match key moments in credit risk and the dynamics of firms and financial intermediaries in the U.S. economy between 1990 and 2023. The goal of the calibration is to match three key groups of data moments: (i) credit line characteristics; (ii) balance-sheet compositions, including leverage and default of banks and NBLs; and (iii) credit risk, including corporate loan defaults and loss severities.

Parameters are either externally or internally calibrated. Externally calibrated parameters (Table 1) are taken directly from the data or from the literature. Internally calibrated parameters (Table 2) are chosen to align model-implied moments with their empirical counterparts. I organize the discussion by category—credit risk, financial intermediation, preferences, and regulation[12]—

[12]The regulation category includes only externally calibrated parameters derived from Basel institutional details.

presenting externally calibrated parameters first, followed by internally calibrated ones. Further calculation details are provided in Calibration Appendix D.

Table 1: Externally Calibrated Parameters

Parameter	Description	Value	Source
		Credit Risk	
π^d	Annual prob. of disaster	3.97%	Exp. disaster prob. (Moody's)
π^s	Prob. of staying in disaster	32%	Exp. disaster length 1 year
		Financial Intermediation	
s	Credit line spread	88 bps	DealScan Legacy and LSEG Loan Connector, Appendix D.1
δ	Corporate loan average life	0.928	FRED, Bloomberg, Appendix D.3
ϕ_0^B	Target bank dividend	0.068	Elenev et al. (2021)
ϕ_0^N	Target NBL dividend	0.072	Average NBL dividend
κ	Bank deposit insurance fee	0.00142	Begenau and Landvoigt (2022)
π	NBL bailout	0	Baseline
		Preferences	
σ_H	Households risk aversion	1	Log utility
ν_H	Households IES	1	Log utility
		Regulation	
ξ	Max. bank leverage	0.93	Basel II reg. capital charge
ω^C	Drawn portion adjustment	1.0075	Basel CCF details in Section 5.4
ω^U	Undrawn portion adjustment	-0.0275	Basel CCF details in Section 5.4

5.1 Credit Risk

I calculate the probability of transitioning into a disaster, $\pi_d = 3.97\%$, from the expected annual disaster probability. I characterize the disaster threshold as 2.5 standard deviations above the mean expected default probability from Moody's expected default frequency, weighted by total assets of U.S. non-financial corporations within one year. This is close to the unconditional annual disaster probability of 3.55% in Wachter (2013). In the model, "disasters" are simply rare events meant only to capture the depth of financial crises. The parameter π_s is the probability of remaining in the disaster state. Spells are geometrically distributed with $\Pr(\text{duration} = n) = \pi_s^{n-1}(1 - \pi_s)$, giving mean length $1/(1-\pi_s)$. Setting this equal to 4 quarters implies $\pi_s = 0.75$. The probability of staying in the disaster for four consecutive quarters is $0.75^4 \approx 0.32$.

Table 2: Calibrated Parameters

Par	Description	Value	Target	Model	Data
			Credit Risk		
ρ	persistence of dividends	0.8	persistence of corp. default	0.7	0.7
σ	volatility of dividends	0.05	volatility of corp. default	0.4%	0.5%
σ^i	volatility of idios. shocks	0.37	Moody's EDF NFC	0.6%	0.6%
χ	corp. LGD	0.3	loan losses	51.2%	51.4%
ζ	disaster multiple	0.081	corp. default in disaster	2.3%	2.4%
			Financial Intermediation		
μ_ι	mean of investment opportunity(IU) shocks	0.068	NBL loan share	51.6%	[43.48%, 59.76%]
σ_ι	dispersion of IU shocks	0.055	credit line utilization ratio	82%	81%
ζ_ι	IU multiple	0.7	volatility of credit line util.	2.0%	3.0%
ϕ_1^B	bank equity issu. cost	8	bank equity issu. ratio	0.4%	0.4%
ϕ_1^N	NBL equity issu. cost	5	NBL equity issu. ratio	3.7%	4.5%
ζ^B	bank loss given default	0.74	bank debt recovery (Begenau and Landvoigt, 2022)	48%	48.1%
ζ^N	NBL loss given default	0.765	sub. debt recovery (Begenau and Landvoigt, 2022)	40%	38%
$\sigma_{\epsilon,B}$	cross-sect. dispersion ϵ_t^B	0.8	bank default (Begenau and Landvoigt, 2022)	0.1%	0.2%
$\sigma_{\epsilon,N}$	cross-sect. dispersion ϵ_t^N	0.34	NBL leverage	0.59	0.55
			Preferences		
β_H	time discount factor	0.99	risk-free rate	0.94%	1%
ς	dep. vs. cons. weight	0.0046	deposit rate	0.26%	0.3%
θ	dep. vs. CP weight	0.7	commercial paper convenience yield	0.29%	0.24%

Aggregate shocks to the firm's collateral value, denoted as Z_t, follow an autoregressive process of order 1, AR(1). Z_t is treated as an exogenous state variable. I employ the method outlined in Rouwenhorst (1995) for discretizing Z_t into a five-state Markov chain. The parameters $\rho = 0.8$

and $\sigma = 0.05$ are chosen to match the persistence of the average default rate of non-financial corporations, which is 0.7, and the volatility of the corporate default rate, which is 0.5%, in the data. I use the volatility of idiosyncratic shocks to firms $\sigma^i = 0.37$ to target the average corporate default rate. I calculate this target from Moody's average expected default frequency (EDF) within one year of non-financial corporations in the US, weighted by total assets, which is 0.6%.[13] The corporate loan loss given default χ is set to 0.3 match corporate loan losses of 51.4% as in Elenev et al. (2021). I use the disaster multiple $\zeta = 0.081$ to match the corporate default probability conditional on disaster, which is 2.4% in the data.

5.2 Financial Intermediation

Credit Line Spread. The average fixed spread over the floating base rate on bank credit lines, computed from DealScan Legacy and LSEG Loan Connector, is 88 bps.[14]

Corporate Loan Average Life. Corporate loans are modeled as geometrically declining perpetuities, with the borrower promising payments of δ^{t-1} for all $t \in \mathbb{N}^+$. I follow (Elenev et al., 2021) but extend the data through 2023. Using investment-grade and high-yield bonds from Bank of America Merrill Lynch (BofAML) and Barclays Capital (BarCap) from 1997 to 2023, I construct an aggregate bond index weighted by market value to compute weighted-average maturity (WAM) and weighted-average coupon (WAC). I then compare the price of a benchmark bond with WAM = 10 years and WAC = 5.93% to a theoretical bond, calibrating the decay rate $\delta = 0.928$ to match the observed duration of corporate loans. Further details are provided in Calibration Appendix D.3. The implied average loan duration in the model is 7.01 years.

[13] An alternative target for the corporate loan default rate is Elenev et al. (2021), who use two datasets. The first, from the Federal Reserve Board of Governors, reports delinquency and charge-off rates for Commercial and Industrial loans and Commercial Real Estate loans issued by U.S. commercial banks (19912015), with an average delinquency rate of 3.1%. The second, from Standard & Poor's, reports default rates on publicly rated corporate bonds (19812014), averaging 1.5% overall—0.1% for investment grade and 4.1% for high yield. Because their measure covers only loans on bank balance sheets, while my paper includes both bank and NBL loans, I instead use Moody's EDF.

[14] According to DealScan glossary, the all-in-spread drawn (AISD) is the bps over floating base rate (SOFR now, LIBOR in the past) paid per dollar drawn, combining the loan spread with any annual or facility fee. DealScan reports this "all-in" spread without separating the fixed spread from fees, and fee itemization is too inconsistent to isolate the spread component. Appendix Figure C.1 reports AISD and AISU for credit lines of different maturities.

Target Dividends. I use bank target dividend parameter from Elenev et al. (2021), which is 6.8% of bank net worth. I am able to match a subset, 193 out of 371 NBLs to their Global Company Keys (GVKEYs). I construct a time series of total annual dividends relative to book equity for these NBLs and find an average dividend payout ratio of 7.2%, slightly higher than that of banks but not significantly.[15]

Deposit Insurance. Banks pay $\kappa = 0.00142$ deposit insurance fee per unit of deposit (Begenau and Landvoigt, 2022).

NBL Partial Bailout. In the baseline model, NBLs are not bailed out (probability of NBL bailout $\pi = 0$). I conduct a policy counterfactual in Section 6.3.3 where NBL bailout probability is increased to 0.3.

Investment opportunity. Investment opportunity shocks are log-normally distributed with mean μ_ι and standard deviation σ_ι. The mean μ_ι is calibrated to match an NBL loan share of 51.6%. Because banks often divest portions of syndicated loans after origination, origination shares do not reflect final exposures (Blickle et al., 2020). Lacking access to the Shared National Credit (SNC) database, I infer holding shares from origination data (DealScan Legacy and Loan Connector) using the regression coefficients in Blickle et al. (2020) (see Appendix D.2). My estimation yields a range of $[43.48\%, 59.76\%]$, depending on whether only term loans to firms are counted or whether drawn credit lines from financial intermediaries to firms are also included. The standard deviation σ_ι is chosen to match a credit-line utilization ratio of 81%. Consistent with Section 2, adverse aggregate shocks amplify NBL investment opportunities. The uncertainty multiple in the model is set to 0.7 to match the estimated 3.0% volatility of credit-line utilization.

Equity Funding. I calibrate bank and NBL equity issuance costs to match observed issuance ratios, defined as equity issuance divided by book equity. Falasconi (2025) estimates that U.S. large bank equity issuance from 2000 to 2020 to be 0.4%.[16] I set the bank equity issuance cost

[15] Damodaran (2024) has data on dividends. However, since my sample contains very few insurance firms which tend to have higher payout ratios, I cannot directly use Damodaran (2024)'s data.

[16] This is smaller than Elenev et al. (2021)'s estimation of bank equity issuance ratio of 1.05%. This is because Falasconi (2025) focuses on the 38 largest banks in the U.S., many of which are global systemically important banks (G-SIBs). This is the most suitable target for my model because only the largest banks extend credit lines to NBLs.

parameter to $\phi_1^B = 8$ to match this ratio. Using CRSP, I calculate the NBL equity issuance ratio at 4.5% and set $\phi_1^N = 5$ accordingly.

Default. I calibrate bank loss given default (LGD) to 0.74 to match debt recovery rates in Begenau and Landvoigt (2022) and set the cross-sectional dispersion of bank profitability shocks, $\epsilon_t^B = 0.8$, to target the 0.2% bank default rate reported in Begenau and Landvoigt (2022). For NBLs, I set LGD to 0.765, to match Moody's estimated 38.2% recovery rate on unsecured and subordinated debt Begenau and Landvoigt (2022). To match NBL leverage, I use the dispersion of NBL profitability shocks, $\epsilon_t^N = 0.34$. Using Compustat Financial Ratios (1990-2023), I match 123 of 371 DealScan NBLs and estimate an average leverage[17] ratio (total debt to total assets) of 0.6. This is consistent with regulatory limits such as the 1940 Investment Company Act (maximum 2:1 debt-to-equity) and reflects the composition of NBLs that borrow from banks while lending to firms, mainly finance companies and investment funds.

5.3 Preferences

Household risk aversion and intertemporal elasticity are set to 1 for log utility. The discount factor $\beta_H = 0.99$ matches a risk-free rate of about 1%. The deposit-service weight $\varsigma = 0.0046$ targets a net transaction deposit rate of 0.3% as in Begenau et al. (2024), measured as interest on transaction deposits (excluding time deposits) minus time-deposit interest, scaled by beginning-of-period balances. The utility weight between deposits and commercial paper is set to 0.7 to match commercial paper convenience yield. I use the 24 bps spread between the three-month general collateral repo rate and the T-bill yield in Nagel (2016) as a proxy for commercial paper convenience yield.

5.4 Regulation

I externally calibrate maximum bank leverage to $\xi = 0.93$, consistent with a 7% capital requirement. As discussed in Section 3.3.2 on CCFs, Basel Committee on Banking Supervision (2020) (items 599 and 83) assign a 90% CCF to committed retail credit lines; commitments under one year receive a 20% CCF, those over one year a 50% CCF, and unconditionally cancellable commitments a 0% CCF. Basel III further refines these rules by applying positive CCFs even to unconditionally cancellable

[17] Ideally, symmetry with bank targets would call for targeting NBL default as well. I use leverage instead, given the lack of reliable NBL default data.

commitments, enhancing risk sensitivity. To estimate the relative capital weight on credit lines, I compute weighted averages of CCFs across drawn and undrawn exposures from banks to NBLs. From derivations (3.11) and (3.12) in Section 3.3.2, the debt-adjusted factor on drawn credit lines is $\omega^C = \frac{1-\xi^E \omega^{CCF}_{\text{drawn}}}{\xi} = \frac{1-0.07\times 0.90}{0.93} \approx 1.0075$. For undrawn commitments, I distinguish maturities below and above one year. Commitments under one year (40.30% from 364-day facilities and 4.31% from revolver/line < 1 year, totaling 44.61%) receive a 20% CCF; those over one year (53.27% plus the remaining 2.12%, totaling 55.39%) receive 50%. The maturity-weighted average CCF is $0.20 \times 0.4461 + 0.50 \times 0.5539 = 0.3648 \quad (36.48\%)$.[18] Applying the same derivations, the debt-adjusted factor on undrawn credit lines is $\omega^U = -\frac{\xi^E \omega^{CCF}_{\text{undrawn}}}{\xi} = -\frac{0.07\times 0.3648}{0.93} = -0.0275$.

6 Results

In this section, I present three results on the financial stability and welfare implications of bank credit lines to NBLs. First, when investment opportunities expand, the additional revenues from providing insurance to NBLs bolster bank equity, allowing banks to lend more to firms. Consequently, banks operate with a larger balance sheet that can support more deposits.

Second, to unpack this mechanism, I compare credit lines with simpler cash and loan contracts to highlight their contingent features. Credit lines are *flexible*: they lower funding costs relative to cash, though they carry more risk. Fundamentally, credit lines are *insurance contracts*. In equilibrium, the model prices an *option* rather than a standard defaultable debt. Compared with loans, credit lines' endogenous limit and upfront fee help reduce default risk, though this insurance comes at a higher cost than standard defaultable loans. The counterfactual comparison rationalizes current regulatory preferences for credit lines over loans. Overall welfare comparisons show that credit lines outperform both cash and loans.

Third, with full government insurance on bank deposits, banks do not internalize their own default risks. This leads them to extend credit limit beyond the social optimum. necessitating regulation. I use the model to study spillovers from bank regulation to NBLs and the role of off-balance-sheet rules. Capital requirements and CCF adjustments reduce intermediary defaults, but

[18] Because utilization by facility varies, I use facility counts to avoid overstating credit lines as a share of bank funding to NBLs (Section 2.2.1). Therefore here I use facility count as well to be consist. However, weighting by facility amount gives similar result: commitments less than 1 year (364-day facilities and revolver/line < 1 year (45.4%)) at 20% CCF and long-term commitments (54.6%) at 50% CCF yield $0.20 \times 0.454 + 0.50 \times 0.546 = 0.36 \quad (36\%)$. See breakdown of credit line subtypes by facility amount in Appendix Section A.

only modestly. These tools matter less than banks' fundamental liquidity advantage. A final experiment, motivated by proposals to backstop systemically important nonbanks,[19]illustrates this point. Partial guarantees to NBLs have unintended effects. By supporting NBL debt funding, they erode banks' comparative liquidity edge. Intermediation shifts from bank-disciplined credit lines to market commercial paper. The result is lower stability and welfare. This highlights the central role of banks' liquidity advantage in sustaining credit-line provision and financial stability, and more broadly, clarifies an important distinction in how intermediation moves outside the banking system. When banks retain a senior claim on nonbanks through credit lines, risk-sharing can enhance stability; but when nonbanks operate entirely independently-financed, for instance, by commercial paper, the same shift can amplify fragility. The general-equilibrium analysis thus not only captures these contrasting outcomes but also reveals why regulation that reshapes bank–nonbank linkages can have fundamentally different welfare implications.

6.1 Investment Opportunities, Credit Lines, and Financial Stability

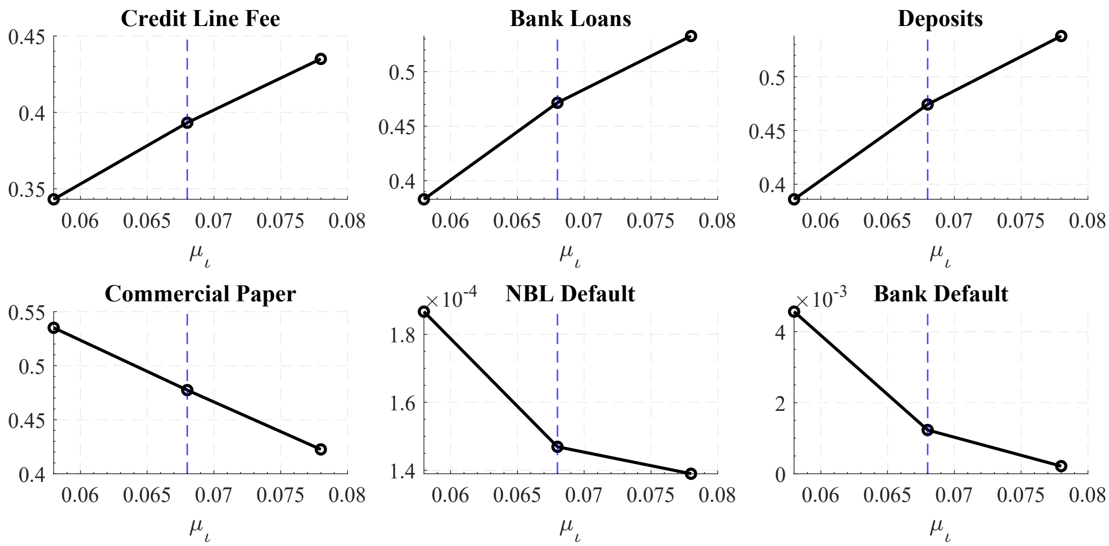
I begin by analyzing how an increase in the mean of NBLs' investment opportunities affects credit-line arrangements between banks and NBLs, and, in turn, risk transfers within the financial system. In my model, I capture this by raising the mean of investment opportunity, μ_ι. I solve for the stationary equilibrium at three levels of μ_ι: low, medium, and high. For each case, I report the ergodic mean of key financial variables. These include the credit line fee, deposits, bank loans, corporate loan prices, commercial paper, NBL default, bank default and welfare measured in consumption-equivalent terms (Figure 7).

When the mean of investment opportunities rises by one-third, from 0.06 to 0.08, NBLs demand more credit lines for flexible funding. This raises their willingness to pay, increasing credit line fees by 28.6%. Higher fees bolster banks' equity, which allows banks to originate more loans. This in turn helps bank support more deposits. Because NBLs rely on bank credit lines to capture investment shocks, banks can extract rents and expand banks' own share of loan origination. This mechanism helps explain why nonbank lending is more cyclical than bank lending (Gopal and Schnabl, 2022).

As credit line funding expands, NBLs reduce reliance on commercial paper, and their default probability declines. This points to the disciplining role of bank-provided credit lines. Credit lines

[19]See "Too Big to Fail" Financial Institutions: Policy Issues, and related legislation: H.J.Res. 120 and P.L. 111-203.

Figure 7: Credit-line Funded Investment Opportunities



Notes. The plots show the shift from low investment opportunity when NBLs demand fewer credit lines to high uncertainty when demand rises. The horizontal axis in each panel shows the mean of investment opportunity, μ_ι. The vertical axes report the key macro-financial variables.

differ from standard debt: they are insurance contracts. When drawn, they resemble loans on bank balance sheets, but banks also earn fees on the undrawn portion. This structure has two key effects in the model (Section 3). First, banks internalize how the credit limit affects fees per dollar of limit. Second, they internalize how higher limits influence NBL drawdowns. Stronger demand relative to supply therefore raises credit line fees, which compensate banks for risk-sharing with NBLs and support deeper financial depth. As NBL default risk falls, so does bank default risk, reducing deadweight losses.

To deepen the understanding of this result from a contractual perspective, I examine how the unique contingent features of credit lines affect financial stability. In the following Section 6.2, I conduct a comparison of credit line contracts with simpler non-contingent cash and standard defaultable loan contracts.

6.2 Unpacking Features of the Credit Line Contract

Credit lines have two contingent features: *flexibility* and *optionality*. They delay most funding costs until investment opportunities arise, underscoring *flexibility*. The endogenous limit and upfront fee price the NBL's option to draw, highlighting credit lines' insurance features, i.e., *optionality*. These features stand out in comparison: relative to cash, credit line contract is flexible; different from loan, credit line is an option-like insurance contract. Holding parameters fixed, I compare contracts in normal times and under aggregate shocks. Figure 8 contrasts credit lines with cash (yellow) and loans (blue) across eight financial metrics, reported as ergodic means relative to the credit line economy. Figure 9 shows impulse responses to a crisis, simulated as a sudden fall in corporate loan collateral values. Credit lines offer flexibility but expose banks to heavy drawdowns in downturns. The credit limit caps this exposure, delivering measured risk-sharing and keeping defaults moderate.

6.2.1 Flexibility

I first compare a counterfactual *cash economy*, where NBLs put cash in the bank, to the *credit line economy*. The full optimization problems in the *cash economy* are in Appendix E. I first highlight the lower funding cost of credit lines versus cash in Figure 8 by comparing ergodic averages across the two economies and their relative response to crisis in Figure 9. I then discuss the implications for all other metrics.

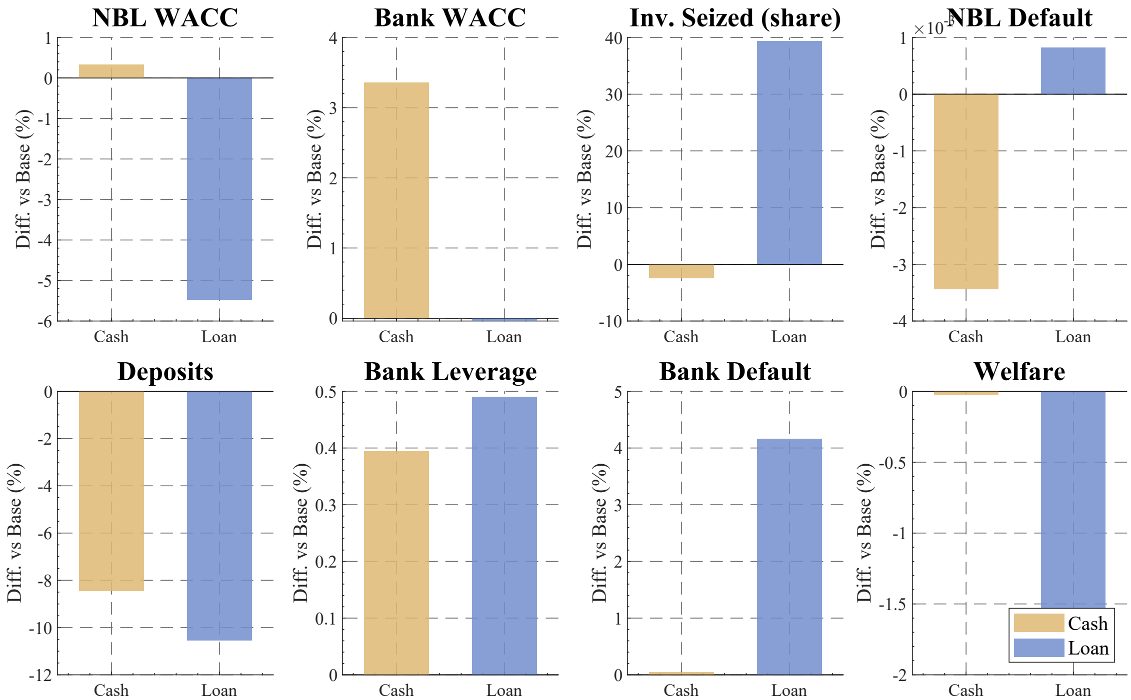
For banks, cash functions as an uninsured deposit. NBLs can "park" cash at the bank for later usage. Credit line, by contrast, is hybrid: when undrawn, it is a bank commitment and an asset for NBLs; once drawn, it becomes an option asset for the bank and a liability for NBLs. Why does the hybrid nature of the credit line contract allow NBLs to economize on funding costs? Its pay-as-you-draw feature lets NBLs defer most financing costs until profitable investment opportunities actually arise. Before drawing funds, the borrower pays only a modest upfront fee q_t^L, avoiding the opportunity cost of holding idle cash. If no investment opportunity materializes, the NBL only incurs minimal cost.

By contrast, in the *cash economy*, NBLs raise and pay for the entire amount upfront. Idle cash then sits on banks' balance sheets, earning low returns equivalent to that of uninsured deposits. Therefore cash can lead to over-investment in liquidity, which is an opportunity cost for NBLs. In the *cash economy*, NBL net worth evolves as

$$n_t^N = \mathscr{P}_t^A \left[a_t^N + \mathcal{I}^{seized}(l_t^{cash})\right] + \mathscr{P}_t^{\Delta cash} \Delta cash_t - b_t^N, \tag{6.1}$$

where $\mathcal{I}^{seized}(l_t^{cash})$ is the optimal investment undertaken (a subset of total investment uncertainties)

Figure 8: Credit Line Contract vs. Cash vs. Loan



Notes. This figure compares the credit line contract with cash and loan contracts across eight financial metrics, shown as differences in ergodic means from the baseline *credit line economy*. Yellow bars denote cash and blue bars denote loans, all solved under the same parameters. WACCs for banks and NBLs are reported in Appendix B.5 (*credit line*), Appendix E.4 (*cash*), and Appendix F.3 (*loan*). Investment seized is the share of uncertain opportunities taken by NBLs. Bank leverage is in book terms. Bank and NBL defaults follow equations (3.16) and (3.17). Welfare is measured by the household value function.

when projects are financed with cash. If available cash exceeds this optimal investment, i.e., $l_t^{cash} > \mathcal{I}^{seized}(l_t^{cash})$, the NBL holds a cash surplus:

$$\Delta cash_t = \mathbb{1}_{\{l_t^{cash} > \mathcal{I}^{seized}\}} \left(l_t^{cash} - \mathcal{I}^{seized}(l_t^{cash})\right). \tag{6.2}$$

Excess cash earns a payoff of

$$\mathscr{P}_t^{\Delta cash} = \left(1 - F_{\epsilon,t}^B\right) + F_{\epsilon,t}^B RV_t^{cash}, \tag{6.3}$$

where, if banks remain solvent, each unit of excess cash recovers its full value; if banks default, it earns the recovery value (see Appendix equation (E.4) for the expression of recovery value). Holding parameters identical to the *credit line economy*, the *cash economy* invariably ends with excess cash ($l_t^{cash} > \mathcal{I}^{seized}$). This arises because financing uncertain investment opportunities entirely with cash raises NBL default risk, prompting them to optimally allocate cash between risky loans and "parking" them at banks.

Having explained how the cash contract works differently than the credit line contract, Figure 8 compares the weighted average cost of capital (WACC) of banks and NBLs in the *credit line economy* and the *cash economy*. Full WACC calculations are in Appendix B.5 for credit line and Appendix E.4 for cash. In the former, the pay-as-you-draw structure reduces NBL funding costs, since they pay interest only on the drawn portion $c(l_t)$ and a modest fee on the undrawn balance. By contrast, in the *cash economy*, NBLs bear the full cost of l_t^{cash} upfront (see equation (E.34)). Credit lines also reduce bank's WACC. Cash is an uninsured debt that increases leverage and limits deposit capacity. Undrawn credit lines are only potential liabilities not yet realized on bank balance sheet.

In the *credit line economy*, lower funding costs let NBLs capture more uncertain investment opportunities on average (Figure 8). This same advantage is also salient in impulse responses to crises (Figure 9). When investment opportunity shocks rise in crises, credit limits expand more than cash, enabling greater NBL investment. A credit line is an insurance option and utilization often rises in crisis, leading to higher NBL default risk than in the *cash economy*. This holds true both in the ergodic average (Figure 8) and in the dynamic response to crisis (Figure 9). Yet idle cash balances sit on bank balance sheets as uninsured debt, which counts toward leverage constraints and limits insured deposit issuance. In the absence of insurance fee revenue from credit lines, the *cash economy* sustains fewer deposits with even fewer assets, and the resulting bank leverage is on average about 0.4% higher compared to the *credit line economy* in Figure 8. Overall welfare is about 0.02% higher in the *credit line economy*. This means households would be as well off as if their lifetime consumption were permanently higher by $30 USD per household annually.[20]

Whereas the *cash economy* counterfactual highlights credit lines' *flexibility*, the next section shows credit lines' insurance function, i.e., *optionality*.

[20] In the U.S., consumption is about 68% of GDP, or $19.8 trillion annually. A 0.01% increase in consumption-equivalent welfare equals a permanent rise of about $1.98 billion per year. With 132.6 million households, this is roughly $15 per household annually.

6.2.2 Optionality

I now compare the counterfactual *loan economy*, where banks extend NBLs loans, to the *credit line economy*. Loans are cheaper but riskier. Different from credit lines, many financial institutions can offer direct loans. In standard defaultable debt contracts, it is the borrower (NBL) that internalizes how borrowing more increases funding costs through higher default risk. In contrast, few institutions can provide credit lines. Among them, banks are large players, and much like large sovereigns that internalize their price impact, banks internalize how extending a higher limit reduces their marginal profit per additional limit. Banks' large role in credit line provision leads them to ration credit, which partially offsets the risk-taking incentives created by deposit guarantees. Credit lines reduce both bank and NBL defaults because they function as insurance contracts. The endogenous limit and upfront fee together price NBLs' default probability and drawdown risk, allowing banks to choose exposure optimally. The full optimization problems in the *loan economy* are in Appendix F. Following Section 6.2.1, I first compare ergodic averages along eight metrics in Figure 8 and crisis dynamics in Figure 9, then discuss other metrics.

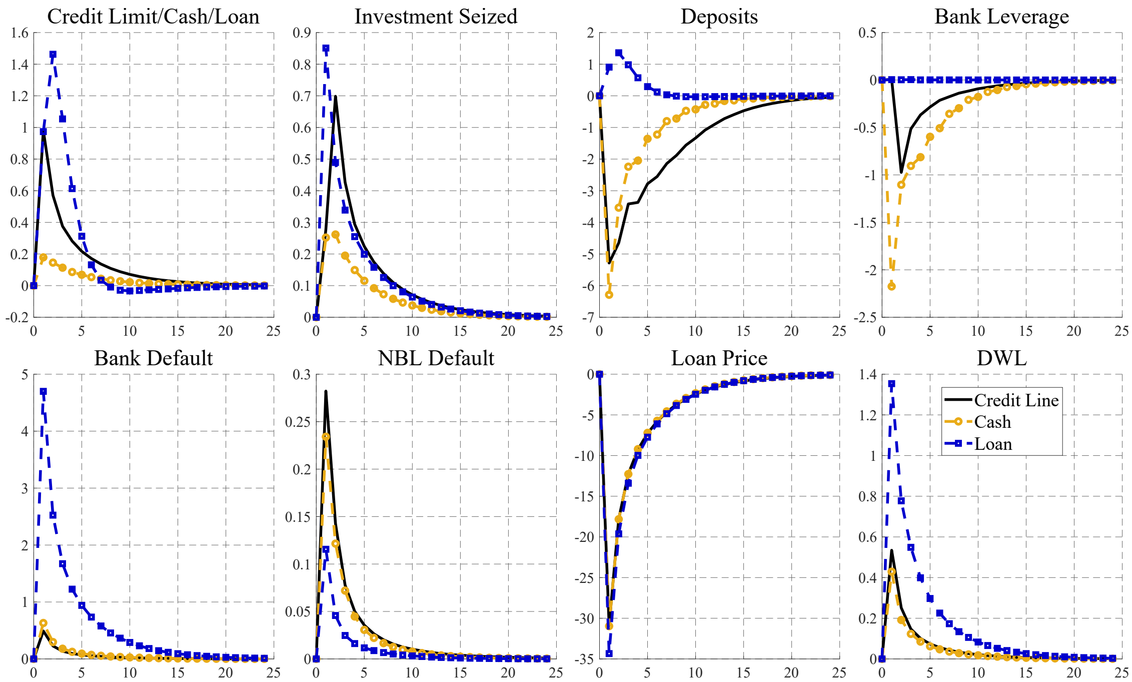
In the *credit line economy*, it is the insurer (bank) that internalizes the effect of an additional limit on NBLs' willingness to pay, $\frac{\partial q_t^L}{\partial L_{t+1}}$ (see equation (4.6)). While in the *loan economy*, it is the borrower (NBL) that internalizes the effect of loan quantity on price through default risk $\frac{\partial q_t^{loan}}{\partial L_{t+1}^{loan}}$ (see equation (F.17)).

In addition, when a bank makes a loan, its exposure is fixed at origination. By contrast, a credit line is an insurance contract: the NBL pays an upfront fee for the right to draw later. The banks do not have discretion on NBL drawdown. Anticipating this loss of control, banks internalize the risk of large drawdowns when setting the credit limit L *ex ante*. A higher limit raises potential liabilities, since $\frac{\partial C(L_t)}{\partial L_t} > 0$ (equation 4.4, Section 4). This internalization is unique to the credit line contract, not present in the loan contract due to fixed lender exposure at loan origination. Banks therefore cap limits and collect upfront fees that expand their balance sheet. This insurance mechanism builds internal equity and lowers default risk (Figure 8). The credit line limit is not a realized loan, but an upper bound on insurance that caps potential drawdowns.

The difference is also transparent in the bank budget constraint. Under a loan contract, lending to NBLs appears as an expense in the bank's budget constraint:

$$q_t a_{t+1}^B - (q_t^f - \kappa) d_{t+1} \leq (1 - \phi_0^B) n_t^B - q_t^{loan} l_{t+1}^{loan} + e_t^B - \Psi^B(e_t^B), \tag{6.4}$$

Figure 9: Crisis Dynamics



Notes. These plots show impulse responses to a crisis under three scenarios: the *credit line economy* (baseline, black), the *cash economy* (counterfactual 1, yellow circles), and the *loan economy* (counterfactual 2, square blue). The y-axis reports percentage deviations from steady state; the x-axis shows time in years. The analysis starts in year 0 with collateral at its mean ($Z_t = 0$) and endogenous states at their ergodic averages. In year 1, Z_t falls by two standard deviations (yellow line), after which it follows its stochastic process. I simulate 50,000 paths over 25 years and plot the average dynamics.

where $q_t^{loan} l_{t+1}^{loan}$ is bank's investment in NBLs. In the NBL's budget constraint, this same term appears as an inflow:

$$q_t a_{t+1}^N - q_t^{loan} l_{t+1}^{loan} \leq (1 - \phi_0^N) n_t^N + e_t^N - \Psi^N(e_t^N). \tag{6.5}$$

By contrast, in the *credit line economy*, the key corresponding term is the upfront fee $q_t^L l_{t+1}$, a revenue for banks and an expense for NBLs (equations (3.10) and (3.6)). This reversal matters: credit lines expand the bank's balance sheet relative to loans. With larger assets, bank leverage is lower in the *credit line economy*. In the *loan economy*, even with fewer deposits, the smaller asset side makes leverage higher, further explaining the rise in default risk (see Figure 8). To see this even more clearly, we can dive deeper into the equilibrium properties of the *loan economy* versus the *credit line economy*. Since the model allows adjustment along other margins (corporate loan holdings, intermediary equity issuance or dividend payouts), all three contracts can solve under the same parameters. However, their asset-liability structures differ. In the *loan economy*, banks withdraw from direct corporate lending and instead only fund NBLs with deposits. NBLs, unconstrained in the *loan economy*, finance all corporate loans with commercial paper and bank loans. They even pay dividends rather than issue equity.

Credit lines reduce financial stability risks but are costlier for both NBLs and banks (Figure 8). NBLs pay insurance fees on undrawn limits. Banks must reserve balance-sheet capacity for potential drawdowns, as required by regulation (equation (4.5) in Section 4), but are compensated by the insurance fees collected from NBLs. These effects are most visible in crises (Figure 9). In crises, investment opportunities for unregulated NBLs rise across all three economies. As discussed before in Figure 8, loans are the cheapest source of funding relative to cash and credit lines, so loan issuance to NBLs rises the most during crises relative to their ergodic means across all three contracts. Moreover, as explained before, across three contracts, only loans are a pure asset for banks, directly relaxing leverage constraints. To the extent that banks do not internalize their own default risks due to full deposit insurance, banks will take deposits up to the point their capital requirement binds. As a result, in the *loan economy* banks do not deleverage in crises. By contrast, in the *credit line* and *cash* economies, banks deleverage since idle cash and undrawn credit lines count toward leverage constraints. This is not only driving higher bank defaults in the *loan economy* compared to the *credit line economy* and the *cash economy* (Figure 9), but also making the recession in the *loan economy* longer to recover, taking about 15 periods. Even though heavy drawdowns in crises raise NBL defaults, bank defaults increase by less in the *credit line economy* relative to the *loan economy*. This translates to milder falls in loan prices during crises in the *credit line economy*. Overall, dead-weight loss is smaller on average (Figure 8) and increases less in crisis (Figure 9) in the *credit line economy*. Compared to the funding NBLs through loans, credit lines increases welfare by 1.83% (Figure 8).This means households would be as well off as if their lifetime consumption were permanently higher by $2,740 per household annually.

Credit lines are more expensive individually for banks and NBLs but produces lower default risk. Through the lens of my model, this rationalizes why current regulation in the Basel framework places credit conversion factors that subsidizes credit lines over loans.[21]

[21] As mentioned in Section 5.4, credit lines receive lower credit conversion factors than loans.

6.3 Policy Evaluations

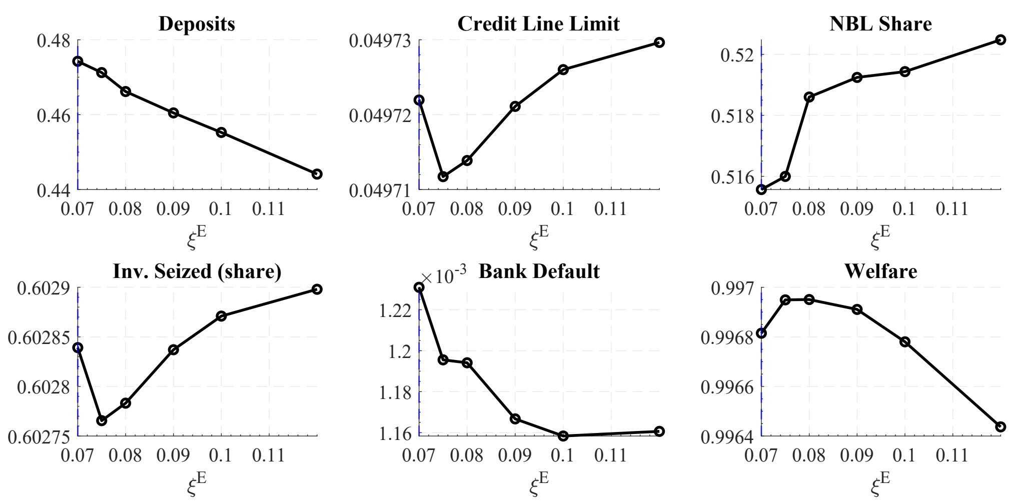
Finally, I use the model to evaluate policies. Two existing regulations already shape the supply of credit lines. The first is the overall capital requirement, which constrains the total scale of banks' risk-taking. The second is the credit conversion factors (CCFs), which convert off-balance-sheet exposures from undrawn credit lines into on-balance-sheet equivalents (loans), thereby affecting the composition of bank risk-taking. I begin by evaluating these two policies.

Beyond these, a more contested policy discussion concerns whether the government should support NBL debt. This policy has unintended consequences on the relative funding advantage of banks versus NBLs, and therefore affects financial stability and welfare more generally.

6.3.1 Spillover of Bank Regulation

In the model, raising the overall capital requirement increases the equity needed per unit of bank asset, i.e. a rise in $\xi^E = 1 - \xi$. Figure 10 illustrates how tighter requirements spill over to NBLs. As requirements tighten, deposits shrink, reflecting banks' reduced reliance on deposit-funded leverage and lower default risk.

Figure 10: Spillover of Bank Capital Regulation on NBLs



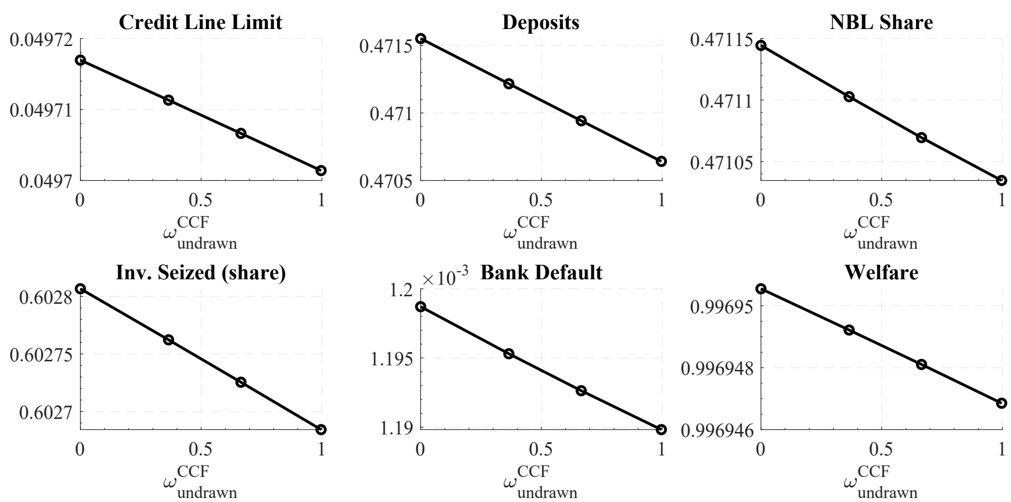
Notes. This figure shows the effect of overall bank capital requirement ξ^E. Higher ξ^E means tighter overall bank capital requirement.

A small tightening of bank capital requirements reduces both banks' direct lending to firms and their provision of credit lines to NBLs. As capital requirements tighten further, credit line supply becomes scarce, raising the upfront fee per unit of credit limit and making lending to NBLs more profitable than direct lending to firms. Banks therefore shift away from direct firm lending toward providing credit lines to NBLs. As NBLs originate a larger share of loans in the economy using relatively expensive commercial paper funding, intermediation becomes less efficient and aggregate welfare declines.

6.3.2 Off-balance-sheet Regulation

Through the lens of the model, banks, as large providers of credit lines, internalize the declining marginal willingness to pay in upfront fee for additional units of credit line insurance. As a result, the market structure of financial intermediation already disciplines credit line contract design, making excessive off-balance-sheet regulation unnecessary.

Figure 11: Off-balance-sheet Regulation



Notes. This figure shows the effect of off-balance-sheet regulation by moving the credit conversion factor $\omega^{CCF}_{undrawn}$ on undrawn credit lines. Higher $\omega^{CCF}_{undrawn}$ means tighter off-balance-sheet regulation.

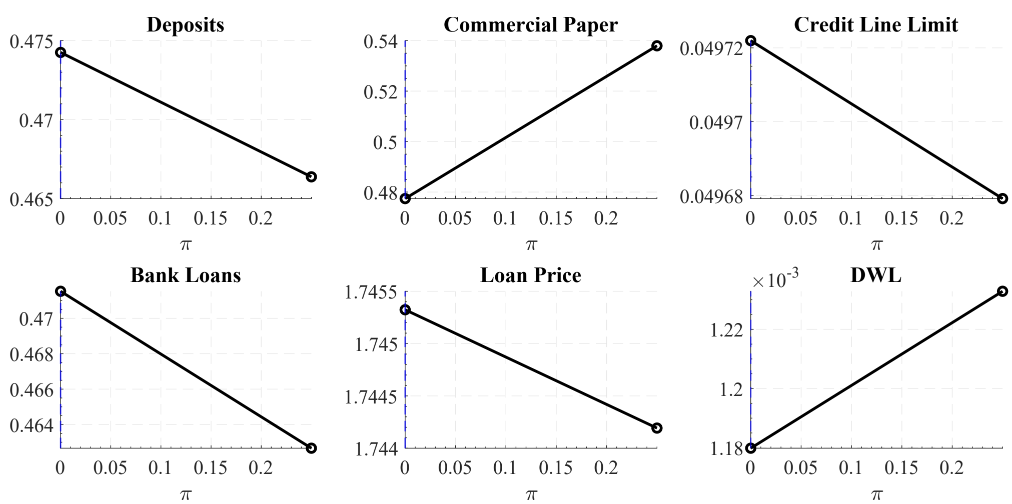
$\omega^{CCF}_{undrawn}$ is the maturity-weighted average credit conversion factor (CCF) applied to undrawn credit lines, which converts off-balance-sheet exposures into on-balance-sheet equivalents under Basel regulation (as discussed in Sections 3.3.2 and 5.4). The calculations based on the maturity composition of bank credit lines to NBLs explained in Section 5.4 yield a current estimate of

$\omega_{undrawn}^{CCF} = 36\%$. Fixing the optimal overall capital requirement at $\xi^E = 7.5\%$, I explore locally the effects of changing the credit conversion factor on undrawn credit lines in Figure 11. Tightening such regulation raises $\omega_{undrawn}^{CCF}$, requiring banks to hold more equity against undrawn credit lines under equation (3.11). Intuitively, banks are penalized more heavily for maintaining balance-sheet capacity to insure potential drawdowns, lowering deposit creation. As off-balance-sheet regulation tightens, banks provide less liquidity in two ways: (i) reduce credit line limits extended to NBLs, (ii) issue fewer deposits. Lower credit line limits restrict NBLs' ability to seize uncertain investment opportunities. As banks deleverage, their default risk declines. However, welfare also decreases, since tighter credit limits constrain overall investment.

Overall, the effects of off-balance-sheet regulation are modest. This again suggests that bank credit lines to NBLs are not merely artifacts of regulation. Banks have incentives to combine their debt advantage with NBLs' capital advantage. Moreover, the endogenous design of credit line contracts allows banks to share risk with NBLs while capping their own exposure.

6.3.3 Guaranteeing NBL Debt Funding

Figure 12: Bank Vs. NBL Debt Funding



Notes. This figure shows the effect of backstopping NBL commercial paper debt by increasing the government bailout probability π for NBLs, from $\pi = 0$ in the baseline to $\pi = 0.2$ in this policy counterfactual.

In the main model, banks' liquidity advantage stems from their ability to issue deposits. Deposits not only carry a higher convenience yield than commercial paper, but are fully insured, making them a uniquely attractive funding source for banks. This liquidity advantage is the fundamental economic reason that makes banks natural insurers of NBLs.

In the baseline, bank deposits and NBL commercial paper are split 1:1. I then consider a partial government bailout of NBLs, shifting the ratio to 1:1.2. This policy, akin to discussions on bailing out nonbanks, makes NBL debt more deposit-like, narrowing the funding gap. Figure 12 reports the results. When the government partially backstops NBL commercial paper with bailout probability 0.2 (versus 0 in the baseline), there is not so much need for NBLs to get credit lines to back their commercial paper program. Deposits contract, banks issue more equity, and their liquidity advantage over NBLs diminishes. This shift has two implications for banks. First, banks supply fewer credit lines, limiting NBLs' ability to manage uncertain investment shocks. Second, banks reduce direct lending to firms. More loans are originated by NBLs, which are increasingly funded by commercial paper. With NBLs relying more on government-backed commercial paper and less on bank credit lines, bank discipline weakens, NBL defaults rise, increasing deadweight losses and lowering welfare.

7 Conclusion

This paper studies the private and social value of contingent liquidity provided by banks to NBLs. Banks and NBLs are tightly connected through credit lines. These contracts account for 90% of bank funding to NBLs. Credit lines deliver private benefits. They insure NBLs against uncertain investment opportunities and allow banks to profit from their liquidity advantage. But they also shape macroeconomic outcomes and financial stability.

To evaluate these effects, I develop and calibrate a dynamic stochastic general equilibrium model of bank–nonbank intermediation. The model places their credit line connection at the center of analysis. In a general equilibrium framework, the design features of credit lines—the limits and the fees—respond endogenously to idiosyncratic investment and aggregate shocks, jointly determining the equilibrium pricing of nonbank liquidity providers' (NBLs') drawdown option.

In particular, because banks must earn profits to credibly commit, they are not atomistic price-takers and instead must internalize the increasing drawdown exposure and decreasing marginal return to each additional dollar of limit. The core insight is that market structure of intermediation shapes credit line design in a way that partially offsets the risk-taking incentives created by deposit insurance. This provides the key stabilizing mechanism when banks provide NBLs credit lines.

The model delivers three main findings. First, credit lines expand bank balance sheets and support safe-asset creation by allowing banks to collect rents when funding NBL investment opportunities. Second, the model decomposes the value of contingent liquidity into *flexibility* and *optionality*. Flexibility arises because credit lines defer funding costs until investment opportunities materialize, making them superior to cash. Optionality comes from the credit limit and upfront fee, which price the NBL's option to draw, setting them apart from standard loans. Welfare comparison shows credit lines outperform both loan and cash.

I use the model to evaluate policies. Capital requirements constrain the overall scale of risk-taking, whereas credit conversion factors (CCFs) influence its composition. A moderate tightening of capital rules raises welfare, but excessive tightening becomes counterproductive as intermediation through NBLs grows less efficient. Off-balance-sheet regulation through credit conversion factors entails similar trade-offs: greater safety comes at the cost of reduced investment. I also analyze proposals to extend guarantees to NBLs. The model shows that partial guarantees to NBL debt are not only suboptimal but, through the bank–NBL linkage, can inadvertently weaken banks' liquidity advantage. This contraction in credit line provision ultimately reduces both investment and financial stability.

Taken together, the results indicate that bank credit lines are not merely artifacts of regulation but emerge endogenously from fundamental economic incentives on both sides of the bank–nonbank relationship. Credit lines' design features are a source of stability, and not fragility. Policy-making in a connected financial system must take this mechanism into account. As we alter incentives along this contractual arrangement, we reshape the entire financial system.

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List of Appendices

A Empirical Appendix

This section contains additional empirical findings, textual evidence, and large-language model prompting and results that are referenced in the main texts.

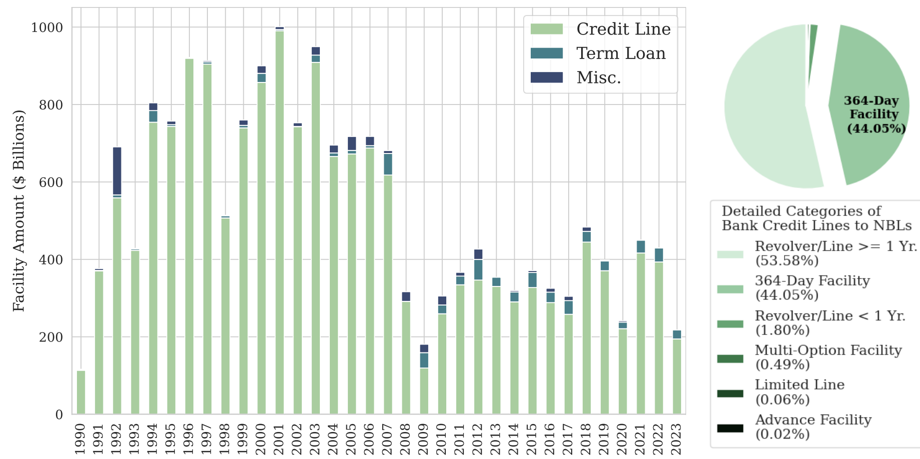
A.1 Additional Empirical Findings

Figure A.1.1 shows the breakdown of bank funding to NBLs by facility amount. Using facility amounts may overstate the role of credit lines, as they reflect total availability rather than drawdowns. To be conservative, the main text reports bank funding to NBLs by facility count. By amount, credit lines account for 94% of bank funding to NBLs. While the main focus of the paper is on NBLs that both lend to firms and borrow from banks. I show additional results on bank lending to all nonbanks in Figure A.1.2, where nonbanks are defined as all non-depository institutions. For this broader group, credit lines still represent 94% of bank funding when measured by facility amount. By deal count, credit lines also dominate, accounting for 87%. This is also consistent with evidence of bank funding to REITs in (Acharya et al., 2024b). Figure A.1.3 shows nonbanks rely heavily on banks for funding, but not vice versa, consistent with the finding in Acharya et al. (2024a). Figure A.1.4 is a 100% stacked bar chart showing the time variation in term loan origination by nonbank type. Over time, finance companies and investment funds account for about 90% of the share of nonbank loan origination to firms. Figure A.1.5 highlights the strong overlap between nonbanks that borrow from banks and those that lend to firms. Panel 5(a) shows that finance companies and investment funds account for about 90% of nonbank lending to firms—the main objects of my model. Panel 5(b) shows that about 70% of all bank funding to nonbanks goes to these same two groups, underscoring the tight link between the providers of credit to firms and the recipients of bank funding. Figure A.1.6 complements Figure 4 in the main text by showing NBL's total credit line availability alongside their lending. The figure is based on all DealScan NBLs that I can match to Capital IQ, representing about 25% of the NBLs in the DealScan sample.

Figure A.1.7 isolates credit risk from maturity risk by focusing on bank credit lines with a fixed maturity of exactly 364 days. Panel 7(a) reports all-in-drawn and all-in-undrawn spreads on bank credit lines to NBLs, and Panel 7(b) reports the same for corporates. For 364-day facilities, both drawn and undrawn spreads are systematically lower for NBLs. This indicates that banks price credit lines to NBLs more favorably than to corporates, consistent with banks' incentives to use cheap debt to access NBLs' relatively cheaper equity.

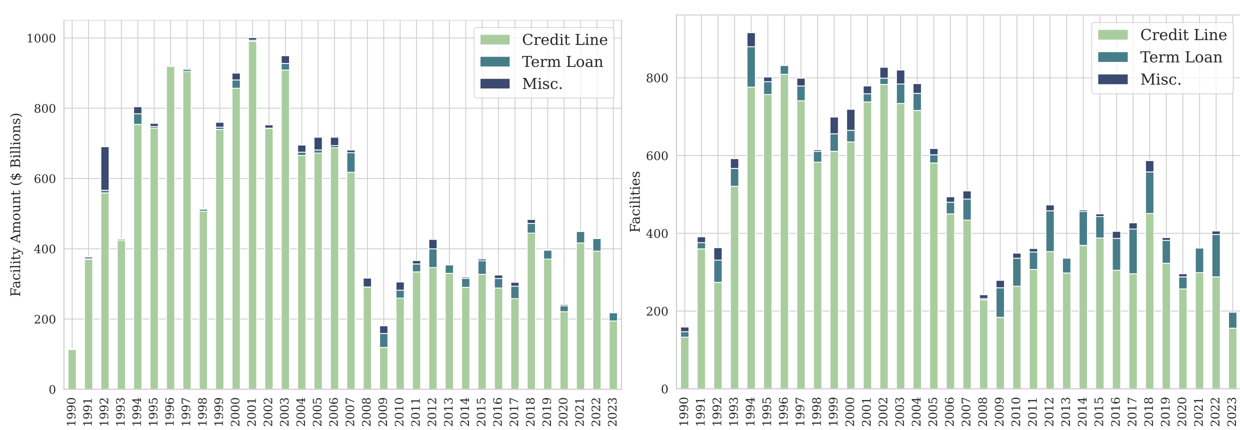
Figure A.1.8 reports the mean and standard deviations of covenant metrics, distinguishing between loans originated by banks and those originated by nonbanks. Although covenants within a syndication are typically standardized across participants, differences emerge when banks or nonbanks are sole lenders. These differences translate into systematic variation in covenant requirements. In particular, nonbank loans display greater dispersion in covenant metrics and allow looser thresholds on ratios such as debt-to-EBITDA, debt-to-equity, and debt-to-net-worth. This suggests that nonbanks compete by offering more flexible contractual terms, consistent with their business model of reaching borrowers that may be constrained under traditional bank lending. Banks, by contrast, impose relatively tighter covenants, reflecting regulatory discipline.

Figure A.1.1: Types of Bank Funding to NBLs (in Deal Amount)



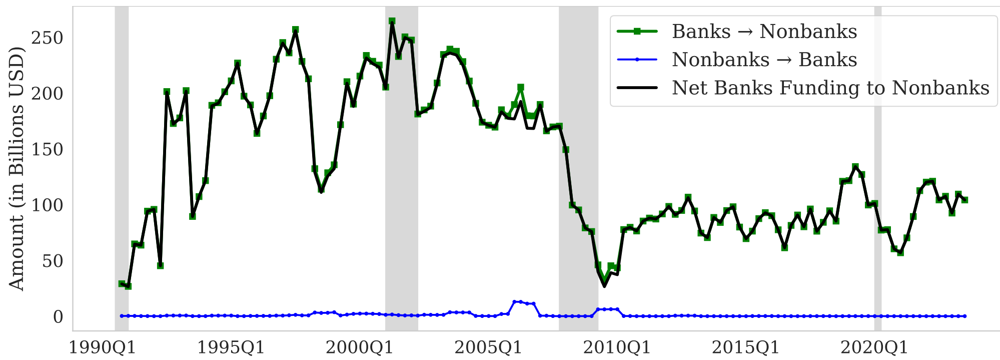
Notes. The left panel reports bank funding to NBLs by facility amount, broken down into three broad categories: credit lines (green), term loans (blue), and miscellaneous (navy). The right panel, using different shades of green, further decomposes credit lines into specific credit line types by facility amount: revolvers/lines $<$ 1 year, 364-day facilities, standby letters of credit, revolvers/lines $\geq$ 1 year, and other.

Figure A.1.2: Types of Bank Funding to All Nonbanks



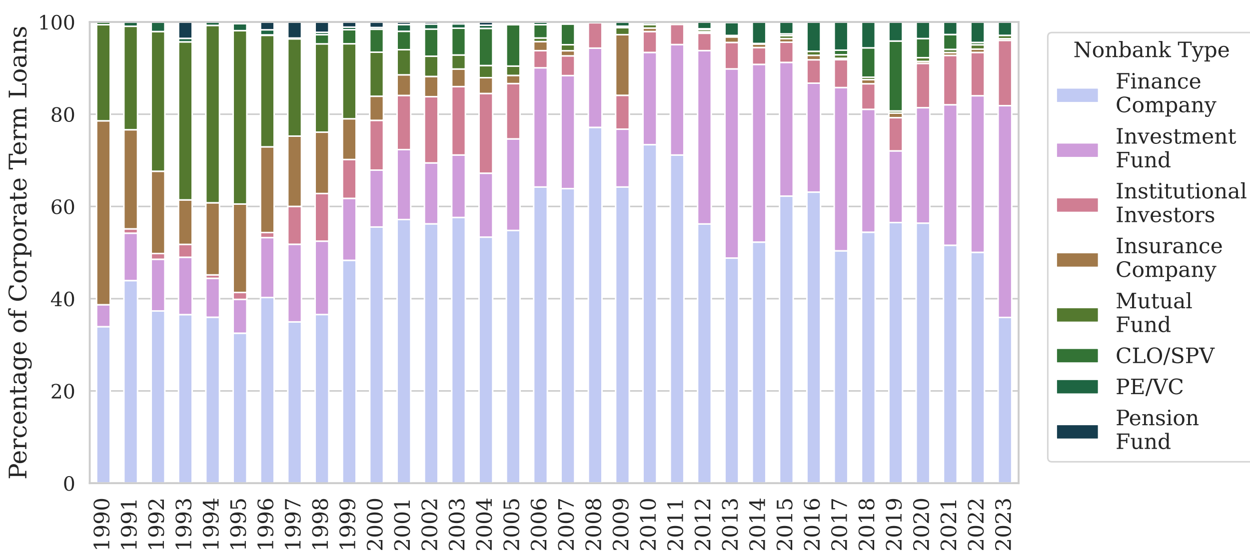
Notes. This figure plots the facility count of bank lending to *all* nonbanks by facility type.

Figure A.1.3: Net Bank Funding to Nonbanks



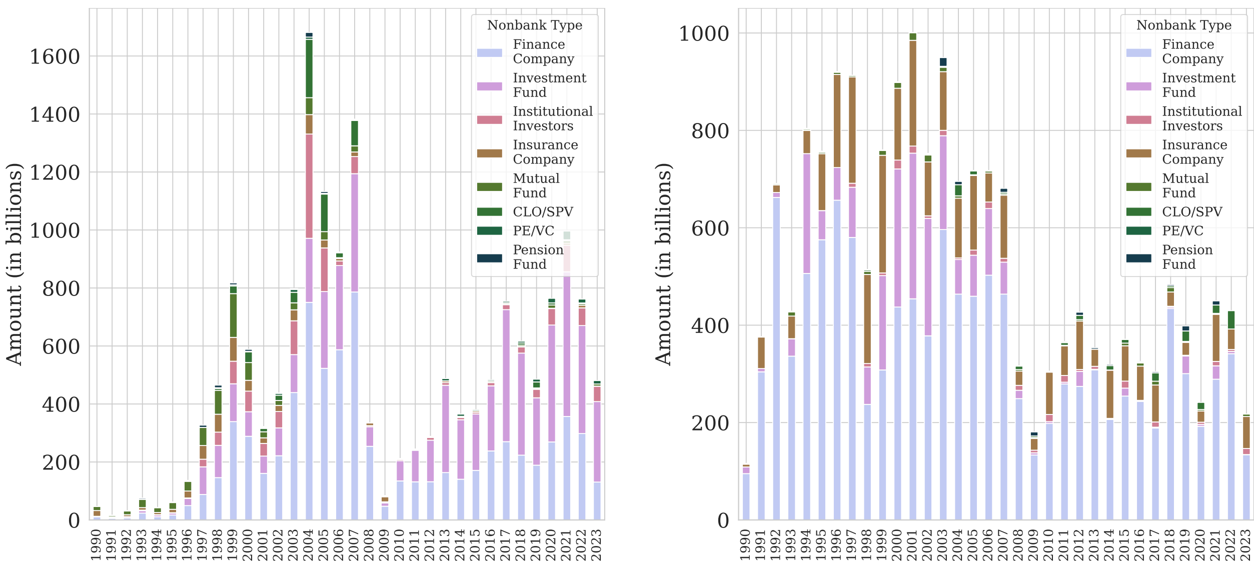
Notes. This figure reports the one-year moving average of quarterly bank funding (in billions of USD) to nonbanks, combining facility-level data from DealScan Legacy and the LSEG Loan Connector. The green line shows bank funding to nonbanks, the blue line shows nonbank funding to banks, and the black line shows the net bank funding to nonbanks.

Figure A.1.4: Term Loan Origination by Nonbank Type



Notes. This figure reports the time variation in term loan origination by nonbank type. Finance companies account for about 46% of total term loans originated by NBLs, followed by investment funds at 44%.

Figure A.1.5: Nonbank Lending and Funding from Banks

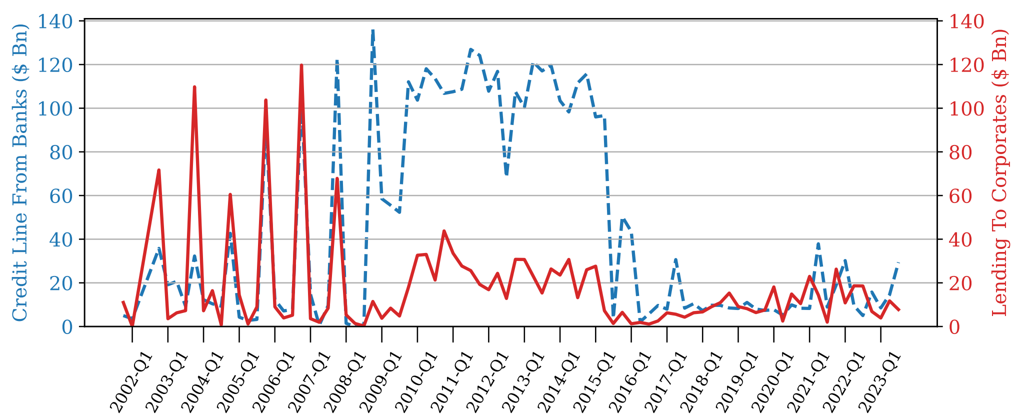


(a) Nonbank Lending by Nonbank Type

(b) Bank Funding to Nonbanks by Type

Notes. Panel (a) reports term loan originations by nonbank type. Finance companies and investment funds together account for 90% of nonbank lending to firms. Panel (b) reports bank funding to nonbanks by type. Approximately 70% of all bank funding to nonbanks is directed to these two groups: finance companies and investment funds.

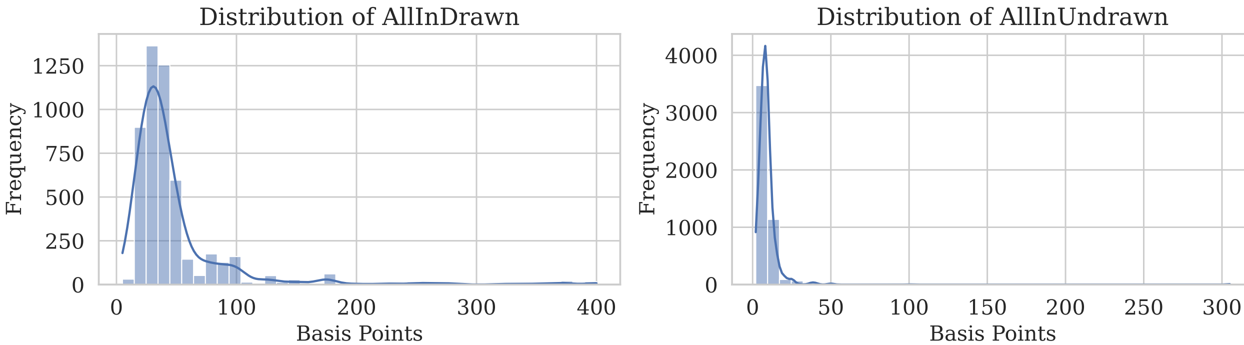
Figure A.1.6: NBL Credit Line Funding Vs. Lending



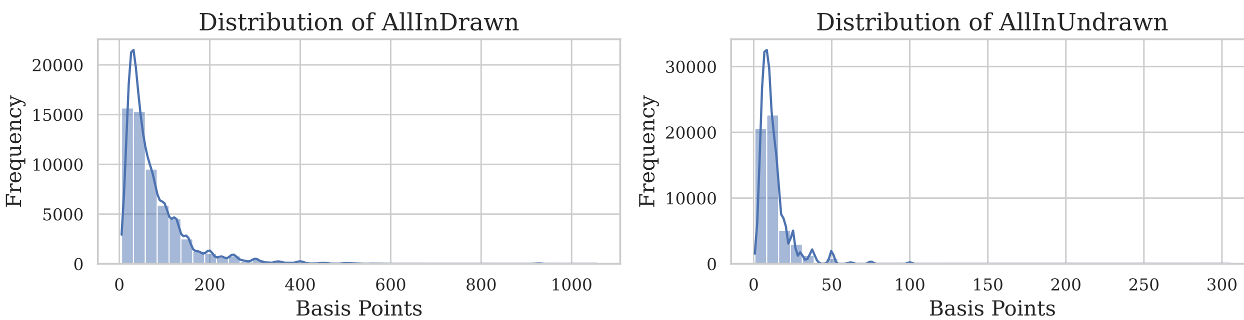
Notes. Solid red shows total quarterly lending for the 25% of DealScan NBLs that I am able to match in Capital IQ. Blue dotted shows total quarterly undrawn credit lines for the same subset.

Figure A.1.7: Pricing for 364-day Credit Facilities

(a) 364-day Credit Facilities Extended by Banks to Nonbank Financial Institutions

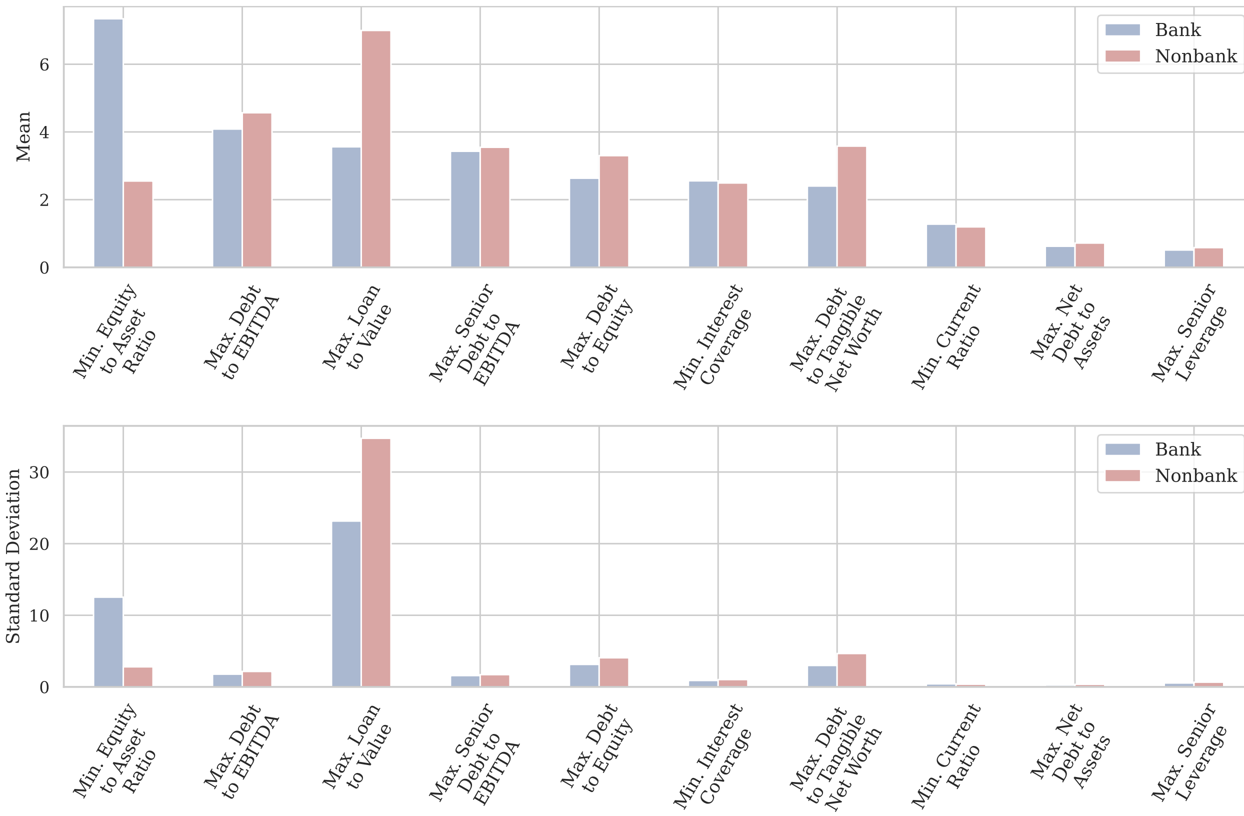


(b) 364-day Credit Facilities Extended by Banks to Non-Financial Corporates



Notes. This figure isolates credit risk from maturity risk by comparing 364-day bank credit facilities extended to NBLs and to non-financial firms. For NBLs (Panel a), the average drawn spread is 47.98 basis points (standard deviation = 48.94; N = 50,805), and the average undrawn spread is 93.19 basis points (standard deviation = 84.87; N = 4,810). For firms (Panel b), the average drawn spread is 76.86 basis points (standard deviation = 74.27; N = 58,746), and the average undrawn spread is 126.09 basis points (standard deviation = 114.7; N = 54,041).

Figure A.1.8: Covenant Differences between Bank-Originated and Nonbank-Originated Loans

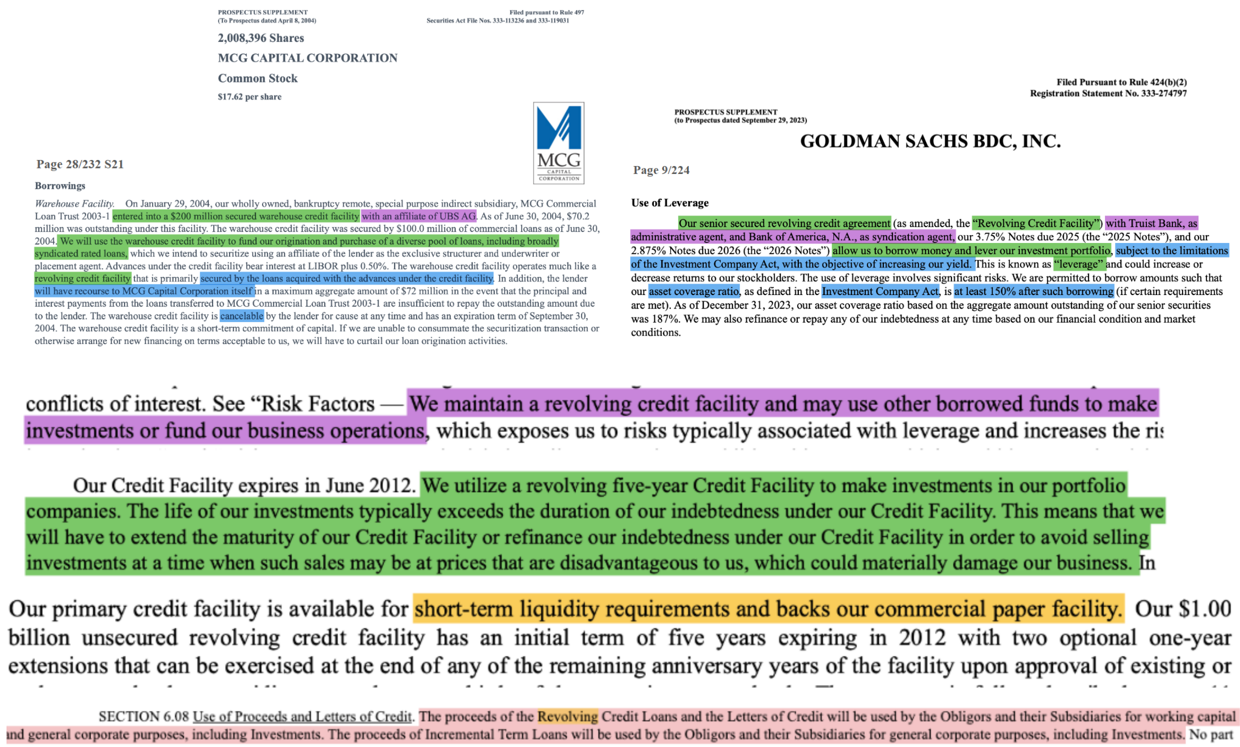


Notes. This figure reports the mean and standard deviation of loan covenant metrics, including minimum equity-to-asset ratio, maximum debt-to-EBITDA ratio, maximum loan-to-value ratio, maximum senior debt-to-EBITDA ratio, maximum debt-to-equity ratio, minimum interest coverage ratio, maximum debt-to-tangible-net-worth ratio, minimum current ratio, maximum net-debt-to-assets ratio, and maximum senior leverage. Blue bars represent covenants on loans originated by banks, and red bars represent those on loans originated by nonbanks.

A.2 Textual Evidence

Figure A.2.1 and Figure A.2.3 are additional textual evidence. Figure A.2.1 are illustrative screenshot examples of SEC prospectuses filed by NBLs. Figure A.2.3 are two word clouds are made from sentences that indicate investment opportunity (left) and liquidity support (right). Algorithm for Classification Using LLMs is implemented for a few-shot large language model (LLM) classifier (Wei et al., 2022).

Figure A.2.1: Illustrative Examples of SEC Prospectuses



PROSPECTUS SUPPLEMENT
(To Prospectus dated April 8, 2004)

Filed pursuant to Rule 497
Securities Act File Nos. 333-113236 and 333-119031

2,008,396 Shares

MCG CAPITAL CORPORATION

Common Stock

$17.62 per share

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Borrowings

Warehouse Facility. On January 29, 2004, our wholly owned, bankruptcy remote, special purpose indirect subsidiary, MCG Commercial Loan Trust 2003-1 entered into a $200 million secured warehouse credit facility with an affiliate of UBS AG. As of June 30, 2004, $70.2 million was outstanding under this facility. The warehouse credit facility was secured by $100.0 million of commercial loans as of June 30, 2004. We will use the warehouse credit facility to fund our origination and purchase of a diverse pool of loans, including broadly syndicated rated loans, which we intend to securitize using an affiliate of the lender as the exclusive structurer and underwriter or placement agent. Advances under the credit facility bear interest at LIBOR plus 0.50%. The warehouse credit facility operates much like a revolving credit facility that is primarily secured by the loans acquired with the advances under the credit facility. In addition, the lender will have recourse to MCG Capital Corporation itself in a maximum aggregate amount of $72 million in the event that the principal and interest payments from the loans transferred to MCG Commercial Loan Trust 2003-1 are insufficient to repay the outstanding amount due to the lender. The warehouse credit facility is cancelable by the lender for cause at any time and has an expiration term of September 30, 2004. The warehouse credit facility is a short-term commitment of capital. If we are unable to consummate the securitization transaction or otherwise arrange for new financing on terms acceptable to us, we will have to curtail our loan origination activities.

Filed Pursuant to Rule 424(b)(2)
Registration Statement No. 333-274797

PROSPECTUS SUPPLEMENT
(to Prospectus dated September 29, 2023)

GOLDMAN SACHS BDC, INC.

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Use of Leverage

Our senior secured revolving credit agreement (as amended, the "Revolving Credit Facility") with Truist Bank, as administrative agent, and Bank of America, N.A., as syndication agent, our 3.75% Notes due 2025 (the "2025 Notes"), and our 2.875% Notes due 2026 (the "2026 Notes") allow us to borrow money and lever our investment portfolio, subject to the limitations of the Investment Company Act, with the objective of increasing our yield. This is known as "leverage" and could increase or decrease returns to our stockholders. The use of leverage involves significant risks. We are permitted to borrow amounts such that our asset coverage ratio, as defined in the Investment Company Act, is at least 150% after such borrowing (if certain requirements are met). As of December 31, 2023, our asset coverage ratio based on the aggregate amount outstanding of our senior securities was 187%. We may also refinance or repay any of our indebtedness at any time based on our financial condition and market conditions.

conflicts of interest. See "Risk Factors — We maintain a revolving credit facility and may use other borrowed funds to make investments or fund our business operations, which exposes us to risks typically associated with leverage and increases the ris

Our Credit Facility expires in June 2012. We utilize a revolving five-year Credit Facility to make investments in our portfolio companies. The life of our investments typically exceeds the duration of our indebtedness under our Credit Facility. This means that we will have to extend the maturity of our Credit Facility or refinance our indebtedness under our Credit Facility in order to avoid selling investments at a time when such sales may be at prices that are disadvantageous to us, which could materially damage our business. In

Our primary credit facility is available for short-term liquidity requirements and backs our commercial paper facility. Our $1.00 billion unsecured revolving credit facility has an initial term of five years expiring in 2012 with two optional one-year extensions that can be exercised at the end of any of the remaining anniversary years of the facility upon approval of existing or

SECTION 6.08 Use of Proceeds and Letters of Credit. The proceeds of the Revolving Credit Loans and the Letters of Credit will be used by the Obligors and their Subsidiaries for working capital and general corporate purposes, including Investments. The proceeds of Incremental Term Loans will be used by the Obligors and their Subsidiaries for general corporate purposes, including Investments. No part

Notes. Highlighted passages in these screenshots illustrate evidence of investment opportunities and liquidity support. The full corpus of filings is systematically processed by the large language model described in the main text and in Algorithm for Classification Using LLMs.

Figure A.2.2: Word Clouds

Figure A.2.3: *Notes.* The two word clouds are constructed from sentences referencing investment opportunities (left) and liquidity support (right).

Algorithm for Classification Using LLMs

Require: Documents $D = \{d_1, d_2, \ldots, d_n\}$, Keywords $\mathcal{K}$, LLM θ

Ensure: Investment uncertainty classification for each company's document

- **for** document $d \in D$ **do**
  - **for** keyword $k \in \mathcal{K}$ **do**
    - **if** k in any sentence s of d **then**
      - Extract surrounding sentences $S_{\text{set}} = \{s_{-2}, s_{-1}, s, s_{+1}, s_{+2}\}$
      - **if** $\theta(S_{\text{set}}) = \text{YES}$ **then**
        - Mark company as YES for investment uncertainty
        - **break** from keyword loop
      - **end if**
    - **end if**
  - **end for**
  - **if** no match or all classified NO **then**
    - Mark company as NO for investment uncertainty
  - **end if**
- **end for**

B Model Appendix

B.1 Proof of Proposition 2

Proof. Aggregation to a representative bank and a representative NBL relies on three assumptions: (i) objectives are linear in idiosyncratic profit shocks $\epsilon^B_{t,i}$ and $\epsilon^N_{t,i}$; (ii) these shocks affect only contemporaneous payouts (not net worth); and (iii) any defaulting bank or NBL is replaced by a new entrant endowed with the same equity as a survivor.

Denote by $n^B_{t,i}$ ($n^N_{t,i}$) the beginning-of-period net worth of a non-defaulting bank (NBL) i, and let $\mathcal{S}_t = (Z_t,\, d_t,\, N^B_t,\, N^N_t,\, W^H_t,\, L_t)$ denote all aggregate state variables exogenous to the individual bank and NBL problem, including aggregate net worths. The recursive problem of a non-defaulting bank is:

$$
\begin{aligned}
V^B(n^B_{i,t}, \epsilon^B_{i,t}, \mathcal{S}_t) = & \max_{a^B_{i,t+1}, b^B_{i,t+1}, l_{i,t+1}, e^B_{i,t}} \phi^B_0 n^B_t - e^B_{i,t} + \epsilon^B_{i,t} \\
& + \mathrm{E}_t \left[\mathcal{M}^B_{t,t+1} \max \left\{ V^B(n^B_{i,t+1}, \epsilon^B_{i,t+1}, \mathcal{S}_{t+1}), 0 \right\} \right],
\end{aligned}
$$

subject to no-shorting constraint (3.13), budget constraint (3.10), capital requirement (3.12) and definition of bank net worth (3.9). Similarly, the recursive problem of a non-defaulting NBL is:

$$
\begin{aligned}
V^N(n^N_{i,t}, \epsilon^N_{i,t}, \iota_{i,t}, \mathcal{S}_t) = & \max_{a^N_{i,t+1}, b^N_{i,t+1}, l_{i,t+1}, e^N_{i,t}} \phi^N_0 n^N_t - e^N_{i,t} + \epsilon^N_{i,t} \\
& + \mathrm{E}_t \left[\mathcal{M}^N_{t,t+1} \max \left\{ V^N(n^N_{i,t+1}, \epsilon^N_{i,t+1}, \iota_{i,t+1}, \mathcal{S}_{t+1}), 0 \right\} \right],
\end{aligned}
$$

subject to no-shorting constraint (3.7) and budget constraint (3.6). Given linearity in $\epsilon^B_{i,t}, \epsilon^N_{i,t}$, define value functions net of idiosyncratic profit shocks: $\tilde{V}^B_t = V^B - \epsilon^B_{i,t}$, $\tilde{V}^N_t = V^N - \epsilon^N_{i,t}$, which yield:

$$
\begin{aligned}
\tilde{V}^B_t(n^B_{i,t}, \mathcal{S}_t) = & \max_{a^B_{i,t+1}, b^B_{i,t+1}, l_{i,t+1}, e^B_{i,t}} \phi^B_0 n^B_t - e^B_{i,t} \\
& + \mathrm{E}_t \left[\mathcal{M}^B_{t,t+1} \max \left\{ \tilde{V}^B_{t+1}(n^B_{i,t+1}, \mathcal{S}_{t+1}) + \epsilon^B_{i,t+1}, 0 \right\} \right], \\
\tilde{V}^N_t(n^N_{i,t}, \iota_{i,t}, \mathcal{S}_t) = & \max_{a^N_{i,t+1}, b^N_{i,t+1}, l_{i,t+1}, e^N_{i,t}} \phi^N_0 n^N_t - e^N_{i,t} \\
& + \mathrm{E}_t \left[\mathcal{M}^N_{t,t+1} \max \left\{ \tilde{V}^N_{t+1}(n^N_{i,t+1}, \iota_{i,t+1}, \mathcal{S}_{t+1}) + \epsilon^N_{i,t+1}, 0 \right\} \right],
\end{aligned}
$$

subject to the same set of constraints as before. Thus, with identical state variables, all banks (NBLs) choose the same optimal controls irrespective of idiosyncratic shocks, which—by assumption (ii)—do not alter aggregate net worth. Absent defaults, each nondefaulting bank (NBL) enters period $t+1$ with equity N^B_t (N^N_t). Any defaulting institution is immediately replaced by a newcomer endowed with the same equity, restoring full homogeneity each period. Hence, aggregation holds and one need only solve the representative bank and the representative NBL problem.

Regarding drawdown aggregation, we start from an individual NBL, whose drawdown is characterized by $c_{t,\iota_t} = \min(\iota_t, l_t)$. Since idiosyncratic inventory uncertainty shocks are i.i.d. across NBLs, we can write total drawdown across all NBL credit lines:

$$
C(L_t) = \int_0^\infty \min(\iota, l_t) dF(\iota) = \int_0^{l_t} \iota dF(\iota) + \int_{l_t}^\infty l_t dF(\iota), \tag{B.1}
$$

□

B.2 Nonbank Lenders (NBLs)

B.2.1 Optimization Problem

Let N_t^N denote aggregate NBL net worth after defaults and recapitalizations. At the end of each period, they solve the optimization problem in equation (3.8) in the main text:

$$V\left(\mathcal{S}_t^N, N_t^N\right) = \max_{A_{t+1}^N, B_{t+1}^N, L_{t+1}, e_t^N} \phi_0^N N_t^N - e_t^N$$
$$+\epsilon_t^N + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \max\{\tilde{V}_{t+1}^N\left(\mathcal{S}_{t+1}^N, N_{t+1}^N\right) + \epsilon_{t+1}^N, 0\}\right],$$

subject to

$$q_t A_{t+1}^N + q_t^L L_{t+1} \leq (1-\phi_0^N) N_t^N + e_t^N - \Psi^N\left(e_t^N\right) + q_t^r(A_{t+1}^N, B_{t+1}^N, L_{t+1}; \mathcal{S}_t) B_{t+1}^N, \tag{B.2}$$
$$0 \leq A_{t+1}^N, \tag{B.3}$$
$$0 \leq L_{t+1}, \tag{B.4}$$

and the evolution of NBL net worth

$$N_t^N = \mathscr{P}_t^A[A_t^N + C(L_t)] - R_t^C C(L_t) - B_t^N. \tag{B.5}$$

B.2.2 First-order Conditions

Attach Lagrange multiplier ν_t^N to budget constraint (B.2), μ_t^N to NBL no-shorting constraint on loans (B.3), and $\mu_{t,L}^N$ to NBL no-shorting constraint on credit limit (B.4). Denote $\tilde{V}_{N,t}^N = \partial \tilde{V}_t^N / \partial N_t^N$.

Equity Issuance. Differentiating the objective function with respect to e_t^N: $\nu_t^N\left(1-\phi_1^N e_t^N\right) = 1$,

NBL Loan Origination. The FOC for NBL loans A_{t+1}^N is

$$\left(q_t - \frac{\partial q_t^r}{\partial A_{t+1}^N} B_{t+1}^N\right)\nu_t^N = \mu_t^N + \mathrm{E}\left[\mathcal{M}_{t,t+1}\tilde{V}_{N,t+1}^N\left(1-F_{\epsilon,t+1}^N\right)\mathscr{P}_{t+1}^A\right],$$

NBL Commerical Paper Debt. The FOC for NBL commericial paper debt B_{t+1}^N is

$$\left(q_t^r + \frac{\partial q_t^r}{\partial B_{t+1}^N} B_{t+1}^N\right)\nu_t^N = \mathrm{E}\left[\mathcal{M}_{t,t+1}\tilde{V}_{N,t+1}^N\left(1-F_{\epsilon,t+1}^N\right)\right],$$

Credit Limit. The FOC for credit limit L_{t+1} is

$$\left(q_t^L - \frac{\partial q_t^r}{\partial L_{t+1}} B_{t+1}^N\right) \nu_t^N = \mu_{t,L}^N + \mathrm{E}\left[\mathcal{M}_{t,t+1} \tilde{V}_{N,t+1}^N \left(1 - F_{\epsilon,t+1}^N\right) \left(\mathscr{P}_{t+1}^A - R_{t+1}^C\right) \frac{\partial c(L_{t+1})}{\partial L_{t+1}}\right],$$

where $\frac{\partial c(L_t)}{\partial L_t}$ is specified in equation (4.4) in the main text.

B.2.3 Euler Equations

Combining the envelope condition $\tilde{V}_{N,t}^N = \phi_0^N + \left(1 - \phi_0^N\right) \nu_t^N$ with the FOC for equity issuance above yields $\tilde{V}_{N,t}^N = \phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_t^N}$. Define the stochastic discount factor of NBL as:

$$\mathcal{M}_{t,t+1}^N \equiv \mathcal{M}_{t,t+1} \left(1 - \phi_1^N e_t^N\right) \left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right) \left(1 - F_{\epsilon,t+1}^N\right) \tag{B.6}$$

I can organize the FOCs as:

$$q_t - \frac{\partial q_t^r}{\partial A_{t+1}^N} B_{t+1}^N = \tilde{\mu}_t^N + \mathrm{E}\left[\mathcal{M}_{t,t+1}^N \mathscr{P}_{t+1}^A\right], \tag{B.7}$$

$$q_t^r + \frac{\partial q_t^r}{\partial B_{t+1}^N} B_{t+1}^N = \mathrm{E}\left[\mathcal{M}_{t,t+1}^N\right], \tag{B.8}$$

$$q_t^L - \frac{\partial q_t^r}{\partial L_{t+1}} B_{t+1}^N = \tilde{\mu}_{t,L}^N + \mathrm{E}\left[\mathcal{M}_{t,t+1}^N \left(\mathscr{P}_{t+1}^A - R_{t+1}^C\right) \frac{\partial C(L_{t+1})}{\partial L_{t+1}}\right], \tag{B.9}$$

where I define $\tilde{\mu}_t^N \equiv \mu_t^N / \nu_t^N$ and $\tilde{\mu}_{t,L}^N \equiv \mu_{t,L}^N / \nu_t^N$.

B.3 Banks

B.3.1 Proof of Proposition 1

Proof. By the book-value balance-sheet identity at $t+1$, $e_{t+1}^{B,\text{tot}} = a_{t+1}^B + c_{t+1} - d_{t+1}$. Impose the requirement (3.11) and solve for d_{t+1}:

$$\begin{aligned} d_{t+1} &\leq a_{t+1}^B + c_{t+1} - \xi^E \Big(a_{t+1}^B + \omega_{\text{drawn}}^{CCF}\ \mathrm{E}[c(l_{t+1})] + \omega_{\text{undrawn}}^{CCF} \Big(l_{t+1} - \mathrm{E}[c(l_{t+1})]\Big)\Big) \\ &= \left(1 - \xi^E\right) A_{t+1}^B + \left(1 - \xi^E \omega_{\text{drawn}}^{CCF}\right)\ \mathrm{E}[c(l_{t+1})] - \xi^E \omega_{\text{undrawn}}^{CCF} \Big(l_{t+1} - \mathrm{E}[c(l_{t+1})]\Big) \\ &\equiv \xi \Big(a_{t+1}^B + \omega^C\ \mathrm{E}[c(l_{t+1})] + \omega^U \Big(l_{t+1} - \mathrm{E}[c(l_{t+1})]\Big)\Big), \end{aligned} \tag{B.10}$$

Collect terms, set $\xi \equiv 1 - \xi^E$, $\omega^C \equiv (1 - \xi^E \omega^{CCF}_{\text{drawn}})/\xi$, $\omega^U \equiv -\xi^E \omega^{CCF}_{\text{undrawn}}/\xi$ to obtain (3.12). Finally, since $\xi^E \in (0,1)$ and $\omega^{CCF}_{\text{drawn}} \in [0,1]$, we have $\omega^C > 0$; likewise $\omega^{CCF}_{\text{undrawn}} \geq 0$ implies $\omega^U < 0$. Thus the equity requirement and the deposit ceiling are equivalent characterizations of the feasible set. □

B.3.2 Optimization Problem

Let N^N_t denote aggregate bank net worth after defaults and recapitalizations; at each period's end, they solve the optimization problem in equation (3.14) in the main text:

$$V^B(\mathcal{S}_t) = \max_{A^B_{t+1}, D_{t+1}, L_{t+1}, e^B_t} \phi^B_0 N^B_t - e^B_t + \epsilon^B_t + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \max\{V^B(\mathcal{S}_{t+1}), 0\}\right] \ ,$$

subject to

$$q_t A^B_{t+1} - \left(q^f_t - \kappa\right) D_{t+1} \leq (1-\phi^B_0) N^B_t + q^L_t(L_{t+1}; \mathcal{S}_t) L_{t+1} + e^B_t - \Psi^B\left(e^B_t\right), \tag{B.11}$$

$$D_{t+1} \leq \xi\big(A^B_{t+1} + \omega^C \mathrm{E}[C(L_{t+1})] + \omega^U \left(L_{t+1} - \mathrm{E}[C(L_{t+1})]\right)\big), \tag{B.12}$$

$$0 \leq A^B_{t+1}, \tag{B.13}$$

and the evolution of bank net worth

$$N^B_t = \mathscr{P}^A_t A^B_t - D_t + \mathcal{P}^L_t C(L_t) - C(L_t). \tag{B.14}$$

B.3.3 First-Order Conditions

Attach Lagrange multipliers ν^B_t to the budget constraint (B.11), λ^B_t to the bank capital requirement (B.12), and μ^B_t to the no-shorting constraint on bank loans (B.13). Denote $\tilde{V}^B_{N,t} = \frac{\partial \tilde{V}^B_t}{\partial N^B_t}$.

Equity Issuance. Differentiating the objective function with respect to e^B_t: $\nu^B_t\left(1 - \phi^B_1 e^B_t\right) = 1$,

Bank Loan Origination. The FOC for bank loans A^B_{t+1}

$$q_t \nu^B_t = \lambda^B_t \xi + \mu^B_t + \mathrm{E}\left[\mathcal{M}_{t,t+1} \tilde{V}^B_{N,t+1} \mathscr{P}^A_{t+1}\right] \ ,$$

Deposits. The FOC for deposits D_{t+1}

$$\left(q_t^f - \kappa\right)\nu_t^B = \lambda_t^B + \mathrm{E}\left[\mathcal{M}_{t,t+1}\tilde{V}_{N,t+1}^B\right] \ ,$$

Credit Limit. The FOC for credit limit L_{t+1} is

$$\begin{aligned}&\nu_t^B\left(q_t^L + \tfrac{\partial q_t^L}{\partial L_{t+1}}L_{t+1}\right) + \lambda_t^B\xi\left(\omega^C\tfrac{\partial \mathrm{E}[C(L_{t+1})]}{\partial L_{t+1}} + \omega^U\left(1 - \tfrac{\partial \mathrm{E}[C(L_{t+1})]}{\partial L_{t+1}}\right)\right)\\ =&\mathrm{E}\left[\mathcal{M}_{t,t+1}\tilde{V}_{N,t+1}^B\tfrac{\partial}{\partial L_{t+1}}\left[\left(1 - \mathscr{P}_{t+1}^L\right)C(L_{t+1})\right]\right] \ .\end{aligned}$$

Because C is increasing, concave and 1-Lipschitz,[22] we can write $\frac{\partial}{\partial L_{t+1}}\mathrm{E}\left[C(L_{t+1})\right] = \mathrm{E}\left[\frac{\partial C(L_{t+1})}{\partial L_{t+1}}\right]$.

B.3.4 Euler Equations

Combining the envelope condition $V_{N,t}^B = \phi_0^B + \left(1 - \phi_0^B\right)\nu_t^B$ with the FOC for equity issuance above yields $V_{N,t}^B = \phi_0^B + \frac{1-\phi_0^B}{1-\phi_1^B e_t^B}$. Define the stochastic discount factor of bank as

$$\mathcal{M}_{t,t+1}^B \equiv \mathcal{M}_{t,t+1}\left(1 - \phi_1^B e_t^B\right)\left(\phi_0^B + \tfrac{1-\phi_0^B}{1-\phi_1^B e_{t+1}^B}\right)\left(1 - F_{\epsilon,t+1}^B\right) \tag{B.15}$$

I can organize the FOCs as:

$$q_t = \tilde{\lambda}_t^B\xi + \tilde{\mu}_t^B + \mathrm{E}\left[\mathcal{M}_{t,t+1}^B\mathscr{P}_{t+1}^A\right] \ , \tag{B.16}$$

$$q_t^f - \kappa = \tilde{\lambda}_t^B + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^B\right] \ , \tag{B.17}$$

$$\begin{aligned}&q_t^L + \tfrac{\partial q_t^L}{\partial L_{t+1}}L_{t+1} + \tilde{\lambda}_t^B\xi\left(\omega^C(1 - \mathrm{E}[F(L_{t+1})]) + \omega^U\mathrm{E}[F(L_{t+1})]\right)\\ =&\mathrm{E}_t\left[\mathcal{M}_{t,t+1}^B\left((1 - F(L_{t+1}))\left(1 - \mathscr{P}_{t+1}^L\right) - C(L_{t+1})\tfrac{\partial \mathscr{P}_{t+1}^L}{\partial L_{t+1}}\right)\right] \ ,\end{aligned} \tag{B.18}$$

where I define $\tilde{\mu}_t^B \equiv \mu_t^B/\nu_t^B$ and $\tilde{\lambda}_t^B \equiv \lambda_t^N/\nu_t^B$, the full expression of $\partial q_t^L/\partial L_{t+1}$ is in equation (4.6) in the main text, and $\partial\mathscr{P}_{t+1}^L/\partial L_{t+1}$ is derived below in equation (B.21).

[22] Formally, the interchange is valid under mild conditions: (i) $\mathrm{E}[L_{t+1}] < \infty$, which ensures $\mathrm{E}[C(L_{t+1})] < \infty$ since $C(l) \leq l$; (ii) $C'(l)$ exists almost everywhere with $|C'(l)| \leq 1$, so dominated convergence applies; and (iii) at points where the distribution F of ι has atoms, the identity holds for one-sided derivatives or any measurable subgradient $\partial C(l) = [\,1 - F(l),\, 1 - F(l^-)\,]$.

B.3.5 Partial Derivative of $\mathscr{P}^L_{t+1}$ with respect to L_{t+1}.

$$\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}} = \left(RV^N - R^C_{t+1}\right)\frac{\partial F^N_{\epsilon,t+1}}{\partial L_{t+1}} + F^N_{\epsilon,t+1}\frac{\partial RV^N}{\partial L_{t+1}} + \frac{\partial}{\partial L_{t+1}}\left(\frac{F^N_{\epsilon,t+1}\epsilon^{N,-}_{t+1}}{B^N_{t+1}+c(L_{t+1})}\right)$$

First I compute

$$\frac{\partial RV^N}{\partial L_{t+1}} = \left(1-\zeta^N\right)\mathscr{P}^A_{t+1}\frac{\partial C(L_{t+1})}{\partial L_{t+1}}\frac{B^N_{t+1}-A^N_{t+1}}{((B^N_{t+1}+C(L_{t+1}))^2}.$$

Then using Leibniz rule,

$$\begin{aligned}\frac{\partial F^N_{\epsilon,t+1}}{\partial L_{t+1}} &= \frac{\partial}{\partial L_{t+1}}\int_{-\infty}^{-\tilde{V}^N_{t+1}} f^N_{\epsilon,t+1}d\epsilon = -f^N_\epsilon\left(-\tilde{V}^N_{t+1}\right)\frac{\partial \tilde{V}^N_{t+1}}{\partial N^N_{t+1}}\frac{\partial N^N_{t+1}}{\partial L_{t+1}} \\ &= -f^N_\epsilon\left(-\tilde{V}^N_{t+1}\right)\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right)\frac{\partial C(L_{t+1})}{\partial L_{t+1}}. \end{aligned} \tag{B.19}$$

Similarly,

$$\begin{aligned}\frac{\partial\left(\epsilon^{N,-}_{t+1}F_{\epsilon,t+1}\right)}{\partial L_{t+1}} &= \frac{\partial}{\partial L_{t+1}}\int_{-\infty}^{-\tilde{V}^N_{t+1}} \epsilon^N_{t+1} f^N_{\epsilon,t+1}d\epsilon = \frac{\partial\left(-\tilde{V}^N_{t+1}\right)}{\partial N^N_{t+1}}\frac{\partial N^N_{t+1}}{\partial L_{t+1}}\left(-\tilde{V}^N_{t+1}\right) f^N_\epsilon\left(-\tilde{V}^N_{t+1}\right) \\ &= f^N_\epsilon\left(-\tilde{V}^N_{t+1}\right)\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\tilde{V}^N_{t+1}\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right)\frac{\partial C(L_{t+1})}{\partial L_{t+1}}. \end{aligned} \tag{B.20}$$

Therefore,

$$\frac{\partial}{\partial L_{t+1}}\left(\frac{F^N_{\epsilon,t+1}\epsilon^{N,-}_{t+1}}{B^N_{t+1}+c(L_{t+1})}\right) = \frac{\frac{\partial\left(\epsilon^{N,-}_{t+1}F_{\epsilon,t+1}\right)}{\partial L_{t+1}}\left(B^N_{t+1}+C(L_{t+1})\right) - \epsilon^{N,-}_{t+1}F_{\epsilon,t+1}\frac{\partial C(L_{t+1})}{\partial L_{t+1}}}{\left(B^N_{t+1}+C(L_{t+1})\right)^2}.$$

Plugging each item in, we have:

$$\begin{aligned}\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}} = \frac{\partial C(L_{t+1})}{\partial L_{t+1}}\Bigg\{ &\left(R^C_{t+1} - RV^N_{t+1}\right) f^N_{\epsilon,t+1}\left(-\tilde{V}^N_{t+1}\right)\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right) \\ &+ F^N_{\epsilon,t+1}\left(1-\zeta^N\right)\mathscr{P}^A_{t+1}\frac{B^N_{t+1}-A^N_{t+1}}{\left(B^N_{t+1}+c(L_{t+1})\right)^2} \\ &+ \frac{f^N_{\epsilon,t+1}\left(-\tilde{V}^N_{t+1}\right)\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\tilde{V}^N_{t+1}\left(\mathscr{R}^A_{t+1} - R^C_{t+1}\right)\left(B^N_{t+1}+c(L_{t+1})\right) - \epsilon^{N,-}_{t+1}F^N_{\epsilon,t+1}}{\left(B^N_{t+1}+c(L_{t+1})\right)^2}\Bigg\}. \end{aligned} \tag{B.21}$$

B.3.6 Proof of Lemma 1

Lemma 1 (When the payoff on the credit-line *falls* in the limit)**.** *Let*

$$\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}} = \frac{\partial C(L_{t+1})}{\partial L_{t+1}}\big[\mathcal{T}_1 + \mathcal{T}_2 + \mathcal{T}_3\big], \qquad \frac{\partial C(L_{t+1})}{\partial L_{t+1}} > 0,$$

with

$$\mathcal{T}_1 = -\big(RV^N - R^C_{t+1}\big)\, f^N_{\epsilon,t+1}(-\tilde{V}^N)\Big(\phi^N_0 + \tfrac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\Big)\big(\mathscr{P}^A_{t+1} - R^C_{t+1}\big),$$

$$\mathcal{T}_2 = F^N_{\epsilon,t+1}\,(1-\zeta^N)\,\mathscr{P}^A_{t+1}\,\tfrac{B^N_{t+1} - A^N_{t+1}}{(B^N_{t+1} + C(L_{t+1}))^2},$$

$$\mathcal{T}_3 = \frac{f^N_{\epsilon,t+1}(-\tilde{V}^N)\Big(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\Big)\tilde{V}^N\Big(\mathscr{P}^A_{t+1} - R^C_{t+1}\Big)(B^N_{t+1} + C(L_{t+1})) - \epsilon^{N,-}_{t+1} F^N_{\epsilon,t+1}}{(B^N_{t+1} + C(L_{t+1}))^2}.$$

Then

$$\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}} < 0 \quad \Longleftarrow \quad \Big[\mathscr{P}^A_{t+1} < R^C_{t+1}\Big] \wedge \Big[B^N_{t+1} \leq A^N_{t+1}\Big]$$

and, more generally,

$$\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}} < 0 \quad \Longleftrightarrow \quad \mathcal{T}_2 < -\big(\mathcal{T}_1 + \mathcal{T}_3\big).$$

Proof. Since $R^C_{t+1} > RV^N, f^N_{\epsilon,t+1} > 0, 0 < F^N_{\epsilon,t+1} < 1, \epsilon^{N,-}_{t+1} > 0$, we observe that

$$\begin{aligned} \text{sign}\big(\mathcal{T}_1\big) &= \text{sign}\big(\mathscr{P}^A_{t+1} - R^C_{t+1}\big), \\ \text{sign}\big(\mathcal{T}_2\big) &= \text{sign}\big(B^N_{t+1} - A^N_{t+1}\big). \end{aligned}$$

Let us write

$$\mathcal{T}_3 = (X - \epsilon^{N,-}_{t+1} F^N_{\epsilon,t+1})/(B^N_{t+1} + c)^2$$

with

$$X = f^N_{\epsilon,t+1}(-\tilde{V}^N)\Big(\phi^N_0 + \tfrac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\Big)\tilde{V}^N\big(\mathscr{P}^A_{t+1} - R^C_{t+1}\big)\big(B^N_{t+1} + C(L_{t+1})\big).$$

Since the denominator is positive,

$$\operatorname{sign}(\mathcal{T}_3) = \operatorname{sign}(X - \epsilon_{t+1}^{N,-} F_{\epsilon,t+1}^{N}).$$

If $\mathscr{P}_{t+1}^{A} < R_{t+1}^{C}$, then $X < 0$, so $\mathcal{T}_3 < 0$ *regardless* of the size of $\epsilon_{t+1}^{N,-} F_{\epsilon,t+1}^{N}$. If $\mathscr{P}_{t+1}^{A} > R_{t+1}^{C}$, then the sign of $\mathcal{T}_3$ flips when $\epsilon_{t+1}^{N,-} F_{\epsilon,t+1}^{N} = X$. Therefore, under the joint conditions $\mathscr{P}_{t+1}^{A} < R_{t+1}^{C}$ and $B_{t+1}^{N} \leq A_{t+1}^{N}$, we have $\mathcal{T}_1 < 0, \mathcal{T}_2 \leq 0, \mathcal{T}_3 < 0$ so their sum is negative. Because $\partial c_{t+1}/\partial L_{t+1} > 0$, the derivative itself is negative. □

B.3.7 Proof of Proposition 4

Proof. From the first order equation in the main text (4.5), define the normalized SDF and the Q measure

$$\widehat{\mathcal{M}}_{t,t+1}^{B} \equiv \frac{\mathcal{M}_{t,t+1}^{B}}{\mathrm{E}_t\left[\mathcal{M}_{t,t+1}^{B}\right]}, \qquad \frac{dQ}{dP}\Big|_{\mathcal{F}_{t+1}} = \widehat{\mathcal{M}}_{t,t+1}^{B}$$

Then

$$\begin{aligned}
&\mathrm{E}_t\left[\mathcal{M}_{t,t+1}^{B} \tfrac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}_{t+1}^{L}-1\right) C\left(L_{t+1}\right)\right)\right] \\
=&\mathrm{E}_t\left[\mathcal{M}_{t,t+1}^{B}\right] \mathrm{E}_t^{Q}\left[\tfrac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}_{t+1}^{L}-1\right) C\left(L_{t+1}\right)\right)\right] \\
=&\mathrm{E}_t\left[\mathcal{M}_{t,t+1}^{B}\right]\Bigg(\underbrace{\mathrm{E}_t\left[\tfrac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}_{t+1}^{L}-1\right) C\left(L_{t+1}\right)\right)\right]}_{\text{average marginal benefit}} \\
&+\underbrace{\mathrm{Cov}_t\left(\widehat{\mathcal{M}}_{t,t+1}^{B}, \tfrac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}_{t+1}^{L}-1\right) C\left(L_{t+1}\right)\right)\right)}_{\text{bad-state cost}}\Bigg)
\end{aligned}$$

The first term is on average how raising L changes $\left(\mathscr{P}^{L}-1\right) C$. The second term is bad-time cost. Now, let's sign $\frac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}_{t+1}^{L}-1\right) C\left(L_{t+1}\right)\right)$ in the bad states when $\widehat{\mathcal{M}}^{B}$ is high.

$$\tfrac{\partial}{\partial L_{t+1}}\left(\left(\mathscr{P}_{t+1}^{L}-1\right) C\left(L_{t+1}\right)\right) = \underbrace{C\left(L_{t+1}\right) \frac{\partial \mathscr{P}_{t+1}^{L}}{\partial L_{t+1}}}_{\text{repayment effect}} + \underbrace{\left(\mathscr{P}_{t+1}^{L}-1\right) \frac{\partial C\left(L_{t+1}\right)}{\partial L_{t+1}}}_{\text{utilization effect}}.$$

Under Lemma 1, we know that if $\mathscr{P}^A_{t+1} < R^C_{t+1}$ and $B^N_{t+1} \leq A^N_{t+1}$, then $\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}} < 0$. Keep that as our baseline sign for the repayment effect. There are a few cases.

1. Case A ($\iota_{t+1} < L_{t+1}$). In this case, $\frac{\partial C}{\partial L} = 0, C\left(L_{t+1}\right) = \iota_{t+1}$. Therefore,

$$\tfrac{\partial}{\partial L_{t+1}} \left(\left(\mathscr{P}^L_{t+1} - 1\right) C\left(L_{t+1}\right)\right) = \iota_{t+1} \frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}}.$$

   Under our baseline $\left(\frac{\partial \mathscr{P}^L}{\partial L} < 0\right)$, when drawdown is slack, the only margin is repayment risk: raising the limit lowers the marginal payoff.

2. Case B ($\iota_{t+1} \geq L_{t+1}$).

$$\frac{\partial}{\partial L_{t+1}} \left(\left(\mathscr{P}^L_{t+1} - 1\right) C\left(L_{t+1}\right)\right) = L_{t+1} \frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}} + \left(\mathscr{P}^L_{t+1} - 1\right).$$

   With $\frac{\partial \mathscr{P}^L}{\partial L} < 0$, a sufficient condition for $\frac{\partial}{\partial L_{t+1}} \left(\left(\mathscr{P}^L_{t+1} - 1\right) C\left(L_{t+1}\right)\right) < 0$ is

$$\mathscr{P}^L_{t+1} - 1 \leq -L_{t+1} \frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}},$$

   Using the formula in equation (B.21), $\partial \mathscr{P}^L / \partial L = \frac{\partial c}{\partial L} \left[\mathcal{T}_1 + \mathcal{T}_2 + \mathcal{T}_3\right]$ with $[\cdot] \leq -\kappa < 0$, we can write the condition as $\mathscr{P}^L_{t+1} - 1 \leq L_{t+1} \frac{\partial c}{\partial L} \kappa$, i.e., the negative repayment effect dominates the "more likely to draw" benefit. Intuitively, when the net payoff $\mathscr{P}^L - 1$ is small, or when the marginal default sensitivity $\left|\frac{\partial \mathscr{P}^L}{\partial L}\right|$ is large, the derivative is negative.

Therefore, the covariance term $\mathrm{Cov}_t \left(\widehat{\mathcal{M}}^B_{t,t+1}, \frac{\partial}{\partial L_{t+1}} \left(\left(\mathscr{P}^L_{t+1} - 1\right) C\left(L_{t+1}\right)\right)\right)$ is more negative during aggregate bad states. $\square$

B.4 Households

B.4.1 The Optimization Problem

The problem of the representative household is

$$V^H\left(W_t^H, \mathcal{S}_t\right) = \max_{C_t^H, D_{t+1}^H, B_{t+1}^H} \left\{ (1-\beta_H)\left(u_t^H\right)^{1-1/\nu_H} + \beta_H \left(\mathrm{E}_t \left[\left(V^H\left(W_{t+1}^H; \mathcal{S}_{t+1}\right)\right)^{1-\sigma_H} \right] \right)^{\frac{1-1/\nu_H}{1-\sigma_H}} \right\}^{\frac{1}{1-1/\nu_H}}$$

subject to

$$C_t^H = W_t^H + Y_t - q_t^f D_{t+1}^H - q_t^r B_{t+1}^H + O_t \tag{B.22}$$

$$W_t^H = D_t^H + Div_t^B + Div_t^N + B_t^H \mathscr{P}_t^B. \tag{B.23}$$

Rebate to household is $O_t = q_t^A \mathcal{I}_{t+1} - \mathscr{P}_t^A \mathcal{I}_t - c_t\big(\mathscr{P}_t^A - 1\big) = q_t^A \mathcal{I}_{t+1} - \big[\mathscr{P}_t^A(\mathcal{I}_t - c_t) + c_t\big]$, where $q_t^A \mathcal{I}_{t+1}$ is the expense of funding new loans at price q_t^A, $\mathscr{P}_t^A \mathcal{I}_t$ is the payoff on last period's loan investment $\mathcal{I}_t$, and $c_t(\mathscr{P}_t^A - 1)$ captures the immediate net gain from committed credit lines. Equivalently, $\mathcal{I}_t - c_t$ measures the residual loan demand that NBLs cannot satisfy due to credit limits and thus must offload to households. Denote the value function of household as $V_t^H \equiv V_t^H\left(W_t^H, \mathcal{S}_t\right)$, and the marginal value of wealth is $V_{W,t}^H \equiv \frac{\partial V_t^H\left(W_t^H, \mathcal{S}_t\right)}{\partial W_t^H}$. Then, I define the certainty equivalent of future utility as $CE_t^H = \mathrm{E}_t\left[\left(V_{t+1}^H\right)^{1-\sigma_H}\right]^{\frac{1}{1-\sigma_H}}$.

B.4.2 First-Order Conditions

Deposits. The FOC for bank deposits D_{t+1}^H

$$\left(V_t^H\right)^{1/\nu_H}(1-\beta_H)\frac{\left(u_t^H\right)^{1-1/\nu_H}}{C_t^H}\left((1-\varsigma)\, q_t^f - \varsigma\theta \frac{C_t^H}{D_{t+1}^H}\right)$$
$$= \left(V_t^H\right)^{1/\nu_H} \beta_H \left(CE_t^H\right)^{\sigma_H - 1/\nu_H} \mathrm{E}\left[\left(V_{t+1}^H\right)^{-\sigma_H} V_{W,t+1}^H\right].$$

NBL Commerical Paper. The FOC for NBL commercial paper B^H_{t+1} is

$$\begin{aligned}&\left(V_t^H\right)^{1/\nu_H}(1-\beta_H)\frac{\left(u_t^H\right)^{1-1/\nu_H}}{C_t^H}\left((1-\varsigma)\,q_t^r-(1-\theta)\,\varsigma\frac{C_t^H}{B_{t+1}^H}\right)\\ &=\left(V_t^H\right)^{1/\nu_H}\beta_H\left(CE_t^H\right)^{\sigma_H-1/\nu_H}\mathrm{E}\Bigg\{\left(V_{t+1}^H\right)^{-\sigma_H}V_{W,t+1}^H\Bigg[1-F_{\epsilon,t+1}^N\\ &+F_{\epsilon,t+1}^N\left((1-\zeta^N)\frac{\mathscr{P}_{t+1}^A(A_{t+1}^N+C(L_{t+1}))}{B_{t+1}^N+C(L_{t+1})}\right)\frac{F_{\epsilon,t}^N\epsilon_t^{N,-}}{B_{t+1}^N+C(L_{t+1})}\Bigg]\Bigg\}.\end{aligned}$$

B.4.3 Marginal Values of State Variables and SDF

The marginal value of saver wealth is

$$V_{W,t+1}^H=\left(V_{t+1}^H\right)^{\frac{1}{\nu_H}}(1-\beta_H)\frac{\left(u_{t+1}^H\right)^{1-1/\nu_H}}{C_{t+1}^H}(1-\varsigma).$$

Define the household stochastic discount factor (SDF) from t to $t+1$ as:

$$\mathcal{M}_{t,t+1}\equiv\beta_H\left(\frac{C_{t+1}^H}{C_t}\right)^{-1}\left(\frac{u_{t+1}^H}{u_t^H}\right)^{1-1/\nu_H}\left(\frac{V_{t+1}^H}{CE_t^H}\right)^{1/\nu_H-\sigma_H}\tag{B.24}$$

B.4.4 Euler Equations

$$q_t^f=\mathrm{E}_t\left[\mathcal{M}_{t,t+1}\right]+\frac{\theta\varsigma C_t^H}{(1-\varsigma)D_{t+1}^H},\tag{B.25}$$

$$q_t^r=\frac{(1-\theta)\varsigma C_t^H}{(1-\varsigma)B_{t+1}^H}+\mathrm{E}_t\left\{\mathcal{M}_{t,t+1}\left[1-F_{\epsilon,t+1}^N+\frac{F_{\epsilon,t+1}^N\left((1-\zeta^N)\mathscr{P}_{t+1}^A(A_{t+1}^N+C(L_{t+1}))+\epsilon_{t+1}^{N,-}\right)}{B_{t+1}^N+C(L_{t+1})}\right]\right\}.\tag{B.26}$$

B.4.5 Partial Derivatives

Define

$$\mathcal{A}_{t+1}^H\equiv(1-\zeta^N)\,\mathscr{P}_{t+1}^A\,\frac{A_{t+1}^N+C(L_{t+1})}{B_{t+1}^N+C(L_{t+1})},\tag{B.27}$$

and

$$\mathcal{B}_{t+1}^H.\equiv\frac{\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}^N}{B_{t+1}^N+C(L_{t+1})}\tag{B.28}$$

Derivative of q_t^r with respect to A_{t+1}^N. We would like to evaluate:

$$\frac{\partial q_t^r}{\partial A_{t+1}^N} = \mathrm{E}_t \left\{ \mathcal{M}_{t,t+1} \left[\left(\mathcal{A}_{t+1}^H - 1 \right) \frac{\partial F_{\epsilon,t+1}^N}{\partial A_{t+1}^N} + \frac{\partial \mathcal{A}_{t+1}^H}{\partial A_{t+1}^N} F_{\epsilon,t+1}^N + \frac{\partial \mathcal{B}_{t+1}^H}{\partial A_{t+1}^N} \right] \right\} \tag{B.29}$$

First, the derivative of $\mathcal{A}_{t+1}^H$ with respect to A_{t+1}^N is

$$\frac{\partial \mathcal{A}_{t+1}^H}{\partial A_{t+1}^N} = (1-\zeta^N) \frac{\mathscr{P}_{t+1}^A}{B_{t+1}^N + C(L_{t+1})}.$$

Then, using Leibniz rule and the same technique applied in deriving $\partial F_{\epsilon,t+1}^N / \partial L_{t+1}$ in equation (B.19), we have:

$$\frac{\partial F_{\epsilon,t+1}^N}{A_{t+1}^N} = -f_{\epsilon,t+1}^N(-\tilde{V}_{t+1}^N) \frac{\partial \tilde{V}_{t+1}^N}{\partial N_{t+1}^N} \frac{\partial N_{t+1}^N}{\partial A_{t+1}^N} = -f_{\epsilon,t+1}^N(-\tilde{V}_{t+1}^N) \left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N} \right) \mathscr{P}_{t+1}^A.$$

Similarly, using the same technique applied to deriving $\partial F_{\epsilon,t+1}^N \epsilon_{t+1}^{N,-} / \partial L_{t+1}$ in equation (B.20):

$$\frac{\partial \left(\epsilon_{t+1}^{N,-} F_{\epsilon,t+1} \right)}{\partial A_{t+1}^N} = \frac{\partial}{\partial A_{t+1}^N} \int_{-\infty}^{-\tilde{V}_{t+1}^N} \epsilon_{t+1}^N f_{\epsilon,t+1}^N d\epsilon = f_{\epsilon,t+1}^N(-\tilde{V}_{t+1}^N) \left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N} \right) \mathscr{P}_{t+1}^A \tilde{V}_{t+1}^N.$$

Therefore, we have the derivative

$$\frac{\partial \mathcal{B}_{t+1}^B}{\partial A_{t+1}^N} = \frac{1}{B_{t+1}^N + C(L_{t+1})} \left(f_{\epsilon,t+1}^N(-\tilde{V}_{t+1}^N) \left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N} \right) \mathscr{P}_{t+1}^A \tilde{V}_{t+1}^N \right).$$

Plugging each term into the expression for $\partial q_t^r / \partial A_{t+1}^N$ in equation (B.29) yields the final expression.

Derivative of q_t^r with respect to B_{t+1}^N. We would like to evaluate:

$$\frac{\partial q_t^r}{\partial B_{t+1}^N} = \mathrm{E}_t \left\{ \mathcal{M}_{t,t+1} \left[\left(\mathcal{A}_{t+1}^H - 1 \right) \frac{\partial F_{\epsilon,t+1}^N}{\partial B_{t+1}^N} + \frac{\partial \mathcal{A}_{t+1}^H}{\partial B_{t+1}^N} F_{\epsilon,t+1}^N + \frac{\partial \mathcal{B}_{t+1}^H}{\partial B_{t+1}^N} \right] \right\} \tag{B.30}$$

First, the derivative of $\mathcal{A}_{t+1}^H$ with respect to B_{t+1}^N is

$$\frac{\partial \mathcal{A}_{t+1}^H}{\partial B_{t+1}^N} = -(1-\zeta^N) \frac{\mathscr{P}_{t+1}^A (A_{t+1}^N + C(L_{t+1}))}{\left(B_{t+1}^N + C(L_{t+1}) \right)^2}.$$

Then, similar to before,

$$\frac{\partial F^N_{\epsilon,t+1}}{\partial B^N_{t+1}} = f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1}) \left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right).$$

Using Leibniz rule again,

$$\frac{\partial\left(\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}\right)}{\partial B^N_{t+1}} = -f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1}) \left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right) \tilde{V}^N_{t+1}.$$

Therefore,

$$\frac{\partial \mathcal{B}^H_{t+1}}{\partial B^N_{t+1}} = \frac{1}{\left(B^N_{t+1}+C(L_{t+1})\right)^2} \left(\left(B^N_{t+1} + C(L_{t+1})\right) \frac{\partial\left(\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}\right)}{\partial B^N_{t+1}} - \epsilon^{N,-}_{t+1} F_{\epsilon,t+1} \right).$$

Plugging each term into the expression for $\partial q^r_t / \partial B^N_{t+1}$ in equation (B.30) yields the final expression.

Derivative of q^r_t with respect to L_{t+1}. This is captured in the following proof of Proposition 3.

B.4.6 Proof of Proposition 3

Proof. We would like to evaluate:

$$\frac{\partial q^r_t}{\partial L_{t+1}} = \mathrm{E}_t \left\{ \mathcal{M}_{t,t+1} \left[\left(\mathcal{A}^H_{t+1} - 1\right) \frac{\partial F^N_{\epsilon,t+1}}{\partial L_{t+1}} + \frac{\partial \mathcal{A}^H_{t+1}}{\partial L_{t+1}} F^N_{\epsilon,t+1} + \frac{\partial \mathcal{B}^H_{t+1}}{\partial L_{t+1}} \right] \right\} \tag{B.31}$$

First, the derivative of $\mathcal{A}^H_{t+1}$ with respect to L_{t+1} is

$$\frac{\partial \mathcal{A}^H_{t+1}}{\partial L_{t+1}} = \left(1 - \zeta^N\right) \mathscr{P}^A_{t+1} \frac{\left[B^N_{t+1}+C_{t+1}\right] \frac{\partial C(L_{t+1})}{\partial L_{t+1}} - \left[A^N_{t+1}+C_{t+1}\right] \frac{\partial C(L_{t+1})}{\partial L_{t+1}}}{\left(B^N_{t+1}+C(L_{t+1})\right)^2}.$$

Then, using Leibniz rule,

$$\frac{\partial F^N_{\epsilon,t+1}}{\partial L_{t+1}} = -f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1}) \left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right) \left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right) \frac{\partial C(L_{t+1})}{\partial L_{t+1}}.$$

Similarly,

$$\frac{\partial\left(\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}\right)}{\partial L_{t+1}} = f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1}) \left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right) \tilde{V}^N_{t+1} \left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right) \frac{\partial C(L_{t+1})}{\partial L_{t+1}}.$$

Therefore,

$$\frac{\partial \mathcal{B}^{H}_{t+1}}{\partial L_{t+1}} = \frac{1}{\left(B^{N}_{t+1}+C(L_{t+1})\right)^{2}} \left(\frac{\partial\left(\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}\right)}{\partial L_{t+1}} \left(B^{N}_{t+1} + C\left(L_{t+1}\right)\right) - \epsilon^{N,-}_{t+1} F_{\epsilon,t+1} \frac{\partial C(L_{t+1})}{\partial L_{t+1}} \right).$$

Plugging each term into the expression for $\partial q^{r}_{t} / \partial L_{t+1}$ in equation (B.31) yields the final expression.

□

B.5 WACC Calculations

In the baseline *credit line economy*, the WACC for the aggregate NBL sector is:

$$\text{WACC}^{N}_{t} = \frac{V^{N}}{V^{N,tot}_{t}} \cdot \mathscr{R}^{N,E}_{t} + \frac{q^{r}_{t} B^{N}_{t}}{V^{N,tot}_{t}} \mathscr{R}^{N,B}_{t} + \frac{\text{E}[\mathscr{P}^{A}_{t+1}/R^{C}_{t+1}] \cdot C(L_{t})}{V^{N,tot}_{t}} \mathscr{R}^{N,L}_{t}, \tag{B.32}$$

where V^{N} is the cum-dividend equity value from (3.8), and $V^{N,tot}_{t} = V^{N} + q^{r}_{t} B^{N}_{t} + q^{C}_{t} C(L_{t})$ is the NBL's total value. The equity weight is $V^{N}/V^{N,tot}_{t}$, and expected return on NBL equity is

$$\mathscr{R}^{N,E}_{t} = \frac{\text{E}_{t}\left[\max\left\{V^{N} - \epsilon^{N}_{t+1}, 0\right\}\right]}{V^{N} - Div^{N}_{t}}. \tag{B.33}$$

NBLs have two types of debt: commercial paper B^{N}_{t} and drawn credit lines $C(L_{t})$, with respective weights $q^{r}_{t} B^{N}_{t} / V^{N,tot}_{t}$ and $\text{E}[\mathscr{P}^{A}_{t+1}/R^{C}_{t+1}] \cdot C(L_{t})/V^{N,tot}_{t}$. The expected returns on commercial paper and credit lines are

$$\mathscr{R}^{N,B}_{t} = \frac{\text{E}_{t}[\mathscr{P}^{N}_{t+1}]}{q^{r}_{t}} - 1, \quad \mathscr{R}^{N,L}_{t} = \text{E}_{t}[R^{C}_{t+1}] - 1.$$

In the *credit line economy*, the WACC for the bank is:

$$\text{WACC}^{B}_{t} = \frac{V^{B}}{V^{B,tot}_{t}} \cdot \mathscr{R}^{B,E}_{t} + \frac{q^{f}_{t} D_{t}}{V^{B,tot}_{t}} \mathscr{R}^{B,D}_{t} + \frac{q^{L}_{t}(L_{t} - C(L_{t}))}{V^{B,tot}_{t}} \mathscr{R}^{B,L}_{t}, \tag{B.34}$$

where $V_t^{B,tot} = V^B + q_t^f D_t + q_t^L\big(L_t - C(L_t)\big)$ is the bank's total value, and the expected return on equity is

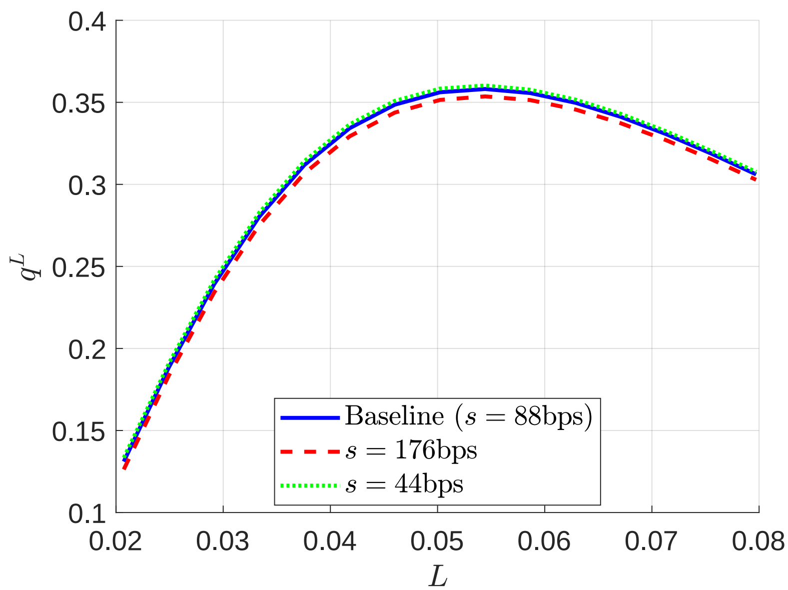
$$\mathscr{R}_t^{B,E} = \frac{\mathrm{E}_t\left[\max\left\{V^B - \epsilon_{t+1}^B, 0\right\}\right]}{V^B - Div_t^B}. \tag{B.35}$$

Deposits and undrawn credit commitments are liabilities, with expected returns

$$\mathscr{R}_t^{B,D} = \frac{1}{q_t^f} - 1, \quad \mathscr{R}_t^{B,L} = \frac{\mathrm{E}[\mathscr{P}_{t+1}^L]}{q_t^L} - 1.$$

B.6 Additional Model Result

Figure B.6.1: Role of Credit Line Spread



Notes. This figure plots for every level of spread, the combination of admissible upfront fee and credit limit.

In the model, I endogenize upfront fees because they capture borrower risk, while spreads are parameters taken from the data. Yet in the model, fees and spreads still jointly generates the screening property. This is consistent with empirical findings that borrowers with low AISU and high AISD are less likely to draw (Berg et al., 2016). The model also predicts lower fixed spreads paired with higher fees (Figure B.6.1).

C Computational Solution Method

This appendix describes the numerical algorithm used to solve the model presented in Appendix B. The implementation follows the transition iteration framework of Elenev et al. (2021). Define the endogenous state vector as to be $\mathcal{S}_{n,t} = [N_t^B,\, N_t^N,\, W_t^H,\, L_t]$, and the exogenous state variables $\mathcal{S}_{x,t} = [Z_t,\, d_t]$. Therefore, the full vector of state variables is $\mathcal{S}_t = [\mathcal{S}_{n,t}, \mathcal{S}_{x,t}]$. Define the vector of policy functions as $\mathcal{P}(\mathcal{S}) = [C^H(\mathcal{S}), D(\mathcal{S}), B(\mathcal{S}), A^B(\mathcal{S}), L(\mathcal{S}), A^N(\mathcal{S}), e^B(\mathcal{S}), e^N(\mathcal{S}), \lambda^B(\mathcal{S}), \mu^B(\mathcal{S}), \mu^N(\mathcal{S}), \mu_L^N(\mathcal{S}), q(\mathcal{S}), q^L(\mathcal{S}), q^f(\mathcal{S}), q^r(\mathcal{S})]$ and the vector of transition functions to be $\mathcal{T}(\mathcal{S}, \mathcal{S}_x') = [N^B(\mathcal{S}, \mathcal{S}_x'),\, N^N(\mathcal{S}, \mathcal{S}_x'), W^H(\mathcal{S}, \mathcal{S}_x'), L(\mathcal{S}, \mathcal{S}_x')]$.

The state space is discretized using a grid defined by the vector $[n_{N^B}, n_{N^N}, n_{W^H}, n_L, n_Z, n_d]$, where each component specifies the number of nodes along a particular state dimension. The exogenous processes Z_t and d_t are approximated by finite-state Markov chains with associated transition matrices P_Z and P_d. For notation, let $\mathcal{G}_n$ denote the set of grid points corresponding to the endogenous states at time t, and $\mathcal{G}_x$ the set of points for the exogenous states at time t. Likewise, $\mathcal{G}_x'$ refers to the grid points of the exogenous states at time $t+1$. The policy functions are thus defined over the domain $\mathcal{G} = [\mathcal{G}_n, \mathcal{G}_x]$, while the transition functions are defined over $\mathcal{M} = [\mathcal{G}, \mathcal{G}_x']$. We let $\hat{\mathcal{P}}_l$ represent the l^{th} approximation of the policy functions evaluated at each $j \in \mathcal{G}$, and $\hat{\mathcal{T}}_l$ the corresponding l^{th} candidate transition functions evaluated at each $m \in \mathcal{M}$.

I approximate the unknown policy and transition functions by discretizing the state space and applying multivariate linear interpolation. Beginning with an initial guess for these functions, I solve the model iteratively at each discretized node. At every node, the optimal policies are obtained by solving the system of nonlinear equilibrium conditions, where the Kuhn–Tucker inequalities are reformulated as equality constraints to make them compatible with standard nonlinear solvers. Using the resulting solutions, we update the transition functions and repeat this process until convergence is achieved. The next sections describe in detail the steps of the solution algorithm and its implementation.

C.1 Compute Expectations

We need to compute the expectations terms of all inter-temporal optimality conditions. This includes the equilibrium conditions of households (B.25)-(B.26), of banks (B.16)-(B.18) and NBLs (B.7)-(B.9). We proceed as follows. First, for each state at time t and each exogenous state at $t+1$ (i.e. for each $m \in \mathcal{M}$), we compute a guess for the state at time $t+1$ using our guess for the transition function $\hat{\mathcal{T}}_l$. Second, since we know the state tomorrow for each $m \in \mathcal{M}$, we can use our guess for the policy function $\hat{\mathcal{P}}_l$ to compute the implied choices and prices at $t+1$. Since future states do not necessarily fall inside the grids, we need to interpolate. Third, using the Markov chains P_Z and P_d, we can take expectations at time t about outcomes in $t+1$. Repeating these steps for each $g \in \mathcal{G}$, results in a set of time t expectations for each point in discretized state-space. We denote the resulting set to be EV_l.

C.2 Compute Equilibrium Policy Functions

Since we have time t expectations about $t+1$ outcomes, we can now solve for optimal choices at time t for each point in the discretized state-space. For each guess $\hat{\mathcal{P}}_{g,l}$, and equipped with expectations EV_l we are in a position to compute the residuals of the optimality conditions. These conditions are the households' budget constraint (B.22), households' optimality conditions (B.25)-(B.26), banks' budget constraint (B.11), banks' optimality conditions (B.16)-(B.18), and constraints (B.12)-(B.13), NBLs' budget constraint (B.2), NBLs' optimality conditions (B.7)-(B.9), and constraints (B.4)-(B.3) and finally the asset market clearing (3.27). We need to solve for C_t^H, D_{t+1}, B_{t+1}, A_{t+1}^B, L_{t+1}, A_{t+1}^N, e_t^B, e_t^N, λ_t^B, μ_t^B, μ_t^N, $\mu_{t,L}^N$, q_t, q_t^L, q_t^f, q_t^r. For each state $g \in \mathcal{G}$ we evaluate the 16 residuals until the it is approximate zero. This constitutes solving a non-linear system of 16 equations and 16 unknowns, which we do numerically using MATLAB's fsolve function. We store as the new guess of the policy function for that specific state $\mathcal{P}_{g,l+1}$, and repeat this process for all $g \in \mathcal{J}$. This procedure delivers a new guess $\hat{\mathcal{P}}_{l+1}$ of the policy functions.

C.3 Update Transition Functions

Given an old guess for the transition function $\hat{\mathcal{T}}_l$ and new guess for the policy functions $\hat{\mathcal{P}}_{l+1}$, we obtain a new guess for the transition function $\hat{\mathcal{T}}_{l+1}$ as follows. Since the transition functions $N^B(\mathcal{S}, \mathcal{S}_x^{'})$, $N^N(\mathcal{S}, \mathcal{S}_x^{'})$, $W^H(\mathcal{S}, \mathcal{S}_x^{'})$, $L(\mathcal{S}, \mathcal{S}_x^{'})$, are independent of time $t+1$ realizations of aggregate uncertainty, we can directly use the policy functions evaluated at each $g \in \mathcal{G}$. For the new update we use the law of motion of bank net worth (B.14), law of motion of NBLs net worth (B.5), law of motion of household wealth (B.23) and directly the policy for L_{t+1}.

C.4 Implementation

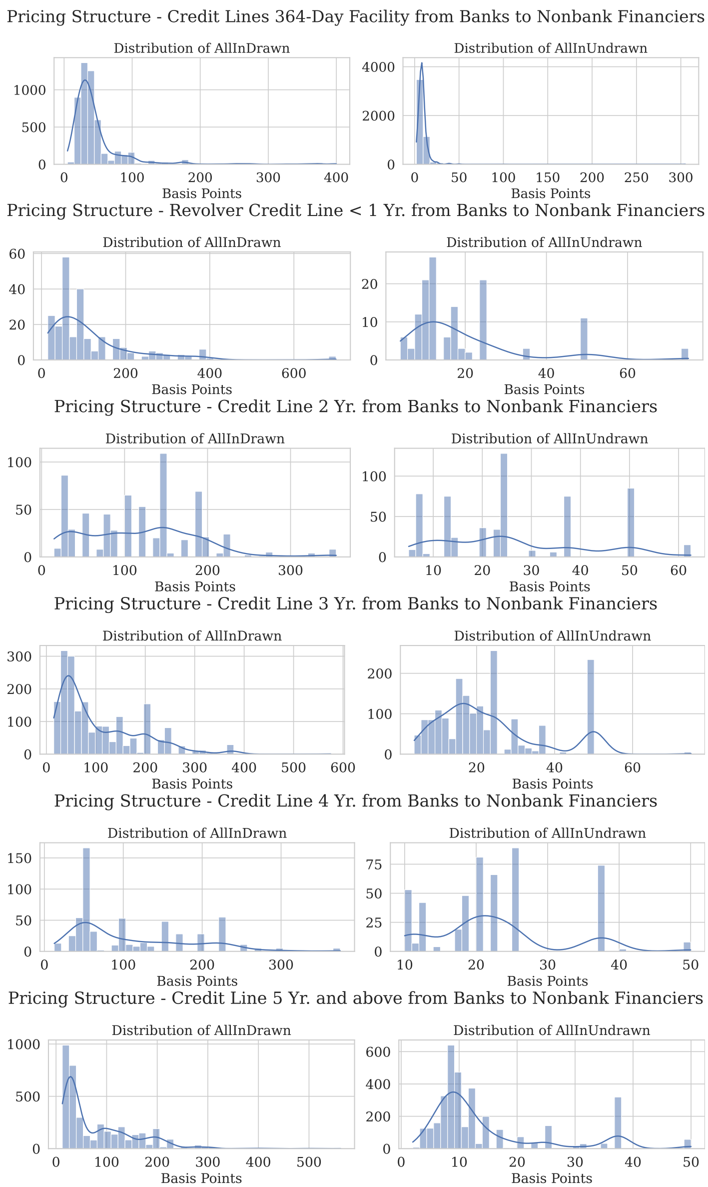
We start the algorithm by setting the initial guess $\hat{\mathcal{P}}_0$ and $\hat{\mathcal{T}}_0$ such that, for all $g \in \mathcal{G}$ and for all $m \in \mathcal{M}$ the candidate solution is simply the steady-state values. We set distance tolerance levels to $\epsilon_{\mathcal{T}}$ and $\epsilon_{\mathcal{P}}$ for transition and policy functions, respectively. We then proceed as follows:

1. Given $\hat{\mathcal{T}}_0$ and $\hat{\mathcal{P}}_0$ use Step 1 to compute expectations EV_1
2. Given EV_1, use Step 2 to compute a new guess for the policy functions $\hat{\mathcal{P}}_1$
3. Use $\hat{\mathcal{P}}_1$ and $\hat{T}_0$ following Step 3 to compute a new guess for the transition functions $\hat{\mathcal{T}}_1$
4. Compute the distance between guesses $||\hat{\mathcal{P}}_1 - \hat{\mathcal{P}}_0|| = d_{\mathcal{P}}$ and $||\hat{\mathcal{T}}_1 - \hat{\mathcal{T}}_0|| = d_{\mathcal{T}}$
5. If either $d_{\mathcal{T}} > \epsilon_{\mathcal{T}}$ or $d_{\mathcal{P}} > \epsilon_{\mathcal{P}}$, set $\hat{\mathcal{T}}_0 = \hat{\mathcal{T}}_1$ and $\hat{\mathcal{P}}_0 = \hat{\mathcal{P}}_1$ and go to 1. Else, set $\mathcal{P} = \hat{\mathcal{P}}_0$ and $\mathcal{T} = \hat{\mathcal{T}}_0$.
6. Use $\mathcal{P}$ and $\mathcal{T}$ to simulate the economy for 10,000 periods, starting at the steady state.
7. If the realization of a state hits the bounds, widen the grid and go back to 1. Otherwise, stop.

D Calibration Appendix

D.1 Credit Line Spread

Figure C.1: Pricing: Bank Credit Lines to NBLs



Notes. This figure plots all-in-drawn and all-in-undrawn spreads from DealScan for bank credit lines to NBLs, by maturity: 364 days, <1 year, 2 years, 3 years, 4 years, and 5+ years.

D.2 Holding Share of Corporate Loans on Bank and NBL Balance Sheets

Banks often offload loans from syndication packages post-origination, meaning origination shares do not necessarily reflect ultimate holdings Blickle et al. (2020). Since I lack access to the Shared National Credit (SNC) database, I estimate holding shares from origination shares using regression estimates from Blickle et al. (2020), with origination data from DealScan Legacy and Loan Connector. Figure 2 of Blickle et al. (2020) reports the fraction of loans where the lead arranger sells its entire share. On a volume-weighted basis, they sell 37% of Term A loans, 53% of Term B loans, 40% of other term loans, increasing to 49%, 73%, 54% over the full duration. Table 3 in Blickle et al. (2020) indicates that lead arrangers are no more or less likely to sell their stake than other bank participants. Accordingly, I apply these estimates uniformly to all bank-originated loans in DealScan.

Category	Amt Share	Lender	Pct. (Orig.)	Pct. (Post-Orig.)	Pct. (Ent. Dur.)
Credit lines	70.65	bank	89.10	86.43	85.54
		nonbank	10.90	13.57	14.46
Term loan A	6.40	bank	89.23	56.21	45.51
		nonbank	10.77	43.79	54.49
Term loan B	10.15	bank	63.45	29.82	17.13
		nonbank	36.54	70.18	82.87
Term loans	5.77	bank	76.04	45.62	34.98
		nonbank	23.96	54.38	65.02
Misc.	7.03	bank	82.45	61.83	53.59
		nonbank	17.55	38.17	46.41

Table C.1: Summary of count share and facility percentage by lender type (volume weighted). All values are in percentage points.

First, we calculate the nonbank holding share of all the term loans, which consist of Term Loan A, Term Loan B and unspecified Term Loans: $\frac{\sum_{\text{all term loans}} \text{Amt. Share} * \text{Pct. (Ent. Dur.)}}{\sum_{\text{all term loans}} \text{Amt Share}} = 70.12\%$. In the empirical section of the paper, the bank holding share of sub-A term loans is approximated as $\frac{\sum_{\text{sub-A term loans}} \text{Amt. Share} * \text{Pct. (Ent. Dur.)}}{\sum_{\text{sub- A term loans}} \text{Amt. Share}} = 23.60\%$.

Now we approximate the nonbank holding share of the entire syndication package. Considering that the average corporate drawdown from credit lines is approximately 30% [23], we adjust

[23]Greenwald et al. (2023) show that firms below the 80th size percentile utilize between 40% and 50% of their

the economy's size by scaling the credit line share in the original syndication by the utilization rate: $70.65\% \times 30\% = 21.19\%$. Thus, the total adjusted economy size is: $21.19 + 6.4 + 10.15 + 5.77 + 7.03 = 50.54$. Next, we rescale each category's amount share by the inverse of the adjusted economy size, incorporating actual utilization ratios: Credit lines: $\frac{21.19}{50.54} = 41.94\%$; Term Loan A: $\frac{6.40}{50.54} = 12.66\%$; Term Loan B: $\frac{10.15}{50.54} = 20.08\%$; Unspecified Term Loans: $\frac{5.77}{50.54} = 11.42\%$; Miscellaneous loans: $\frac{7.03}{50.54} = 13.91\%$. Using these adjusted shares, we compute the calibration target: the nonbank holding share of the entire economy, after accounting for the portion sold, is given by: $\sum_{\text{Category}}$ adj. share $\times$ Pct. (Ent. Dur.) $= 43.48\%$. Given that credit line drawdown data is imprecise, if we exclude credit lines and only care about the term loans held by banks and nonbanks, then the size of the economy is $6.4 + 10.15 + 5.77 + 7.03 = 29.35$. Similarly, rescale each category's amount share by the inverse of the adjusted economy size, incorporating actual utilization ratios: Term Loan A: $\frac{6.40}{29.35} = 21.81\%$; Term Loan B: $\frac{10.15}{29.35} = 34.58\%$; Unspecified Term Loans: $\frac{5.77}{29.35} = 19.66\%$; Miscellaneous loans: $\frac{7.03}{29.35} = 23.95\%$. Using these adjusted shares, we compute the calibration target: the nonbank holding share of the entire corporate loans, after accounting for the portion sold, is given by: $\sum_{\text{Category}}$ adj. share $\times$ Pct. (Ent. Dur.) $= 59.76\%$. In the model, I calibrate to a nonbank share of the economy as 50.8%, a middleground between 43.48% (if we account for bank and nonbank credit lines to firms) and 59.76% (if we only account for term loans).

D.3 Corporate loan average life

I model corporate bonds as geometrically declining perpetuities with no explicit principal repayment. Each bond pays 1 at $t + 1$, δ at $t + 2$, δ^2 at $t + 3$, and so on. Firms must hold capital to collateralize these bonds, with the face value defined as $\frac{\theta}{1-\delta}$, where θ represents the fraction of total repayments treated as principal. The procedure described above closely follows Elenev et al. (2021), but I extend the period to 2023. In syndicated loan markets, term loans vary in structure. Term A loans are typically regularly amortized, while Term B, C, and D loans often feature balloon payments at maturity. However, as a broad classification, these loans can generally be grouped based on their investment-grade or high-yield status. Therefore, I adopt Elenev et al. (2021)'s strategy To align the model with real-world corporate loans, I use investment-grade and high-yield indices from

available credit lines, while the largest firms draw almost none. Since the syndicated loan market primarily serves large U.S. firmsthose above the 80th percentileI infer from Figure 3.2 of Greenwald et al. (2023) that at around the 85th percentile, the drawn credit ratio is approximately 30%. This estimate of credit line utilization ratio is also consistent with what Acharya and Steffen (2020) find.

Bank of America Merril Lynch (BofAML) and Barclays Capital (BarCap) (1997–2023), incorporating data on market values, durations, weighted average maturity (WAM), and weighted-average coupons (WAC). Details on the data collection are provided here:

1. FRED data: we obtain a time series of option-adjusted spreads (OAS) for both high-yield and investment-grade bonds relative to the Treasury yield curve. These OAS values are sourced from Bank of America Merrill Lynch (BofAML) indices, with codes BAMLH0A0HYM2 and BAMLC0A0CM for high-yield OAS and investment-grade OAS, correspondingly.

2. Bloomberg data: Bloomberg Barclays Aggregate Bond Index includes both investment-grade and high-yield securities (codes LUACTRUU and LF98STAT for investment-grade and high-yield corporate bonds). These indices provide a time series of monthly data, including market values, durations (indicating price sensitivity to interest rate changes), maturity (life days), and coupon rates, spanning from January 1997 to September 2023.

Real-world bonds have finite maturity, a principal repayment, and vintage effects, which the model does not explicitly include. With the data, I make the following calculations:

1. I combine Barclays investment grade and high-yield portfolios using market values as the weighting factors to create an aggregate bond index with maturity and coupon rate shown below:

$$\text{Fraction of High Yield} = \frac{\text{High Yield Market Value}}{\text{High Yield Market Value} + \text{Investment Grade Market Value}}$$

$$\text{Weighted Average Maturity} = \text{Fraction of High Yield} \times \text{Barclays US CORP High Yield Maturity}$$
$$+ (1 - \text{Fraction of High Yield}) \times \text{Barclays US CORP Investment Grade Duration}$$

$$\text{Weighted Average Coupon} = \text{Fraction of High Yield} \times \text{Barclays US CORP High Yield Coupon}$$
$$+ (1 - \text{Fraction of High Yield}) \times \text{Barclays US CORP Investment Grade Coupon}$$

2. I then calculate the weighted average coupons (WAC) and weighted-average maturity (WAM) for the aggregate bond index. I find its mean WAC c of 5.93% [24] and WAM T of 10 years

[24] Elenev et al. (2021) finds WAC of 5.5%. There is a slight difference due to my extension of the data time fame

over our time period, similar to Elenev et al. (2021).

3. Next, I assign weights to the time series of Option-Adjusted Spreads (OAS) for both the high-yield and investment-grade indices, using the previously established "Fraction of High Yield." I add the time series of OAS to the constant maturity treasury rate corresponding to that period's WAM to get a time series of yields r_t .

I construct a plain vanilla bond with WAC = 5.93% and WAM = 10 years and compare its price:

$$P^c(r_t) = \sum_{i=1}^{2T} \frac{c/2}{(1+r_t)^{i/2}} + \frac{1}{(1+r_t)^T}$$

with the bond price in the model derived as:

$$P^G(r_t) = \frac{1}{1+r_t-\delta}$$

I calibrate δ and X (units of model bonds needed per real-world bond) by minimizing pricing errors across historical yields:

$$\min_{\delta,X} \sum_{t=1997.1}^{2023.9} \left[P^c(r_t) - XP^G(r_t;\delta)\right]^2$$

I estimate $\delta = 0.928$ and $X = 13.0059$. This value for δ_B implies a time series of durations $D_t = -\frac{1}{P_t^G}\frac{dP_t^G}{dr_t}$ with a mean of 7.009 years, matching observed duration. To approximate principal, I compare the geometric bond to a duration-matched zero-coupon bond. I set the "principal"F of one unit of the geometric bond to be some fraction θ of the undiscounted sum of all its cash flows $\frac{\theta}{1-\delta}$, where

$$\theta = \frac{1}{N} \sum_{t=1997.1}^{2023.9} \frac{1}{(1+r_t)^{D_t}} .$$

Therefore, I estimate $\theta_B = 0.624$ and $F_B = \frac{\theta_B}{1-\delta_B} = 8.67$

$$\theta = \frac{1}{N} \sum_{t=1997.1}^{2023.9} \frac{1}{(1+r_t)^{D_t}}$$

I estimate $\delta = 0.928$ and $X = 13.0059$. This value for δ_B implies a time series of durations

$D_t = -\frac{1}{P_t^G}\frac{dP_t^G}{dr_t}$ with a mean of 7.01 years.

In the following two appendix sections E and F, we follow the same aggregation assumptions for banks and NBLs specified in B.1.

E Counterfactual Cash Contract

E.1 NBLs

The net worth of NBLs in the counterfactual cash economy follows:

$$N_t^N = \mathscr{P}_t^A\big[A_t^N + \mathcal{I}^{seized}(L_t^{cash})\big] + \mathscr{P}_t^{\Delta cash}\Delta cash_t - B_t^N, \tag{E.1}$$

where after satisfying the additional uncertainty investment opportunities, cash in excess is,

$$\Delta cash_t = \mathbb{1}_{\{L_t^{cash} > \mathcal{I}^{seized}\}}\left(L_t^{cash} - \mathcal{I}^{seized}(L_t^{cash})\right) \tag{E.2}$$

earns a payoff of

$$\mathscr{P}_t^{\Delta cash} = \left(1 - F_{\epsilon,t}^B\right) + F_{\epsilon,t}^B RV_t^{cash}, \tag{E.3}$$

If the bank is solvent, per unit of excess cash held at banks recovers its full value 1; if the bank defaults, per unit of excess cash earns recovery value

$$RV_t^{cash} = (1-\zeta^B)\frac{\mathscr{P}_t^A A_t^B}{D_t + L_t^{cash}} + \frac{\epsilon_t^{N,-}}{D_t + L_t^{cash}}. \tag{E.4}$$

The recursive problem of a representative NBL in the cash economy is

$$V\left(\mathcal{S}_t^N,\, N_t^N\right) = \max_{\substack{A_{t+1}^N, B_{t+1}^N,\\ L_{t+1}^{cash}, e_t^N}} \phi_0^N\, N_t^N - e_t^N + \epsilon_t^N + \mathrm{E}_t\Big[\mathcal{M}_{t,t+1}\max\{\tilde{V}^N(\mathcal{S}_{t+1}^N, N_{t+1}^N) + \epsilon_{t+1}^N,\, 0\}\Big],$$

subject to

$$q_t A_{t+1}^N + q_t^{cash} L_{t+1}^{cash} \leq (1-\phi_0^N) N_t^N + e_t^N - \Psi^N(e_t^N) + q_t^r B_{t+1}^N, \tag{E.5}$$

$$0 \leq A_{t+1}^N, \tag{E.6}$$

$$0 \leq L_{t+1}^{cash}, \tag{E.7}$$

E.1.1 First-order Conditions

Attach multipliers ν_t^N to (E.5), μ_t^N to (E.6), and $\mu_{t,L}^N$ to (E.7).

Equity Issuance. Differentiating the objective function with respect to e_t^N: $\nu_t^N \left(1 - \phi_1^N e_t^N\right) = 1$.

NBL Loan Origination.

$$\left(q_t - \frac{\partial q_t^r}{\partial A_{t+1}^N} B_{t+1}^N\right) \nu_t^N = \mu_t^N + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \tilde{V}_{N,t+1}^N (1 - F_{\epsilon,t+1}^N) \mathscr{P}_{t+1}^A\right],$$

NBL Commercial Paper Debt.

$$\left(q_t^r + \frac{\partial q_t^r}{\partial B_{t+1}^N} B_{t+1}^N\right) \nu_t^N = \mathrm{E}_t\big[\mathcal{M}_{t,t+1} \tilde{V}_{N,t+1}^N (1 - F_{\epsilon,t+1}^N)\big],$$

NBL Cash from Bank.

$$\begin{aligned}&\left(q_t^{cash} - \frac{\partial q_t^r}{\partial L_{t+1}^{cash}} B_{t+1}^N\right) \nu_t^N = \mu_{t,L}^N \\ &+ \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \tilde{V}_{N,t+1}^N (1 - F_{\epsilon,t+1}^N) \left(\mathscr{P}_{t+1}^A \frac{\partial \mathcal{I}^{seized}(L_{t+1}^{cash})}{\partial L_{t+1}^{cash}} \mathscr{P}_{t+1}^{\Delta cash} \frac{\partial \Delta cash_{t+1}}{\partial L_{t+1}^{cash}}\right)\right],\end{aligned}$$

where we have the following partial derivatives

$$\frac{\partial \mathcal{I}^{seized}(L_{t+1}^{cash})}{\partial L_{t+1}^{cash}} = 1 - F(L_{t+1}^{cash}), \tag{E.8}$$

$$\frac{\partial \Delta cash_{t+1}}{\partial L_{t+1}^{cash}} = F\left(L_{t+1}^{cash}\right) \mathbb{1}_{\left\{L_{t+1}^{cash} > \mathcal{I}^{seized}\left(L_{t+1}^{cash}\right)\right\}} \tag{E.9}$$

E.1.2 Euler Equations

Combining the envelope condition $V_{N,t}^{N} = \phi_0^N + \left(1-\phi_0^N\right)\nu_t^N$ with the FOC for equity issuance above yields $V_{N,t}^{N} = \phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_t^N}$. Define the stochastic discount factor of the NBL as

$$\mathcal{M}_{t,t+1}^{N} \equiv \mathcal{M}_{t,t+1}\left(1-\phi_1^N e_t^N\right)\left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\left(1-F_{\epsilon,t+1}^{N}\right) \tag{E.10}$$

Then I organize the FOCs as

$$q_t - \frac{\partial q_t^r}{\partial A_{t+1}^N} B_{t+1}^N = \tilde{\mu}_t^N + \mathrm{E}_t\big[\mathcal{M}_{t,t+1}^N \mathscr{P}_{t+1}^A\big], \tag{E.11}$$

$$q_t^r + \frac{\partial q_t^r}{\partial B_{t+1}^N} B_{t+1}^N = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^N\right], \tag{E.12}$$

$$q_t^{cash} - \frac{\partial q_t^r}{\partial L_{t+1}^{cash}} B_{t+1}^N = \tilde{\mu}_{t,L}^{N,cash} + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^N\left(\mathscr{P}_{t+1}^A \frac{\partial \mathcal{I}^{seized}(L_{t+1}^{cash})}{\partial L_{t+1}^{cash}} + \mathscr{P}_{t+1}^{\Delta cash}\frac{\partial \Delta cash_{t+1}}{\partial L_{t+1}^{cash}}\right)\right], \tag{E.13}$$

where $\tilde{\mu}_t^N = \mu_t^N/\nu_t^N$ and $\tilde{\mu}_{t,L}^{N,cash} = \mu_{t,L}^{N,cash}/\nu_t^N$.

E.2 Banks

In the counterfactual cash economy, aggregate bank net worth follows:

$$N_t^B = \mathscr{P}_t^A A_t^B - D_t - L_t^{cash}, \tag{E.14}$$

and the recursive maximization problem of the bank is

$$V^B(\mathcal{S}_t) = \max_{A_{t+1}^B,\, D_{t+1}, L_{t+1}^{cash}, e_t^B}\Big\{\phi_0^B N_t^B - e_t^B + \epsilon_t^B + \mathrm{E}_t\big[\mathcal{M}_{t,t+1} V^B(\mathcal{S}_{t+1})\big]\Big\}, \tag{E.15}$$

subject to

$$q_t A_{t+1}^B - (q_t^f - \kappa) D_{t+1} \le (1-\phi_0^B) N_t^B + q_t^{cash} L_{t+1}^{cash} + e_t^B - \Psi^B(e_t^B), \tag{E.16}$$

$$D_{t+1} + L_{t+1}^{cash} \le \xi A_{t+1}^B, \tag{E.17}$$

$$0 \le A_{t+1}^B\,. \tag{E.18}$$

E.2.1 First-order Conditions

Attach multipliers ν_t^B to (E.16), λ_t^B to (E.17), and μ_t^B to (E.18). Denote $V_{N,t+1}^B = \frac{\partial V^B}{\partial N_{t+1}^B}$.

Equity Issuance. Differentiating the objective function with respect to e_t^B: $\nu_t^B \left(1 - \phi_1^B e_t^B\right) = 1$.

Bank Loan Origination.

$$q_t \, \nu_t^B = \frac{\partial q_t^{cash}}{\partial A_{t+1}^B} L_{t+1}^{cash} + \lambda_t^B \, \xi + \mu_t^B + \mathrm{E}_t \big[\mathcal{M}_{t,t+1} \, V_{N,t+1}^B \, \mathscr{P}_{t+1}^A \big],$$

Deposits.

$$\left(q_t^f - \kappa + \frac{\partial q_t^{cash}}{\partial D_{t+1}} L_{t+1}^{cash} \right) \nu_t^B = \lambda_t^B + \mathrm{E}_t \big[\mathcal{M}_{t,t+1} \, V_{N,t+1}^B \big],$$

NBL Cash from Bank.

$$q_t^{cash} \, \nu_t^B + \frac{\partial q_t^{cash}}{\partial L_{t+1}^{cash}} \, \nu_t^B \, L_{t+1}^{cash} = \lambda_t^B + \mathrm{E}_t \big[\mathcal{M}_{t,t+1} \, V_{N,t+1}^B \big].$$

E.2.2 Euler Equations

Combining the envelope condition $V_{N,t}^B = \phi_0^B + \left(1 - \phi_0^B\right) \nu_t^B$ with the FOC for equity issuance above yields $V_{N,t}^B = \phi_0^B + \frac{1-\phi_0^B}{1-\phi_1^B e_t^B}$. Define the stochastic discount factor of the bank as

$$\mathcal{M}_{t,t+1}^B = \mathcal{M}_{t,t+1} \left(1 - \phi_1^B e_t^B\right) \left(\phi_0^B + \frac{1-\phi_0^B}{1-\phi_1^B e_{t+1}^B} \right) \left(1 - F_{\epsilon,t+1}^B\right). \tag{E.19}$$

Then, I can organize the FOCs as:

$$q_t = \frac{\partial q_t^{cash}}{\partial A_{t+1}^B} L_{t+1}^{cash} + \tilde{\lambda}_t^B \, \xi + \tilde{\mu}_t^B + \mathrm{E}_t \big[\mathcal{M}_{t,t+1}^B \, \mathscr{P}_{t+1}^A \big], \tag{E.20}$$

$$q_t^f - \kappa + \frac{\partial q_t^{cash}}{\partial D_{t+1}} L_{t+1}^{cash} = \tilde{\lambda}_t^B + \mathrm{E}_t \big[\mathcal{M}_{t,t+1}^B \big], \tag{E.21}$$

$$q_t^{cash} + \frac{\partial q_t^{cash}}{\partial L_{t+1}^{cash}} \, L_{t+1}^{cash} - \tilde{\lambda}_t^B = \mathrm{E}_t \big[\mathcal{M}_{t,t+1}^B \big].,\tag{E.22}$$

where $\tilde{\mu}_t^B = \mu_t^B / \nu_t^B$ and $\tilde{\lambda}_t^B = \lambda_t^B / \nu_t^B$.

E.3 Partial Derivatives

E.3.1 Partial Derivatives of $\mathscr{P}_{t+1}^{\Delta cash}$ with respect to L_{t+1}^{cash} and A_{t+1}^{B}, and D_{t+1}

Denote

$$\mathcal{A}_{t+1}^{B,cash} \equiv \left(1-\zeta^B\right) \frac{\mathscr{P}_{t+1}^{A} A_{t+1}^{B}}{D_{t+1}+L_{t+1}^{cash}}, \quad \mathcal{B}_{t+1}^{B,cash} \equiv \frac{F_{\epsilon,t+1}^{B} \epsilon_{t+1}^{B,-}}{D_{t+1}+L_{t+1}^{cash}}$$

Let's write

$$\mathscr{P}_{t+1}^{\Delta cash} = 1 + (\mathcal{A}_{t+1}^{B,cash} - 1) F_{\epsilon,t+1}^{B} + \mathcal{B}_{t+1}^{B,cash}.$$

We want to evaluate the derivative

$$\frac{\partial \mathscr{P}_{t+1}^{\Delta cash}}{\partial L_{t+1}^{cash}} = (\mathcal{A}_{t+1}^{B,cash} - 1) \frac{\partial F_{\epsilon,t+1}^{B}}{\partial L_{t+1}^{cash}} + \frac{\partial \mathcal{A}_{t+1}^{B,cash}}{\partial L_{t+1}^{cash}} F_{\epsilon,t+1}^{B} + \frac{\partial \mathcal{B}_{t+1}^{B,cash}}{\partial L_{t+1}^{cash}} \tag{E.23}$$

where, by applying the Leibniz rule and employing techniques analogous to those in Equations (B.19) and (B.20), the partial derivative terms in (E.23) are

$$\begin{aligned}
\frac{\partial F_{\epsilon,t+1}^{B}}{\partial L_{t+1}^{cash}} &= f_{\epsilon,t+1}^{B}(-V^{B}) \frac{\partial\left(-\tilde{V}_{t+1}^{B}\right)}{\partial N_{t+1}^{B}} \frac{\partial N_{t+1}^{B}}{\partial L_{t+1}^{cash}} = f_{\epsilon,t+1}^{B}(-\tilde{V}_{t+1}^{B}) \left(\phi_0^B + \frac{1-\phi^B}{1-\phi_1^N e_{t+1}^{B}}\right), \\
\frac{\partial \mathcal{A}_{t+1}^{B,cash}}{\partial L_{t+1}^{cash}} &= -(1-\zeta^B) \frac{\mathscr{P}_{t+1}^{A} A_{t+1}^{B}}{\left(D_{t+1}+L_{t+1}^{cash}\right)^2}, \\
\frac{\partial \mathcal{B}_{t+1}^{B,cash}}{\partial L_{t+1}^{cash}} &= -\frac{\tilde{V}^B}{D_{t+1}+L_{t+1}^{cash}} \frac{\partial F_{\epsilon,t+1}^{B}}{\partial L_{t+1}^{cash}} - \frac{F_{\epsilon,t+1}^{B} \epsilon_{t+1}^{B,-}}{\left(D_{t+1}+L_{t+1}^{cash}\right)^2}.
\end{aligned}$$

Similarly, we compute the derivative

$$\frac{\partial \mathscr{P}_{t+1}^{\Delta cash}}{\partial A_{t+1}^{B}} = (\mathcal{A}_{t+1}^{B,cash} - 1) \frac{\partial F_{\epsilon,t+1}^{B}}{\partial A_{t+1}^{B}} + \frac{\partial \mathcal{A}_{t+1}^{B,cash}}{\partial A_{t+1}^{B}} F_{\epsilon,t+1}^{B} + \frac{\partial \mathcal{B}_{t+1}^{B,cash}}{\partial A_{t+1}^{B}} \tag{E.24}$$

where the partial derivative terms in (E.24) are

$$\begin{aligned}
\frac{\partial F_{\epsilon,t+1}^{B}}{\partial A_{t+1}^{B}} &= -f_{\epsilon,t+1}^{B}(-\tilde{V}_{t+1}^{B}) \left(\phi_0^B + \frac{1-\phi^B}{1-\phi_1^N e_{t+1}^{B}}\right) \mathscr{P}_{t}^{A}, \\
\frac{\partial \mathcal{A}_{t+1}^{B,cash}}{\partial A_{t+1}^{B}} &= \left(1-\zeta^B\right) \frac{\mathscr{P}_{t+1}^{A}}{D_{t+1}+L_{t+1}^{cash}}, \\
\frac{\partial \mathcal{B}_{t+1}^{B,cash}}{\partial A_{t+1}^{B}} &= -\frac{\tilde{V}^B}{D_{t+1}+L_{t+1}^{cash}} \frac{\partial F_{\epsilon,t+1}^{B}}{\partial A_{t+1}^{B}}.
\end{aligned}$$

Finally, we evaluate the derivative

$$\frac{\partial \mathscr{P}^{\Delta cash}_{t+1}}{\partial D_{t+1}} = (\mathcal{A}^{B,cash}_{t+1} - 1)\frac{\partial F^B_{\epsilon,t+1}}{\partial D_{t+1}} + \frac{\partial \mathcal{A}^{B,cash}_{t+1}}{\partial D_{t+1}} F^B_{\epsilon,t+1} + \frac{\partial \mathcal{B}^{B,cash}_{t+1}}{\partial D_{t+1}} \tag{E.25}$$

where the partial derivative terms in (E.25) are

$$\begin{aligned}
\frac{\partial F^B_{\epsilon,t+1}}{\partial D_{t+1}} &= f^B_{\epsilon,t+1}(-\tilde{V}^B_{t+1})\left(\phi^B_0 + \frac{1-\phi^B}{1-\phi^N_1 e^B_{t+1}}\right), \\
\frac{\partial \mathcal{A}^{B,cash}_{t+1}}{\partial D_{t+1}} &= -(1-\zeta^B)\frac{\mathscr{P}^A_{t+1} A^B_{t+1}}{\left(D_{t+1}+L^{cash}_{t+1}\right)^2}, \\
\frac{\partial \mathcal{B}^{B,cash}_{t+1}}{\partial D_{t+1}} &= -\frac{\tilde{V}^B_{t+1}}{D_{t+1}+L^{cash}_{t+1}}\frac{\partial F^B_{t,t+1}}{\partial D_{t+1}} - \frac{F^B_{\epsilon,t+1}\epsilon^{B,-}_{t+1}}{\left(D_{t+1}+L^{cash}_{t+1}\right)^2}.
\end{aligned}$$

E.3.2 Partial Derivatives of q^{cash}_t with respect to L^{cash}_{t+1}, A^B_{t+1}, D_{t+1}

From the NBL's Euler equation for cash L^{cash}_{t+1}, we take the derivative of q^{cash}_t with respect to L^{cash}_{t+1}.

$$\frac{\partial q^{cash}_t}{\partial L^{cash}_{t+1}} = \mathrm{E}_t\left[\mathcal{M}^N_{t,t+1}\left(\mathscr{P}^A_{t+1}\left(-f\left(L^{cash}_{t+1}\right)\right) + \frac{\partial \mathscr{P}^{\Delta cash}_{t+1}}{\partial L^{cash}_{t+1}}\frac{\partial \Delta cash_{t+1}}{\partial L^{cash}_{t+1}} + \mathscr{P}^{\Delta cash}_{t+1} f\left(L^{cash}_{t+1}\right)\right)\right], \tag{E.26}$$

where $\frac{\partial \mathscr{P}^{\Delta cash}_{t+1}}{\partial L^{cash}_{t+1}}$ is derived in equation (E.23). Similarly, the derivative of q^{cash}_t with respect to A^B_{t+1} is

$$\frac{\partial q^{cash}_t}{\partial A^B_{t+1}} = \mathrm{E}_t\left[\mathcal{M}^N_{t,t+1}\frac{\partial \mathscr{P}^{\Delta cash}_{t+1}}{\partial A^B_{t+1}}\frac{\partial \Delta cash_{t+1}}{\partial L^{cash}_{t+1}}\right], \tag{E.27}$$

where $\frac{\partial \mathscr{P}^{\Delta cash}_{t+1}}{\partial A^B_{t+1}}$ is derived in equation (E.24). Finally, the derivative of q^{cash}_t with respect to D_{t+1} is

$$\frac{\partial q^{cash}_t}{\partial D_{t+1}} = \mathrm{E}_t\left[\mathcal{M}^N_{t,t+1}\frac{\partial \mathscr{P}^{\Delta cash}_{t+1}}{\partial D_{t+1}}\frac{\partial \Delta cash_{t+1}}{\partial L^{cash}_{t+1}}\right], \tag{E.28}$$

where $\frac{\partial \mathscr{P}^{\Delta cash}_{t+1}}{\partial D_{t+1}}$ is derived in equation (E.25).

E.3.3 Partial Derivatives of q_t^r with respect to L_{t+1}^{cash}, A_{t+1}^N, B_{t+1}^N

Similar to the baseline credit-line economy in Appendix Section B.4.5, the household's Euler equation for NBL commerical paper is

$$q_t^r = \frac{(1-\theta)\varsigma C_t^H}{(1-\varsigma)B_{t+1}^H} + \mathrm{E}_t\left\{\mathcal{M}_{t,t+1}\left[1 - F_{\epsilon,t+1}^N + F_{\epsilon,t+1}^N \mathcal{A}_{t+1}^{H,cash} + \mathcal{B}_{t+1}^{H,cash}\right]\right\},$$

where I denote

$$\mathcal{A}_{t+1}^{H,cash} \equiv (1-\zeta^N)\frac{\mathscr{P}_{t+1}^A\left[A_t^N + \mathcal{I}^{seized}(L_{t+1}^{cash})\right] + \mathscr{P}_{t+1}^{\Delta cash}\Delta cash_{t+1}}{B_{t+1}^N},$$
$$\mathcal{B}_{t+1}^{H,cash} \equiv \frac{\epsilon_{t+1}^{N,-} F_{\epsilon,t+1}^N}{B_{t+1}^N}.$$

The derivative of q_t^r with respect to L_{t+1}^{cash} is

$$\frac{\partial q_t^r}{\partial L_{t+1}^{cash}} = \mathrm{E}_t\Big\{\mathcal{M}_{t,t+1}\big[(\mathcal{A}_{t+1}^{H,cash} - 1)\frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}^{cash}} + F_{\epsilon,t+1}^N \frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial L_{t+1}^{cash}} + \frac{\partial \mathcal{B}_{t+1}^{H,cash}}{\partial L_{t+1}^{cash}}\big]\Big\}, \tag{E.29}$$

where the partial derivatives in (E.29) are

$$\frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial L_{t+1}^{cash}} = (1-\zeta^N)\frac{\mathscr{P}_{t+1}^A\left(1-F\left(L_{t+1}^{cash}\right)\right) + \mathscr{P}_{t+1}^{\Delta cash}F\left(L_{t+1}^{cash}\right)}{B_{t+1}^N}.$$
$$\frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}^{cash}} = -f_{\epsilon,t+1}^N\left(-\tilde{V}_{t+1}^N\right)\left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\left(\mathscr{P}_{t+1}^A\left(1-F\left(L_{t+1}^{cash}\right)\right) + \mathscr{P}_{t+1}^{\Delta cash}F\left(L_{t+1}^{cash}\right)\right),$$
$$\frac{\partial \mathcal{B}_{t+1}^{H,cash}}{\partial L_{t+1}^{cash}} = -\frac{\tilde{V}^N}{B_{t+1}^N}\frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}^{cash}}.$$

The derivative of q_t^r with respect to A_{t+1}^N is

$$\frac{\partial q_t^r}{\partial A_{t+1}^N} = \mathrm{E}_t\Big\{\mathcal{M}_{t,t+1}\big[(\mathcal{A}_{t+1}^{H,cash} - 1)\frac{\partial F_{\epsilon,t+1}^N}{\partial A_{t+1}^N} + F_{\epsilon,t+1}^N \frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial A_{t+1}^N} + \frac{\partial \mathcal{B}_{t+1}^{H,cash}}{\partial A_{t+1}^N}\big]\Big\}, \tag{E.30}$$

where the partial derivatives in (E.30) are

$$\frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial A_{t+1}^N} = (1-\zeta^N)\frac{\mathscr{P}_{t+1}^A}{B_{t+1}^N},$$
$$\frac{\partial F_{\epsilon,t+1}^N}{\partial A_{t+1}^N} = -f_{\epsilon,t+1}^N\left(-\tilde{V}_{t+1}^N\right)\left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\mathscr{P}_{t+1}^A,$$
$$\frac{\partial \mathcal{B}_{t+1}^{H,cash}}{\partial A_{t+1}^N} = -\frac{\tilde{V}^N}{B_{t+1}^N}\frac{\partial F_{\epsilon,t+1}^N}{\partial A_{t+1}^N}.$$

The derivative of q_t^r with respect to B_{t+1}^N is

$$\frac{\partial q_t^r}{\partial B_{t+1}^N} = \mathrm{E}_t\Big\{\mathcal{M}_{t,t+1}\big[(\mathcal{A}_{t+1}^{H,cash} - 1)\,\frac{\partial F_{\epsilon,t+1}^N}{\partial B_{t+1}^N} + F_{\epsilon,t+1}^N\,\frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial B_{t+1}^N} + \frac{\partial \mathcal{B}_{t+1}^{H,cash}}{\partial B_{t+1}^N}\big]\Big\}, \tag{E.31}$$

where the partial derivatives in (E.31) are

$$\begin{aligned}
\frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial B_{t+1}^N} &= -\left(1-\zeta^N\right)\frac{\mathscr{P}_{t+1}^A\left[A_t^N + \mathcal{I}^{seized}\left(L_{t+1}^{cash}\right)\right] + \mathscr{P}_{t+1}^{\Delta cash}\Delta cash_{t+1}}{\left(B_{t+1}^N\right)^2}\\
\frac{\partial F_{\epsilon,t+1}^N}{\partial B_{t+1}^N} &= f_{\epsilon,t+1}^N\left(-\tilde{V}_{t+1}^N\right)\left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right),\\
\frac{\partial \mathcal{B}_{t+1}^{H,cash}}{\partial B_{t+1}^N} &= -\frac{\tilde{V}^N}{B_{t+1}^N}\frac{\partial F_{\epsilon,t+1}^N}{\partial B_{t+1}^N} - \frac{\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}^N}{\left(B_{t+1}^N\right)^2}.
\end{aligned}$$

E.4 WACC Calculations in the Cash Economy

For the *cash economy*, WACC for bank is:

$$\mathrm{WACC}_{cash,t}^B = \frac{V^B}{V_{cash,t}^{B,tot}}\cdot\mathscr{R}_t^{B,E} + \frac{q_t^f D_t}{V_{cash,t}^{B,tot}}\left(\frac{1}{q_t^f} - 1\right) + \frac{q_t^{cash}L_t^{cash}}{V_{cash,t}^{B,tot}}\left(\frac{\mathrm{E}_t[\mathscr{P}_{t+1}^{cash}]}{q_t^{cash}} - 1\right), \tag{E.32}$$

where the expected return on bank equity follows (B.35), and the total value of bank is

$$V_{cash,t}^{B,tot} = V^B + q_t^f D_t + q_t^{cash}L_t^{cash}, \tag{E.33}$$

WACC for NBL is:

$$\mathrm{WACC}_{cash,t}^N = \frac{V^N}{V_{cash,t}^{N,tot}}\cdot\mathscr{R}_t^{N,E} + \frac{q_t^r B_t^N}{V_{cash,t}^{N,tot}}\left(\frac{\mathrm{E}_t[\mathscr{P}_{t+1}^N]}{q_t^r} - 1\right), \tag{E.34}$$

where the expected return on NBL equity follows (B.33), total value of NBL is

$$V_{cash,t}^{N,tot} = V^N + q_t^r B_t^N. \tag{E.35}$$

F Counterfactual Loan Contract

Suppose in the counterfactual economy banks offer a loan contract to NBLs characterized by the loan price q_t^{loan} and the loan quantity L_t^{loan}.

F.1 NBLs

Denote the net worth of NBLs by N_t^N, and we can write the evolution of N_t^N as follows:

$$N_t^N = \mathscr{P}_t^A A_t^N + \mathscr{P}_t^A \mathcal{I}(L_t^{loan}) - L_t^{loan} - B_t^N \tag{F.1}$$

where NBLs use loans to fund investment opportunities in the same fashion as before: $\mathcal{I}_t^{loan} = \int_0^\infty \min\{\iota, L_t^{loan}\} dF(\iota)$ is the additional sporadic investment opportunities seized by having access to bank loans. This implies no change in the environment of the economy but only a modification of the asset markets structure.

F.1.1 Optimization Problem

The recursive problem of a nonbank is:

$$V\left(\mathcal{S}_t^N, N_t^N\right) = \max_{\substack{A_{t+1}^N, B_{t+1}^N, \\ L_{t+1}^{loan}, e_t^I}} \phi_0^N N_t^N - e_t^N + \epsilon_t^N + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \max\{\tilde{V}_{t+1}^N(\cdot) + \epsilon_{t+1}^N, 0\}\right], \tag{F.2}$$

subject to NBL budget constraint

$$q_t A_{t+1}^N - q_t^{loan} L_{t+1}^{loan} \leq (1-\phi_0^N) N_t^N + e_t^N - \Psi^N\left(e_t^N\right) + q_t^r B_{t+1}^N, \tag{F.3}$$

and nonbank no-shorting constraint

$$0 \leq A_{t+1}^N, \tag{F.4}$$

F.1.2 First-order Conditions

Attach Lagrange multiplier and ν_t^N to the budget constraint (F.3) and μ_t^N to the nonbank no-shorting constraint on loans to firms (F.4).

Equity Issuance. We can differentiate the objective function with respect to e_t^N :

$$\nu_t^N \left(1 - \phi_1^N e_t^N\right) = 1\,,$$

NBL Loan Origination. The FOC for NBL loans A^N_{t+1} to firms is

$$\left(q_t - \tfrac{\partial q^r_t}{\partial A^N_{t+1}} B^N_{t+1} - \tfrac{\partial q^{loan}_t}{\partial A^N_{t+1}} L^{loan}_{t+1}\right) \nu^N_t = \mu^N_t + \mathrm{E}\left[\mathcal{M}_{t,t+1} \tilde{V}^N_{N,t+1} \left(1 - F^N_{\epsilon,t+1}\right) \mathscr{P}^A_{t+1}\right] ,$$

NBL Commerical Paper Debt. The FOC for loans B^N_{t+1} is

$$\left(q^r_t + \tfrac{\partial q^r_t}{\partial B^N_{t+1}} B^N_{t+1} + \tfrac{\partial q^{loan}_t}{\partial B^N_{t+1}} L^{loan}_{t+1}\right) \nu^N_t = \mathrm{E}\left[\mathcal{M}_{t,t+1} \tilde{V}^N_{N,t+1} \left(1 - F^N_{\epsilon,t+1}\right)\right] ,$$

Alternative Financing - Loan Contract with Banks. The FOC for bank loans to NBLs L^{loan}_{t+1} is

$$\begin{aligned} &\left(q^{loan}_t + \tfrac{\partial q^{loan}_t}{\partial L^{loan}_{t+1}} L^{loan}_{t+1} + \tfrac{\partial q^r_t}{\partial L^{loan}_{t+1}} B^N_{t+1}\right) \nu^N_t \\ =&\mathrm{E}_t \left[\mathcal{M}_{t,t+1} \tilde{V}^N_{N,t+1} \left(1 - F^N_{\epsilon,t+1}\right) \left(1 - \mathscr{P}^A_{t+1}(1 - F(L^{loan}_{t+1}))\right)\right] . \end{aligned}$$

F.1.3 Euler Equations

First take the envelope condition:

$$\tilde{V}^N_{N,t} = \phi^N_0 + \left(1 - \phi^N_0\right) \nu^N_t .$$

Combining this with the FOC for equity issuance above to eliminate ν^N_t yields

$$\tilde{V}^N_{N,t} = \phi^N_0 + \tfrac{1-\phi^N_0}{1-\phi^N_1 e^N_t} .$$

Define the stochastic discount factor of the intermediary as

$$\mathcal{M}^N_{t,t+1} = \mathcal{M}_{t,t+1} \left(1 - \phi^N_1 e^N_t\right) \left(\phi^N_0 + \tfrac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right) \left(1 - F^N_{\epsilon,t+1}\right)$$

I can organize the FOCs as:

$$q_t - \tfrac{\partial q^r_t}{\partial A^N_{t+1}} B^N_{t+1} - \tfrac{\partial q^{loan}_t}{\partial A^N_{t+1}} L^{loan}_{t+1} = \tilde{\mu}^N_t + \mathrm{E}\left[\mathcal{M}^N_{t,t+1} \mathscr{P}^A_{t+1}\right] \quad , \tag{F.5}$$

$$q^r_t + \tfrac{\partial q^r_t}{\partial B^N_{t+1}} B^N_{t+1} + \tfrac{\partial q^{loan}_t}{\partial B^N_{t+1}} L^{loan}_{t+1} = \mathrm{E}\left[\mathcal{M}^N_{t,t+1}\right] \quad , \tag{F.6}$$

$$q^{loan}_t + \tfrac{\partial q^{loan}_t}{\partial L^{loan}_{t+1}} L^{loan}_{t+1} + \tfrac{\partial q^r_t}{\partial L^{loan}_{t+1}} B^N_{t+1} = \mathrm{E}_t\left[\mathcal{M}^N_{t,t+1} \left(1 - \mathscr{P}^A_{t+1}(1 - F(L^{loan}_{t+1}))\right)\right] . \tag{F.7}$$

where $\tilde{\mu}_t^N \equiv \mu_t^N / \nu_t^N$.

F.2 Banks

In the counterfactual loan economy, aggregate bank net worth follows

$$N_t^B = \mathscr{P}_t^A A_t^B - D_t + \mathscr{P}_t^{loan} L_t^{loan}, \tag{F.8}$$

where

$$\mathscr{P}_{t+1}^{loan}(L_{t+1}^{loan}) = \left(1 - F_{\epsilon,t+1}^N\right) + F_{\epsilon,t+1}^N RV^N + \frac{F_{\epsilon,t+1}^N \epsilon_{t+1}^{N,-}}{B_{t+1}^N + L_{t+1}^{loan}}, \tag{F.9}$$

where the recovery value of NBL default is

$$RV^N = (1 - \zeta^N) \cdot \frac{\mathscr{P}_{t+1}^A \left(A_{t+1}^N + \mathcal{I}_{t+1}^{loan}(L_{t+1}^{loan})\right)}{B_{t+1}^N + L_{t+1}^{loan}}. \tag{F.10}$$

The recursive maximization problem of the bank is

$$V^B(\mathcal{S}_t) = \max_{A_{t+1}^B, D_{t+1}, L_{t+1}^{loan}, e_t^B} \phi_0^B N_t^B - e_t^B + \epsilon_t^B + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \max\{V^B(\mathcal{S}_{t+1}), 0\}\right],$$

subject to the budget constraint

$$q_t A_{t+1}^B - (q_t^f - \kappa) D_{t+1} \leq (1 - \phi_0^B) N_t^B - q_t^{loan} L_{t+1}^{loan} + e_t^B - \Psi^B\left(e_t^B\right), \tag{F.11}$$

bank capital requirement,

$$D_{t+1} \leq \xi\left(A_{t+1}^B + L_{t+1}^{loan}\right), \tag{F.12}$$

no-shorting constraint on bank loans to NBLs,

$$0 \leq L_{t+1}^{loan}, \tag{F.13}$$

and no-shorting constraint on loans to firms,

$$0 \leq A^B_{t+1}, \tag{F.14}$$

F.2.1 First-Order Conditions

Attach Lagrange multipliers ν^B_t to the budget constraint (F.11), λ^B_t to the capital requirement(F.12), μ^L_t to the no-shorting constraint on bank loans to NBLs (F.13), and μ^B_t to the no-shorting constraint on bank loans to firms (F.14). Similar to solving the bank problem in the main credit line model, we denote $V^B_{N,t+1} = \partial V^B_{t+1}/\partial N^B_{t+1}$. FOCs for bank equity issuance, corporate loan origination and deposits look the same as in Section B.3, except for the FOC for term loan L^{loan}_{t+1}:

$$q^{loan}_t \nu^B_t - \mu^L_t - \lambda^B_t \xi = \mathrm{E}_t \left[\mathcal{M}_{t,t+1} \tilde{V}^B_{N,t+1} \left(1 - F^B_{\epsilon,t+1}\right) \left(\mathscr{P}^{loan}_{t+1} + L_{t+1} \frac{\partial \mathscr{P}^{loan}_{t+1}}{\partial L^{loan}_{t+1}} \right) \right] .$$

which can be rewritten as

$$q^{loan}_t - \tilde{\mu}^{loan}_t - \tilde{\lambda}^B_t \xi = \mathrm{E}_t \left[\mathcal{M}^B_{t,t+1} \left(\mathscr{P}^{loan}_{t+1} + L_{t+1} \frac{\partial \mathscr{P}^{loan}_{t+1}}{\partial L^{loan}_{t+1}} \right) \right], \tag{F.15}$$

where I define $\tilde{\mu}^L_t \equiv \mu^L_t / \nu^B_t$ and $\tilde{\lambda}^B_t \equiv \lambda^N_t / \nu^B_t$.

F.2.2 Partial Derivative of $\mathscr{P}^{loan}_{t+1}$ with respect to L^{loan}_{t+1}

From (F.9),

$$\frac{\partial \mathscr{P}^{loan}_{t+1}}{\partial L^{loan}_{t+1}} = \left(RV^N - 1\right) \frac{\partial F^N_{\epsilon,t+1}}{\partial L^{loan}_{t+1}} + F^N_{\epsilon,t+1} \frac{\partial RV^N}{\partial L^{loan}_{t+1}} + \frac{\partial}{\partial L^{loan}_{t+1}} \left(\frac{F^N_{\epsilon,t+1} \epsilon^{N,-}_{t+1}}{B^N_{t+1} + L^{loan}_{t+1}} \right) \tag{F.16}$$

From (F.10),we can derive the following derivative:

$$\frac{\partial RV^N}{\partial L^{loan}_{t+1}} = \left(1 - \zeta^N\right) \mathscr{P}^A_{t+1} \frac{\left(1 - F(L^{loan}_{t+1})\right)(B^N_{t+1} + L^{loan}_{t+1}) - \left(A^N_{t+1} + \mathcal{I}^{loan}_{t+1}(L^{loan}_{t+1})\right)}{\left(B^N_{t+1} + L^{loan}_{t+1}\right)^2}.$$

Then, similar to the technique applied in derivation (B.19), using Leibniz rule yields

$$\frac{\partial F^N_{\epsilon,t+1}}{\partial L^{loan}_{t+1}} = -f^N_\epsilon \left(-\tilde{V}^N_{t+1} \right) \left(\phi^N_0 + \frac{1 - \phi^N_0}{1 - \phi^N_1 e^N_{t+1}} \right) \left(\mathscr{P}^A_{t+1} (1 - F(L^{loan}_{t+1})) - 1 \right).$$

Applying the same technique in derivation (B.20),

$$\frac{\partial\left(\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}\right)}{\partial L_{t+1}^{loan}} = f_{\epsilon}^{N}\left(-\tilde{V}_{t+1}^{N}\right)\left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\tilde{V}_{t+1}^{N}\left(\mathscr{P}_{t+1}^{A}(1-F(L_{t+1}^{loan}))-1\right).$$

Hence,

$$\frac{\partial}{\partial L_{t+1}^{loan}}\left(\frac{F_{\epsilon,t+1}^{N}\epsilon_{t+1}^{N,-}}{B_{t+1}^{N}+L_{t+1}^{loan}}\right) = \frac{\frac{\partial\left(\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}\right)}{\partial L_{t+1}}\left(B_{t+1}^{N}+L_{t+1}^{loan}\right)-\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}}{\left(B_{t+1}^{N}+L_{t+1}^{loan}\right)^2}.$$

Plugging each item in (F.16) yields the full expression of the derivative.

F.2.3 Partial Derivatives of q_t^{loan} with respect to A_{t+1}^N, B_{t+1}^N and L_{t+1}^{loan}

The derivatives of q_t^{loan} with respect to A_{t+1}^N and B_{t+1}^N are very similar to the one for the derivatives of q_t^r with respect to A_{t+1}^N in equation (B.29) and B_{t+1}^N in equation (B.30). In particular, after adjusting for the different SDF (term loans are priced by banks and not households), and for the different recovery values, the derivatives with respect A_t^N and B_t^N are effectively the same. I focus on the derivative with respect to L_t^{loan}. Similar to how we define $\mathcal{A}^H$ and $\mathcal{B}^H$ in (B.26),let us denote

$$\mathcal{A}^{H,loan} \equiv \left((1-\zeta^N)\frac{\mathscr{P}_{t+1}^{A}(A_{t+1}^{N}+\mathcal{I}_{t+1}^{loan}(L_{t+1}^{loan}))}{B_{t+1}^{N}+L_{t+1}^{loan}}\right), \quad \mathcal{B}^{H,loan} \equiv \frac{\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}}{B_{t+1}^{N}+L_{t+1}^{loan}}.$$

Derivative of q_t^{loan} with respect to L_{t+1}^{loan}. We would like to evaluate:

$$\frac{\partial q_t^{loan}}{\partial L_{t+1}^{loan}} = \mathrm{E}_t\left\{\mathcal{M}_{t,t+1}^{B}\left[\left(\mathcal{A}_{t+1}^{H,loan}-1\right)\frac{\partial F_{\epsilon,t+1}^{N}}{\partial L_{t+1}^{loan}} + \frac{\partial \mathcal{A}_{t+1}^{H,loan}}{\partial L_{t+1}^{loan}}F_{\epsilon,t+1}^{N} + \frac{\partial \mathcal{B}_{t+1}^{H,loan}}{\partial L_{t+1}^{loan}}\right]\right\}, \tag{F.17}$$

where

$$\frac{\partial \mathcal{A}_{t+1}^{H,loan}}{\partial L_{t+1}^{loan}} = (1-\zeta^N)\frac{\mathscr{P}_{t+1}^{A}}{B_{t+1}^{N}+L_{t+1}^{loan}}\left(\frac{\partial \mathcal{I}_{t+1}^{loan}(L_{t+1}^{loan})}{\partial L_{t+1}^{loan}} - \frac{A_{t+1}^{N}+\mathcal{I}_{t+1}^{loan}(L_{t+1}^{loan})}{B_{t+1}^{N}+L_{t+1}^{loan}}\right)$$

$$\frac{\partial F_{\epsilon,t+1}^{N}}{\partial L_{t+1}^{loan}} = -f_{\epsilon,t+1}^{N}(-\tilde{V}_{t+1}^{N})\left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\left(\mathscr{P}_{t+1}^{A}\frac{\partial \mathcal{I}_{t+1}^{loan}(L_{t+1}^{loan})}{\partial L_{t+1}^{loan}}-1\right)$$

$$\frac{\partial\left(\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}\right)}{\partial L_{t+1}^{loan}} = f_{\epsilon,t+1}^{N}(-\tilde{V}_{t+1}^{N})\left(\phi_0^N + \frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\left(\mathscr{P}_{t+1}^{A}\frac{\partial \mathcal{I}_{t+1}^{loan}(L_{t+1}^{loan})}{\partial L_{t+1}^{loan}}-1\right)\tilde{V}_{t+1}^{N}.$$

Hence, we have the following expression:

$$\frac{\partial \mathcal{B}^H_{t+1}}{\partial L^{loan}_{t+1}} = \frac{1}{B^N_{t+1}+L^{loan}_{t+1}}\Bigg[\left(\mathscr{P}^A_{t+1}\frac{\partial \mathcal{I}^{loan}_{t+1}(L^{loan}_{t+1})}{\partial L^{loan}_{t+1}} - 1\right)\tilde{V}^N_{t+1} f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1})\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right) - \frac{\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}}{B^N_{t+1}+L^{loan}_{t+1}}\Bigg].$$

Plugging each item in yields the full expression of the derivative.

F.3 WACC Calculations in the Loan Economy

For the *loan economy*, the WACC for bank is

$$\text{WACC}^B_{loan,t} = \frac{V^B_{loan,t}}{V^{B,tot}_{loan,t}} \cdot \mathscr{R}^{B,E}_t + \frac{q^f_t D_t}{V^{B,tot}_{loan,t}}\left(\frac{1}{q^f_t} - 1\right), \tag{F.18}$$

where the expected return on bank equity follows (B.35), and the total value of the bank is:

$$V^{B,tot}_{debt,t} = V^B_{debt,t} + q^f_t D_t, \tag{F.19}$$

For the *loan economy*, the WACC for NBL is

$$\text{WACC}^N_{loan,t} = \frac{V^N_{loan,t}}{V^{N,tot}_{loan,t}} \cdot \mathscr{R}^{N,E}_t + \frac{q^r_t B^N_t}{V^{N,tot}_{loan,t}}\left(\frac{\text{E}_t[\mathscr{P}^N_{t+1}]}{q^r_t} - 1\right) + \frac{q^{loan}_t L^{loan}_t}{V^{N,tot}_{loan,t}}\left(\frac{\text{E}_t[\mathscr{P}^{loan}_{t+1}]}{q^{loan}_t} - 1\right), \tag{F.20}$$

where the expected return on NBL equity follows (B.33), and total value of the NBL is:

$$V^{N,tot}_{debt,t} = V^N_{debt,t} + q^r_t B^N_t + q^{loan}_t L^{loan}_t. \tag{F.21}$$