The Value of Contingent Liquidity from Banks to Nonbank Lenders

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[PRELIMINARY]

Abstract

I document that 90% of bank funding to nonbank lenders (NBLs) is via credit lines, while NBLs hold 70% of corporate term loans. NBLs use credit lines to manage investment and liquidity shocks; banks, with their funding advantage, serve as natural insurers. I develop a macrofinance model calibrated to U.S. syndicated loan data to quantify the value of contingent liquidity. Banks weigh the benefits of renting NBL balance sheets via credit lines against the risks of higher limits and drawdowns. The model yields three main results: (1) demand-driven expansions in credit lines reallocate risk to banks but enhance stability by boosting asset prices and safe asset supply; (2) credit lines outperform cash and debt by providing flexibility and insurance, especially in crises; (3) banking policy non-monotonically spillovers to nonbank lending and off-balance sheet regulation shapes credit line supply and systemic resilience, with optimal policy balancing liquidity and risk.

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1 Introduction

Banks and nonbank lenders (NBLs) are interconnected in todays financial system. NBLs[1] are a subset of nonbanks that both borrow from banks and lend to corporates in the syndicated loan market.[2] In the U.S., banks provide about \$120 billion in quarterly funding to NBLs—96% of which is in the form of revolvers or credit lines, a type of contingent liquidity (Figure 2). These same NBLs originate roughly 30% and hold about 70% of corporate term loans (Figure 4). Their scale of lending and dependence on credit lines make NBLs essential to study.

Following the Great Financial Crisis, regulatory tightening reduced banks risk exposure, prompting NBLs to fill the gap by assuming riskier lending positions.(Irani et al., 2021; Lee et al., 2023) This shift introduced segmentation between regulated and non-regulated lenders. I argue that credit lines—by functioning as options—help complete markets and mitigate this segmentation. Yet, as NBLs expand, so do concerns about their interconnectedness with banks. Do bank-provided credit lines improve systemic risk-sharing, or do they amplify fragility? While the Basel framework regulates only banks, policymakers increasingly recognize the risks transmitted through bank–NBL linkages (Acharya et al., 2024a).

To assess the macroeconomic and financial stability implications of credit lines from banks to NBLs, we need a macro-finance model capable of rich counterfactual analysis and policy design. To fill this gap, I develop a general equilibrium model grounded in new empirical evidence. The paper proceeds in two parts. First, I document the purpose and usage of credit lines from banks to NBLs. Second, I incorporate these institutional details into a quantitative model that evaluates the systemic consequences of financial interconnectedness and informs future regulation.

In the first (empirical) section of my paper, I present three main findings. First, 96% of bank

[1]Note the difference between nonbanks and nonbank lenders (NBLs). I use nonbanks to mean all financial institutions that participate in the syndicated loan market but are not commercial banks. Nonbanks include three subtypes: (1) those that lend to corporates but do not borrow from banks, (2) those that borrow from banks but do not lend to corporates, and (3) those that both borrow from banks and lend to corporates. The last type of nonbank lenders that both lend and borrow from banks is the focus of my study. Major NBLs in the U.S. include finance companies, investment funds, and institutional investors, as shown in Figure 1.

[2]The syndicated loan market, with an aggregate facility size of \$10 trillion per year (nearly half of U.S. GDP), provides large-scale financing to major U.S. corporations and the government.

funding to nonbank lenders (NBLs) takes the form of credit lines. These are valuable because they offer NBLs flexible funding and protection against liquidity shortfalls. Second, using Dealscan, LSEG Loan Connector, and SEC prospectuses, I show that NBLs face significant investment and liquidity uncertainty. On the asset side, as participants rather than lead arrangers in syndicated loans, NBLs have less control over when they are included in deals, leading to uncertainty in deal flow.[3] Large language model analysis of prospectuses shows that 80% cite protection against investment uncertainty as the primary reason for seeking credit lines, while 40% cite liquidity supportoften as backup for commercial paper. Third, I find that NBL credit line utilization closely tracks their lending activity over time, and cross-sectionally, NBLs with more volatile lending draw more heavily and demand greater contingent liquidity.

Importantly, NBL reliance on credit lines increases in crises, raising their share of intermediation. While credit lines are privately optimal for both parties, they transfer risk from NBLs to banksespecially during downturns when drawdowns spike. In partial equilibrium, this risk shift is straightforward. But in general equilibrium, the broader implications remain unclear: How are asset prices affected? What happens to the supply of safe assets? How do bank regulations spill over to NBLs via credit lines? These questions motivate the second part of the paper, which develops a macro-finance model to assess the systemic effects of credit line intermediation.

In the second (model) section, I develop a quantitative macro-finance model that maps the empirical evidence into a general equilibrium framework to quantify the macroeconomic value of contingent liquidity. The model features both banks and nonbank lenders (NBLs) providing debt financing to firms by investing in a Lucas tree. In addition, banks extend credit lines to NBLs. These contracts improve risk-sharing by aligning the private incentives of both parties. The model provides a rationale for the credit line arrangement: unlike NBLs, banks enjoy liquidity advantages from deposit convenience yields and access to the Fed's balance sheet, particularly valuable in crises. Yet regulatory constraints limit bank leverage. Extending credit lines allows banks to rent NBL balance sheetstransferring liquidity while earning option fees and internalizing the risk

[3]Blickle et al. (2020) also documents that banks frequently act as lead arrangers, which gives them more control over investment timing, amount, covenants, and horizon.

of NBL loan portfolios. I also incorporate regulatory features that mirror observed patterns: bank credit lines to NBLs frequently bunch at 364 days, exploiting the lower 20% credit conversion factor applied to undrawn commitments under one year. This captures a key source of regulatory arbitrage, which the model uses to study the transmission of financial regulation through contingent lending.

I calibrate a dynamic model of bank–nonbank intermediation to the full universe of U.S. syndicated loans from 1990 to 2023, targeting key features of the data including net payout rates, investment volatility, commercial bank recovery rates, bank and nonbank default rates, deposit rates, and liquidity premia, among others. The model serves as a laboratory to evaluate the macro-financial role of credit lines—contractual arrangements that provide contingent liquidity from banks to nonbank lenders (NBLs).

The model allows me to distinguish between demand-driven and supply-driven expansions in credit lines and assess their implications for financial stability. It also enables counterfactual comparisons with alternative financing structures—such as cash lending and fixed-term loans—to isolate the distinctive value of credit lines in providing flexibility and insurance. Finally, the model permits policy experiments that examine how regulation affects the supply of credit lines and, in turn, systemic outcomes.

I use the calibrated model to deliver three main sets of results. First, I show that rising investment uncertainty increases NBLs demand for contingent liquidity, prompting banks to expand credit line provision. As credit lines grow, systemic risk declines: NBL defaults fall, bank net worth rises, deposit creation expands, and asset prices increase. The banking sector absorbs a greater share of risk, leading to a structural rebalancing of financial intermediation toward the regulated core. These dynamics underscore the role of credit lines in improving risk-sharing and strengthening the resilience of the financial system.

Second, I compare the credit line economy to two counterfactual contract structures—cash and term debt—holding parameters constant across environments. Credit lines outperform both alternatives: relative to cash, they offer greater flexibility by allowing funding only when investment opportunities arise; relative to debt, they reduce deadweight loss and default risk by reassigning drawdown control to borrowers while preserving pricing discipline. These features are particularly valuable during crises, when credit lines expand countercyclically while debt contracts contract. In crisis simulations, credit lines generate lower default rates, higher asset prices, and smaller welfare losses relative to other contract types.

Third, I explore the regulatory drivers of credit line supply. Two policy experiments reveal important trade-offs. Tighter bank capital requirements reduce banks ability to issue deposits and extend credit lines, shifting risk to nonbanks and raising their default likelihood. Similarly, stricter off-balance sheet treatment of undrawn credit lines increases their capital cost, limiting provision and safe-asset creation. Welfare is maximized at an intermediate regulatory setting that balances financial resilience with credit availability. Together, these findings highlight how regulation shapes supply-driven credit line dynamics and suggest a role for targeted policy support or subsidization to preserve the stabilizing benefits of contingent liquidity.

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

Credit Lines. My paper contributes to our current understanding on credit lines (Holmström and Tirole, 1998; Acharya et al., 2014; Greenwald et al., 2023; Choi, 2022). In Acharya et al. (2014), credit line revocation disciplines borrowers. My model features an *endogenously* determined credit limit, enabling banks to internalize the impact of credit line extensions on the drawdown behavior of NBLs and I provide a quantification of this mechanism in a general equilibrium model of the financial system. My modeling demonstrates the *partial* flexibility bank credit lines provide to NBLs, while accounting for NBL default risks. While Greenwald et al. (2023) model credit line limit and rate as exogenous and show that credit lines to large firms crowd out lending to smaller firms and Choi (2022) highlight liquidity insurance for firms, my paper focuses on credit lines to NBLs with fully endogenous credit limit and option fee. I argue that bank credit lines help NBLs hedge investment uncertainty and offer liquidity support, overcoming two past key credit line modeling challenges by (1) endogenizing credit limits, and (2) capturing realistic, interior credit utilization to improve numerical stability. In this way, my modeling of credit line quantifies not only the option value of contingent liquidity, but also the value of an interconnected financial system.

Related to but different from Acharya et al. (2024a,b), which suggest that bank credit lines to NBLs increase risk for banks, I find that such credit lines enhance stability of the financial system as a whole. This is precisely because banks internalize NBLs' riskier behavior and default risks when setting credit limits. Consequently, my paper demonstrates that an interconnected financial system where banks extend credit lines to NBLs is safer than a segmented one.

Bank-nonbank Interaction and Macro-finance Models. My paper is related to the literature on the interaction between banks and nonbanks, in both modeling and empirical literature, where I make the following three contributions. *First,* I develop a novel quantitative macro-finance model linking banks and NBLs through credit lines, contributing to the literature on macro-finance models, financial shocks, and regulation (He and Krishnamurthy, 2013; Brunnermeier and Sannikov, 2014; Moreira and Savov, 2017; Quarles, 2020; Elenev et al., 2021; Begenau, 2020; Begenau and Landvoigt, 2022; dAvernas et al., 2023; Elliott et al., 2023; Lee et al., 2023). I provide the first foundational framework to examine bank-NBL interaction via credit lines, quantifying their macroeconomic impacts and the spillover effects of bank regulation on NBLs. *Second, I emphasize collabration over competition between banks and NBLs.* Departing from Jiang (2023), which shows that banks compete with nonbanks by charging higher credit line rates to secure their downstream profits, shows how banks and NBLs collaborate: nonbanks hedge investment uncertainty, while banks benefit via "regulatory arbitrage." My findings challenge the competition narrative and quantify how credit lines promote collaboration and macro-financial stability. *Finally,* my paper adds to the growing empirical literature on bank-nonbank interactions, competition, and the rise of nonbanks (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; Jiang, 2023; Buchak et al., 2024; Acharya et al., 2024a,b). I provide the first textual evidence on the use of bank credit lines by NBLs to hedge liquidity uncertainty and secure liquidity support.

Structure of the Financial System. Diamond (2020) and **?** examine how the financial system provides safe assets, with CLOs enabling more deposits by avoiding mark-to-market pressures. In contrast, I show how the system organizes to extend credit to the real economy. Building on Kashyap et al. (2002), which highlights banks' comparative advantage in contingent funding due to imperfect correlations between credit line drawdowns and deposit runs, I emphasize banks incentives for leveraging nonbank balance sheets, and conduct regulatory arbitrage between credit lines and term loans. Extending capital structure literature (Modigliani and Miller, 1958; Myers, 1984), I argue that the nature of debt matters: contingent debt (credit lines) outperforms both long-term and short-term debt. Unlike long-term debt, credit lines avoid debt overhang and impose costs only when investments arise. Compared to short-term debt, credit lines offer fixed spreads, reducing sensitivity to market distress. Their unique structure as long-term options with short-term drawdowns provides these advantages.

Roadmap. Section 2 documents empirical evidence. Section 3 presents my quantitative macro-finance model. Section 5 presents calibration strategy, internally and externally calibrated parameters and results. Section 6 uses the model to study crisis and transition dynamics, the real macroeconomic effects of NBLs and role of frictions. Section 6 also runs several policy experiments on the calibrated model. Section 7 concludes.

2 Empirical Evidence

This section presents both empirical and narrative evidence highlighting the relationship between banks and nonbank lenders (NBLs) and their roles within the syndicated loan market.

2.1 Data

I use four data sources, Dealscan Legacy (1990-2020), LSEG Loan Connector (2020-2023) and Capital IQ, and the SEC prospectuses.

Facility-level Data. DealScan is a commercial loan database maintained by Refinitiv LPC, providing detailed facility-level information on syndicated loans, bilateral loans, club deals, project finance, and other structured lending. I merge the Legacy DealScan and LSEG Loan Connector (New DealScan) data and refer to the combined dataset as DealScan data. In this dataset, a facility represents a loan and includes both syndicated and bilateral structures. The dataset contains rich information on facility types (e.g., term loans, revolvers credit facilities), pricing, covenants, participants, and borrower-lender relationships. For my paper, I focus on two financing types: 1) Corporate loansdebt from financial intermediaries (banks and nonbank lenders, or NBLs) to non-financial corporates, 2) Intermediary-to-intermediary loansdebt from banks to NBLs.

Drawdown Data. Most bank funding to nonbank lenders takes the form of credit lines, as shown in Figure 2. However, DealScan does not report credit line utilization, so I supplement it with drawdown data from Capital IQ. To link the datasets, I use the Roberts DealScanCompustat Linking Database (Chava and Roberts, 2008) to map DealScan facility IDs to GVKEYs, and then to Capital IQ firm identifiers. From Legacy DealScan, I extract the total facility amount for each quarter between a facilitys start date and its maturity. I then construct a pivot table with quarters as rows, NBLs as columns, and total available credit per NBL per quarter as values. Using Capital IQ, I obtain the undrawn amounts and compute the utilization ratio as: drawn fraction = 1- undrawn amount/total credit limit. The utilization ratio is also a calibration target for my quantitative model.

Textual Data. While data from DealScan, LSEG LoanConnector, and Capital IQ are primarily numerical, I also collect textual data from SEC Prospectuses to better understand why nonbank lenders (NBLs) seek credit lines from banks. I manually review 95 of 585 prospectuses to identify stated motivations for obtaining credit lines and label relevant sentences as ground truth for supervised machine reading of the remaining documents. To validate consistency, I cross-check the labeling using two large language models (GPT and Gemini). I then use the LLMs to perform binary classification on each prospectus, identifying whether it contains evidence of investment uncertainty (i.e., liquidity support) or not (see Algorithm 1).

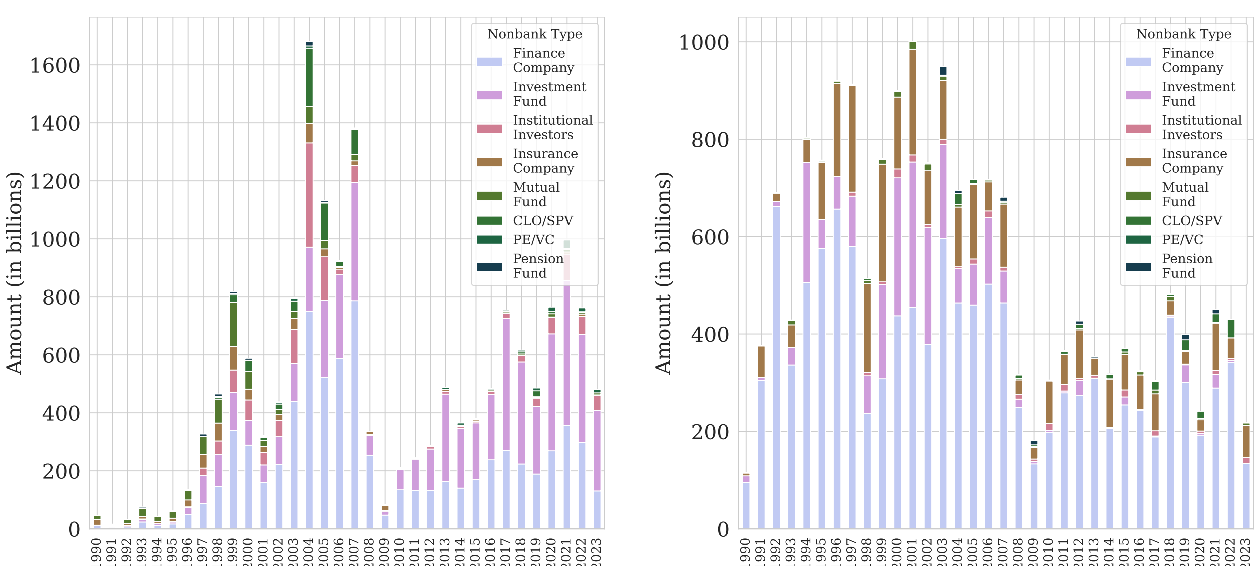
2.2 Empirical Findings

I find that major NBLs in the US syndicated loan markets that both lend to corporates and borrow from banks are primarily finance companies, investment funds, and institutional investors, as shown in Figure 1. I document 371 NBLs that both lend to corporates and borrow from banks, as shown in Figure 1. These NBLs receive 71% of total bank funding to the nonbank sector and originate about 44% of syndicated loan volume from all nonbank lenders. I document three key findings on bank funding to NBLs:

1. 96% of funding is via credit lines, with notable bunching at 364-day maturities.
2. NBLs use these lines to hedge investment risk (assets) and manage liquidity needs (liabilities).
3. NBL lending follows credit line acquisition with a slight lag and is positively correlated with available credit capacity.

The following subsections present these three findings in detail.

Figure 1: Nonbank Lending and Funding from Banks



(a) Nonbank Lending

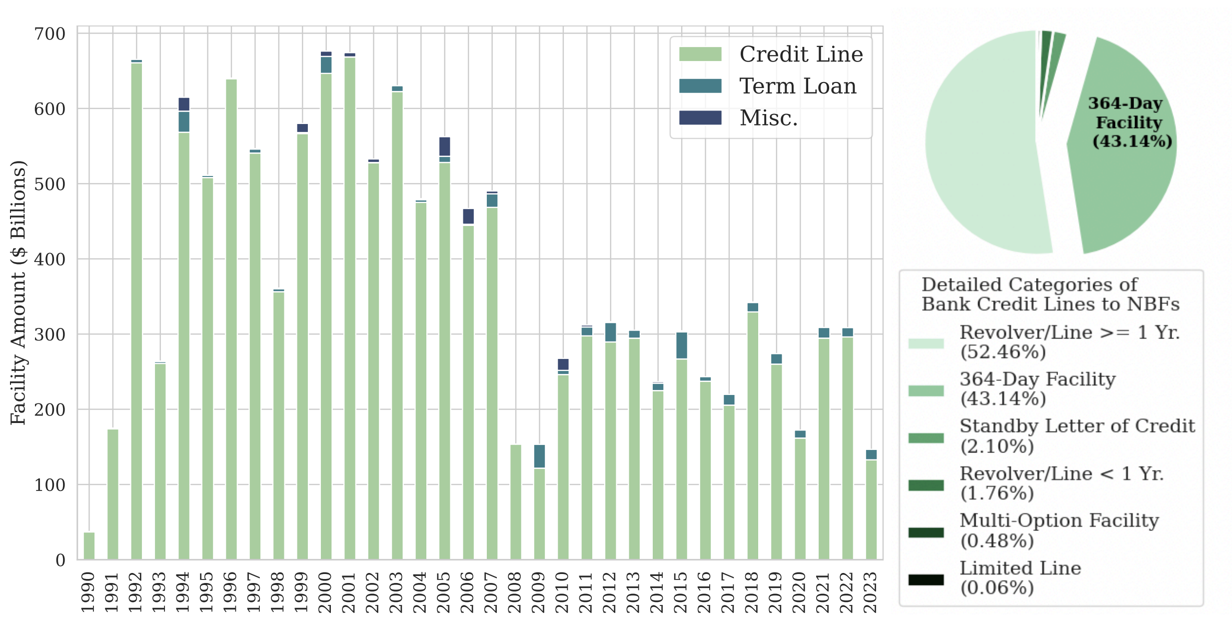
(b) Bank Funding to Nonbanks

Notes. Panel (a) nonbank origination of term loans by nonbank type. Panel (b) is bank funding to nonbanks.

2.2.1 Credit Lines from Banks to Nonbank Lenders (NBLs)

Nonbank lenders rely heavily on banks for funding,[4] with 96% of that funding taking the form of credit lines (Figure 2). Term loans and other financing make up less than 4%.

Figure 2: Types of Bank Funding to NBLs



Notes. There are three primary types of bank funding extended to nonbank lenders (NBLs): credit lines, term loans, and miscellaneous types. The left bar chart shows the distribution of these funding types, with credit lines in green, term loans in cyan, and miscellaneous in dark blue. The right pie chart details credit line categories, ranked by prevalence: Revolver/Line < 1 Yr. (52.46%), 364-Day Facility (43.14%), Standby Letter of Credit (2.10%), Revolver/Line < 1 Yr. (1.76%), etc.

A closer look at bank-issued credit lines to NBLs reveals that 43.14% are exactly 364-day facilities. Why the bunching? Regulation plays a key role. As noted in Basel Committee on Banking Supervision (2020), commitments up to one year carry a 20% credit conversion factor (CCF), while those over a year face a 50% CCF. This sharp increase incentivizes banks to set maturities just under one year to minimize capital chargesan example of regulatory arbitrage. As will be shown in my model, even absent regulation, banks have incentives to share risk with NBLs. The preferential treatment of credit lines, especially those with maturities under one yearrelative to term loansfurther

[4] Appendix Figure B.1.1 shows the 1-year moving average of quarterly bank funding to NBLs. This asymmetryNBLs depend on banks, but not vice versais consistent with Acharya et al. (2024a).

strengthens the arbitrage incentive.

2.2.2 Credit Lines for Investment Uncertainty and Liquidity Support

Nonbank lenders (NBLs) obtain credit lines from banks primarily to manage asset-side investment uncertainty and liability-side liquidity risk. Using textual analysis of SEC prospectuses, I doc-

Algorithm 1 Inventory Uncertainty Classification Using Large Language Models (LLMs)

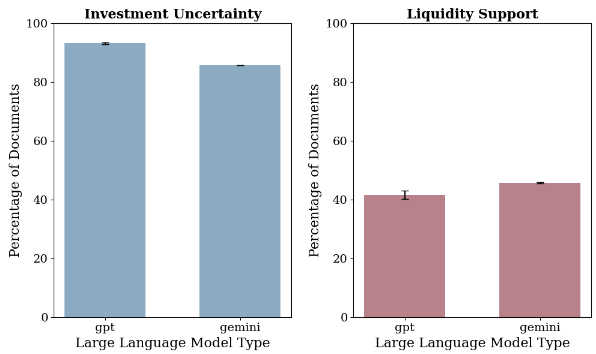
Require: Documents $D = \{d_1, d_2, \ldots, d_n\}$, Keywords $\mathcal{K}$, LLM θ
Ensure: Inventory Uncertainty classification for each company's document

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 $\theta(S_{\text{set}}) =$ YES **then**
                Mark company as YES for inventory uncertainty
                break from keyword loop
            end if
        end if
    end for
    if no match or all classified NO **then**
        Mark company as NO for inventory uncertainty
    end if
end for

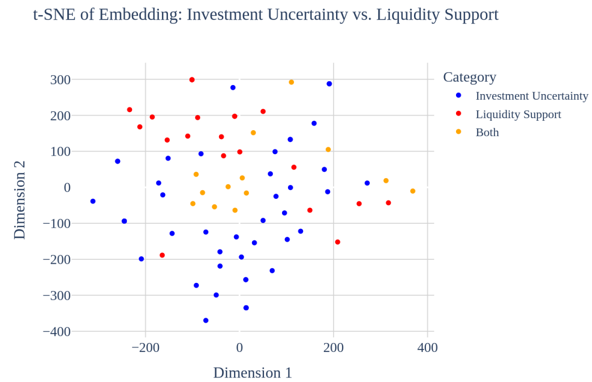
ument narrative evidence supporting these motives: 80% of prospectuses mention credit lines as flexible funding to manage uncertain investment demand, while 40% highlight their role as liquidity backstops, especially for commercial paper programs. These results are consistent across different large language models. I begin by manually reviewing 95 of 585 prospectuses to identify key phrases indicative of credit line usage. Examples include we will use the credit lines to fund our origination and purchase of a diverse pool of loans (investment uncertainty) and we use credit lines as backup support for our commercial papers (liquidity risk). These labeled sentences serve as ground truth for training. I then implement a few-shot large language model (LLM) classifier (Wei et al., 2022), using the prompt shown in Figure B.2.3. Keywords include revolving, line of credit, facility, and credit agreement. For robustness, I use two large LLMs and results from GPT and Gemini are consistent. Representative examples and a word cloud of key phrases are in the Appendix

B.2.

Figure 3: Textual Evidence



(a) Large Language Model Results



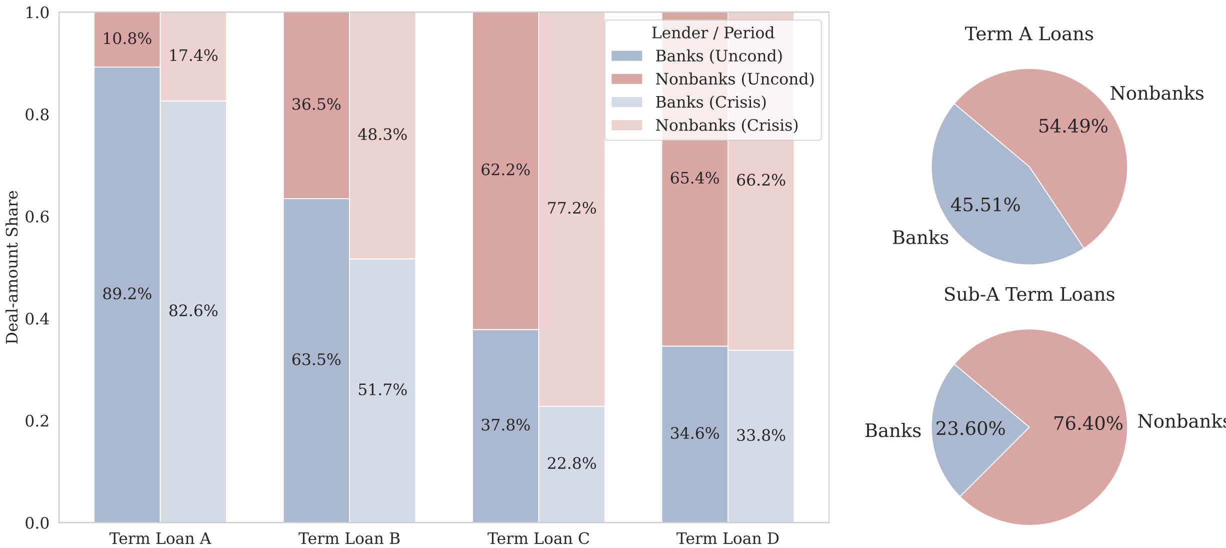
(b) Two-dimensional Embedding Graph

Notes. Panel (a) compares the outputs of two large language models by reporting the share of documents referencing credit lines for investment uncertainty versus liquidity support. Panel (b) presents a two-dimensional embedding of these sentences from the training sample, illustrating their distinct semantic clusters.

First, to understand the asset-side risks, let's consider the role of NBLs in the syndicated loan market. As participants rather than lead arrangers (Blickle et al., 2020), NBLs face volatile investment opportunities, creating investment uncertainty. This narrative evidence is complemented by loan-level data from Dealscan and the LSEG Loan Connector, summarized in Figure 4. I find that NBLs originate and hold a greater share of sub-A term loans than banks.

Corporate term loans in Dealscan are categorized as Term Loans A, B, C, etc. Banks typically *lead-arrange* these loans, while NBLs are more often *participants* (Blickle et al., 2020). Term A loans are smaller, lower-yielding, amortized regularly, and shorter in maturity (under seven years). Sub-A term loans (B, C, D), primarily targeted at nonbanks, are larger, carry higher interest rates, feature bullet payments, and have longer maturities (six to ten years). While covenants are largely standardized, variation arises when nonbanks act as sole lenders or originate sub-A loans. These loans often allow higher debt-to-EBITDA, debt-to-equity, and debt-to-net-worth thresholds (Appendix Figure B.1.5).Since Dealscan provides only origination data, I rely on estimates from Blickle et al. (2020), who supplement with Shared National Credit (SNC) data. They estimate that banks

Figure 4: Share of Corporate Term Loans by Banks and Nonbanks



(a) Origination share (b) Holding share

Notes. Panel (a) displays the origination share breakdown by loan type. The darker pink bars represent the unconditional average share of term loan origination by nonbank lenders for each tranche type (A, B, C, D), while the lighter pink bars reflect the nonbank shares during crisis periods. Similarly, the darker blue bars show the unconditional average origination share by banks, and the lighter blue bars indicate their shares conditional on crisis. Panel (b) approximates the holdingperiod share. Estimates use Blickle et al. (2020); details in Appendix C.2.

sell most loans to NBLs within 10 days. Using their regression coefficients, I infer that banks retain 45.51% of Term A loans, with nonbanks holding 54.49%. For sub-A term loans, banks retain 23.60%, and nonbanks hold 76.40%. Moreover, during crisis times, the share of term loan origination by NBLs increases significantly. This indicates that NBLs retain riskier loans, highlighting asset-side volatility.

Turning to the liability side, NBLs lack traditional liquidity backstops — they cannot take deposits or access central bank facilities. SEC prospectuses frequently contain statements like "our primary credit facility is available for short-term liquidity requirements and backs[5] our commercial paper facility," or "The revolving credit facilities are committed and provide 100% back-stop

[5]By saying that the primary credit facility "backs" the commercial paper facility, the NBL is indicating that it has a revolving line of credit (or another form of committed funding) that can be drawn upon if needed to repay the commercial paper. This acts as a safety net, ensuring that the NBL can meet its short-term obligations even if it faces challenges in rolling over or refinancing its commercial paper in the market.

support[6] for our commercial paper program," or "we use credit lines as backup support[7] for our commercial papers." These reflect the need for liquidity support beyond short-term market funding, which is prone to rollover risk.[8] Applying machine learning to the full prospectus set, I find that about 40% reference credit lines as liquidity buffers, aligning with Blickle et al. (2020)'s findings on nonbank funding instability.

2.2.3 Credit Line Drawdown and Pricing

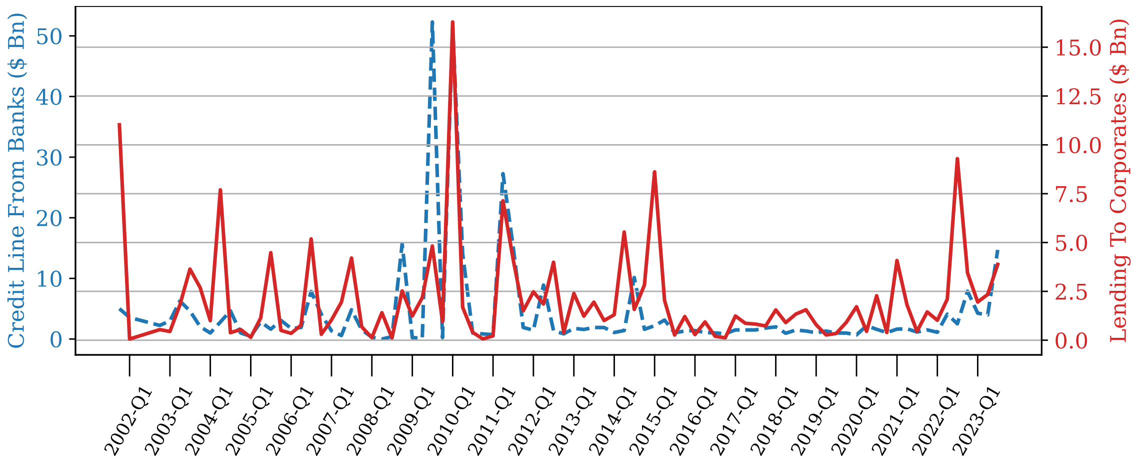
I also examine how nonbank lenders (NBLs) utilize their credit lines. A time-series analysis shows a strong correlation between available (undrawn) credit and lending activity (Figure 5), with credit line availability typically preceding lending. This pattern suggests that NBLs obtain credit lines preemptively to remain flexible and ready to act on future investment opportunities.

[6] "Back-stop" in this context means that the revolving credit facilities serve as a guaranteed fallback or safety net for the commercial paper program. If the NBL is unable to issue or roll over commercial paper (due to market conditions or lack of investor demand), it can fully rely on the revolving credit facility to obtain the necessary funds. This ensures that the NBL can meet its short-term obligations, preventing liquidity shortages.

[7] "Backup support" refers to a secondary or reserve source of funding that can be accessed when needed to ensure that obligations are met. In this case, the revolving credit facility serves as a financial safety net for the operating partnerships commercial paper program. If market conditions make it difficult to roll over (refinance) the commercial paper, or if investors hesitate to buy it, the NBL needs an alternative source of funds to repay the maturing debt. The revolving credit facility acts as this alternative source, ensuring that the NBL has access to cash if commercial paper issuance becomes challenging.

[8] See Appendix B.2 for more examples.

Figure 5: NBL Lending Vs. Credit Line Funding



Notes. Solid red plots quarterly lending for the median NBL (by lending volume) among the 25% of Dealscan NBLs identified in Capital IQ[9]. Blue dotted plots their undrawn credit lines. For total of the 25% of Dealscan NBLs, see Appendix Figure B.1.3

NBLs incur an all-in-drawn spread when drawing down credit lines and an all-in-undrawn spread otherwise. The all-in-drawn spread includes an upfront option premium per committed dollar, a fixed spread, and a risk-free base rate, typically LIBOR/SOFR. Other fees may include annual and utilization fees. My credit line model reflects these institutional features, with credit line limits and option fees set endogenously in Section 3. Additonal details on credit line pricing can be found in Appendix B. This section provides the empirical underpinning for my quantitative model, which I now present in Section 3.

3 Quantitative Model

I develop a quantitative macro-finance model with banks, nonbank lenders (NBLs), and households, highlighting credit lineswith endogenous limits and upfront feesas a key mechanism for liquidity provision and risk-sharing in an interconnected financial system.

In this model, financial intermediaries transform liabilities into corporate loans, represented as Lucas trees. Banks possess a distinct liquidity advantage due to their access to consumer deposits, enabling them to obtain funding at below-market rates. This advantage allows banks not only to invest directly in Lucas trees but also to offer contingent liquidity to NBLs, which encounter investment uncertainty stemming from unpredictable deal flows. Despite facing capital constraints that effectively segment them from NBLs, banks serve as natural insurers for NBLs' investment uncertainties, leveraging their liquidity edge. This segmentation motivates banks to effectively "rent" the balance sheets of NBLs by providing credit lines, which function as options that facilitate risk-sharing and market-completion. A central feature of my model is the endogenous determination of credit line arrangements, whereby banks internalize how increasing credit limits influence NBLs' drawdown behavior and the resulting credit line option premiums.

The subsequent sections first outline the model's preferences, technology, and timing. I then examine in detail the optimization problems faced by NBLs and banks, focusing particularly on the credit line arrangements that connect their balance sheets. Finally, I describe the roles of households and derive the equilibrium market-clearing conditions that close the model.

3.1 Preferences, Technology and Timing

Preferences. Households have EpsteinZin preferences represented by the recursive utility function:

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

where U_t^H denotes household utility at time t. The parameter $\beta_H \in (0,1)$ is the subjective discount factor, $\nu_H > 0$ is the intertemporal elasticity of substitution, and $\sigma_H > 0$ represents relative risk aversion. Period utility u_t^H combines consumption C_t^H and liquidity benefits obtained from holding financial assetsspecifically bank deposits D_{t+1}^H and commercial paper B_{t+1}^Hcarried forward from period t to $t+1$:

$$u_t^H = \left(C_t^H\right)^{1-\varsigma} \left(\left(D_{t+1}^H\right)^{\theta} \left(B_{t+1}^H\right)^{1-\theta} \right)^{\varsigma},$$

where $\varsigma \in (0,1)$ controls the household's preference intensity between consumption and liquidity benefits, and $\theta \in (0,1)$ determines the relative preference between deposits and commercial paper.

Technology. The economy is populated by a constant measure of firms indexed by i. Each firm operates an investment technology requiring one unit of input and delivering a payoff f_t^i at time t, subject to aggregate shocks Z_t and idiosyncratic shocks z_t^i: $f_t^i = \exp(Z_t + z_t^i + \zeta d_t)$, where the aggregate shock Z_t follows an autoregressive process: $Z_t = \rho Z_{t-1} + (1-\rho)\mu + \sigma\varepsilon_t$, with persistence $\rho \in (0,1)$, long-term mean μ, volatility $\sigma > 0$, and standard normal innovation ε_t. The idiosyncratic shock z_t^i is firm-specific and normally distributed: $z_t^i = \sigma^i \varepsilon_t^i$, where ε_t^i are uncorrelated standard normal idiosyncratic shocks across firms. The dummy variable d_t indicates disaster states: $d_t = 1$ if the economy is experiencing a disaster, and $d_t = 0$ otherwise. The disaster state 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 a disaster state, and π_s is the probability of remaining in a disaster state. $\zeta < 0$ is a parameter on disaster severity. Denote $G(f_t^i \mid Z_t, d_t)$ as the density of the payoff f_t^i conditional on the aggregate state (Z_t, d_t).

Non-financial corporates (called "firms" in short) finance investment by issuing long-term debt A_{t+1} at price q_t. Loan payments decline geometrically at rate $\delta \in (0,1)$, and c^A represents coupon payments to the lender. Each period, firms repay a fixed fraction $(1-\delta)$ of the loan principal, with the remaining fraction δ carried forward. The carried-forward portion's value at time $t+1$ is given by the market price q_{t+1}. A firm repays $c^A + (1-\delta) + \delta q_t$ if its payoff satisfies $f_t^i \geq c^A + (1-\delta)$ and defaults otherwise. Upon default, the lender recovers the payoff f_t^i. Due to portfolio diversification, idiosyncratic risks average out, leaving only aggregate shock as the primary driver of firm default. Thus, by the law of large numbers, the aggregate payoff on loans is:

$$\mathscr{P}_t^A = \int_{c^A+(1-\delta)}^{\infty} \left(c^A + (1-\delta) + \delta q_t\right) dG(f_t^i \mid Z_t, d_t) + \int_{-\infty}^{c^A+(1-\delta)} f_t^i dG(f_t^i \mid Z_t, d_t).$$

Finally, firm aggregate dividends, rebated to households, equal residual cash flows after debt payments plus net proceeds from issuing new debt:

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

Timing. The timing of agents' decisions at the beginning of period t is as follows:

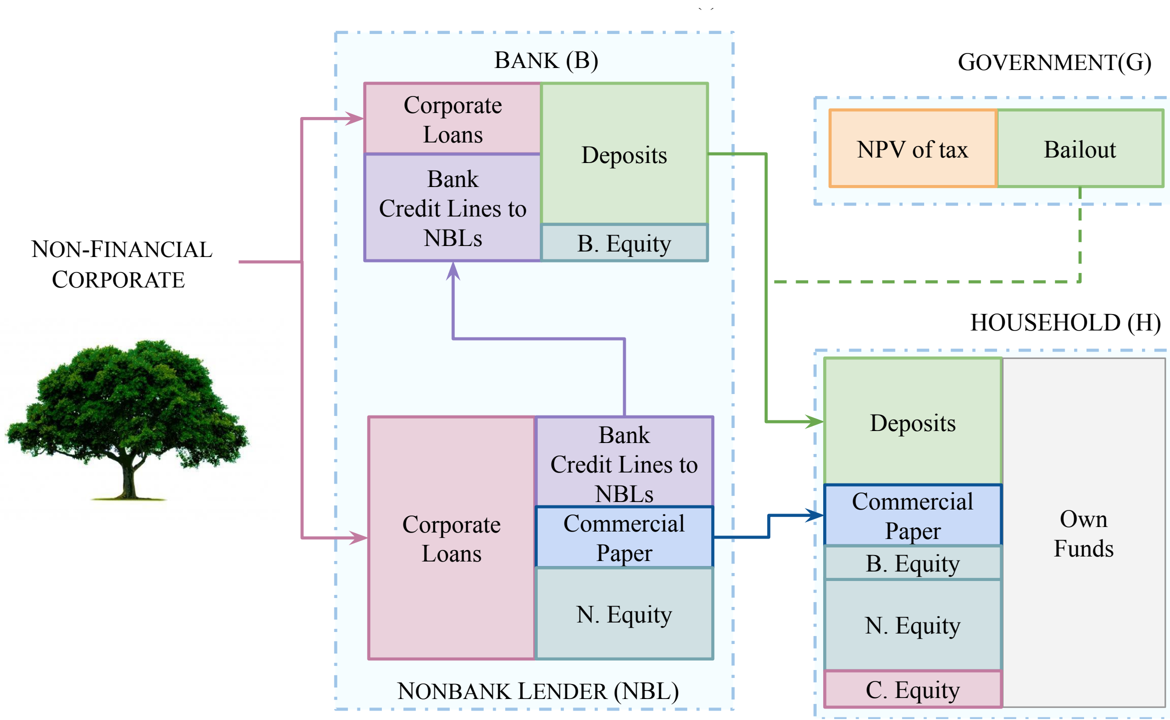
1. Aggregate shocks are realized.
2. Idiosyncratic investment opportunities for NBLs are realized. Individual NBLs decide how much to drawdown from existing credit line commitment.
3. Idiosyncratic profit shocks for banks and NBLs are realized. Individual bank and NBL decide whether to declare bankruptcy. The government liquidates bankrupt banks. If bank assets are insufficient to cover the amount owed to depositors, the government provides the shortfall (deposit insurance). Household take ownership of NBLs and recover the liquidation value of NBL assets.
4. All agents solve their consumption and portfolio choice problems. Markets clear. Households consume.

3.2 Credit Line Contract between Banks and Nonbank Lenders (NBLs)

Real-world credit line contracts are agreements in which lenders (typically banks) grant borrowers the rightbut not the obligationto draw funds up to an agreed-upon limit. This limit reflects the borrowers creditworthiness at the negotiation time. To open a credit line, lenders charge borrowers an upfront fee, effectively functioning as an option premium granting access to liquidity. Additionally, borrowers pay a fixed spread over a floating risk-free rate (formerly LIBOR, now SOFR) for any drawn amounts.[10]

[10]Credit line arrangements also commonly feature annual fees and utilization fees if the drawn portion exceeds certain thresholds. For detailed industry practices, see Ivashina (2005).

Figure 6: Model Overview



To incorporate these realistic features, I model the credit line contract between banks and NBLs as a triple (L_t, q_t^L, s^C). L_t denotes the credit limit agreed upon by banks and NBLs. When setting the credit limit, banks internalize the effect an additional unit of credit availability has on NBL drawdown behavior. The variable q_t^L represents the upfront fee (the option premium) NBLs pay banks for the right to draw down funds when facing investment uncertainty shocks, detailed in Section 3.3. Credit line upfront fees [11] can vary based on several factors, including the size of the facility, the borrower's creditworthiness, and prevailing market conditions. Banks, acting as monopolistic providers of these credit lines, optimally set credit limits, while also internalizing the impact of credit line size on the upfront fee. The fixed spread s^C over the floating risk-free rate r_t^{rf} is determined at the contracts inception and remains unchanged at drawdown.

[11] Credit line upfront fees typically range between 0.25% and 1% of the undisbursed loan amount, varying according to borrower creditworthiness, facility size, and market conditions (see Corporate Finance Institute). Fees tend to vary more significantly among smaller facilities (under \$1 million) compared to larger ones (over \$100 million), which usually exhibit more stable or slightly lower fees (AFSVision). Recent market trends indicate considerable volatility; for instance, subscription line upfront fees rose by 32% during 2023 but stabilized with a modest 1% decline in the first half of 2024 (Haynes Boone).

My credit line modeling approach differs from existing literature by emphasizing the option-like nature of credit lines. If NBLs expect to drawdown more in the face of investment and liquidity uncertainties, they will invest in a higher credit limit *ex ante*. Unlike previous studies (e.g., Greenwald et al., 2023), my model endogenously determines both credit limits and option premiums. When choosing credit limits, banks explicitly account for how increments influence NBL drawdown decisions. Optimal credit limit decisions help banks mitigate corporate credit risks and moral hazard, thereby discouraging excessive risk-taking ("gambling" on credit lines) by NBLs. Furthermore, unlike past literature's binary drawdown choices (Greenwald et al., 2023; Choi, 2022), my model allows for interior drawdown decisions. This flexibility enhances realism and numerical stability.

Additionally, my model integrates realistic regulatory incentives from the Basel framework, where credit lines enjoy preferential capital treatment compared to term loans.[12] Even without regulatory advantages, banks and NBLs naturally benefit from risk-sharing through credit lines; however, banks also internalize the collateral advantages stemming from lower equity buffer requirements for credit lines compared to term loans. Consequently, banks prefer credit line provision, all else equal, to back more deposits effectively.

Lastly, my model captures the real-world flexibility of credit lines, enabling NBLs to efficiently respond to investment opportunities arising from investment uncertainty shocks ι_t. These shocks arise from the fact that NBLs are usually participants rather than lead arrangers in the syndicated loan market, exposing them to less predictable investment opportunities. Credit lines offer crucial funding flexibility in these scenarios, with the upfront fee representing the cost of maintaining this flexibility. Relative to fixed long-term loans or short-term loans sensitive to market fluctuations, credit lines, which are long-term options with short-term drawdown flexibility are a better funding source. NBLs thus optimally balance marginal investment opportunity gains from flexible financing and reduced reliance on commercial paper funding against the costs of upfront fees and repayment obligations. Simultaneously, banks weigh marginal profits from lending and regulatory benefits against risks associated with lending to NBLs. Sections 3.3 and 3.4 detail the optimization problems

[12] Basel II specifies different credit conversion factors (CCF) for credit line products, influencing banks equity buffer requirements. See Basel regulations and an illustration of capital risk-weight calculation.

faced by NBLs and banks, respectively, while Section 4 summarizes these economic mechanisms.

3.3 Nonbank Lenders (NBLs)

I consider the optimization problem of a representative nonbank lender (NBL) facing idiosyncratic default shocks, with aggregation properties to be presented in the paragraphs below. Nonbank lenders invest in Lucas trees and make several key financial decisions each period: investment in loans A^N_{t+1}, establishing a credit line limit L_{t+1} from banks, commercial paper issuance B^N_{t+1}, and equity issuance e^N_t subject to a convex equity issuance cost $\Psi^N(e^N_t)$. They also choose a drawdown policy, detailed below.

Unlike banks, which typically act as lead arrangers in syndicated loan markets, NBLs often participate in loan syndicates, exposing them to deal-flow uncertainties. Banks also frequently sell sub-A term loans (e.g., Term B, C, D, and E loans) to NBLs post-origination (Blickle et al., 2020). I model this exposure through idiosyncratic investment uncertainty shocks, denoted by ι_t, which are independently and identically distributed (i.i.d.) across time and NBLs, according to a log-normal function (CDF) $F(\iota_t)$ defined on the support $[0, \infty)$, with mean $\mathcal{I}$ and time-varying variance $\sigma_{\iota,t}$. The standard of investment uncertainty shocks is positively correlated with aggregate dividend shocks: $\mathcal{I}_t = \bar{\mathcal{I}}\left(1 - \zeta^\iota Z_t\right)$. As will be clear in Section 4, the greater dispersion of investment uncertainty shocks in crisis generates counter-cyclical nonbank origination, for any credit limit $L < \mathcal{I}$. The counter-cyclicality captures securitization substitution from bank-funding to nonbank-funding in crises. When these investment opportunities arise, NBLs draw funds from their pre-negotiated credit lines, subject to the available credit limit. Thus, the individual drawdown amount is $c_{t,\iota} = \min(\iota, L_t)$, leading to the aggregate drawdown:

$$c(L_t) = \int_0^\infty \min(\iota, L_t) dF(\iota) = \int_0^{L_t} \iota dF(\iota) + \int_{L_t}^\infty L_t dF(\iota). \tag{3.2}$$

The drawn credit line amount incurs interest payments at the fixed all-in-drawn spread s above the floating risk-free rate r^{rf}_t, resulting in the rate $R^C_t = r^{rf}_t + s$ per unit drawn.

NBLs also face idiosyncratic profit shocks ϵ_t^N at dividend payout time, which are i.i.d. with mean zero and cumulative distribution F_ϵ^N. These shocks represent variations in credit quality and default outcomes across NBL portfolios à la (Elenev et al., 2021), ensuring a constant fraction $F_{\epsilon,t}^N$ of NBL defaults. These shocks only affect dividend payouts and do not impact future net worth. To aggregate to a representative NBL, I adopt three key assumptions: (i) linearity of the NBL objective with respect to idiosyncratic profit shocks, (ii) shocks affect only current payouts without influencing future net worth, and (iii) defaulting NBLs are replaced by new entrants with equity matching that of surviving NBLs. Details on aggregation appear in Appendix A.1. The representative NBLs net worth N_t^N evolves as $N_t^N = \mathscr{P}_t^A[A_t^N + c(L_t)] - R_t^C c(L_t) - B_t^N$, where $\mathscr{P}_t^A$ represents returns from NBL investments, the second term reflects repayment obligations on drawn credit, and the third term captures commercial paper debt outstanding.

Each period, NBLs distribute a fraction ϕ_0^N of their book equity as dividends but may deviate by issuing equity e_t^N, incurring issuance costs $\Psi^N(e_t^N) = \frac{\phi_1^N}{2}(e_t^N)^2$. The NBL budget constraint reflects the use of retained earnings $(1-\phi_0^N)N_t^N$, net equity proceeds, and commercial paper issuance to finance loan investments A_{t+1}^N and credit line premiums q_t^L per unit of credit line L_{t+1}:

$$q_t A_{t+1}^N + q_t^L L_{t+1} \leq (1-\phi_0^N)N_t^N + e_t^N - \Psi^N(e_t^N) + q_t^r B_{t+1}^N, \tag{3.3}$$

subject to non-negativity constraints on investments and credit lines:

$$0 \leq A_{t+1}^N, \quad 0 \leq L_{t+1}. \tag{3.4}$$

Formally, the representative NBL solves:

$$V(\mathcal{S}_t^N, N_t^N) = \max_{\substack{A_{t+1}^N, L_{t+1}, \\ e_t^N, B_{t+1}^N}} \phi_0^N N_t^N - e_t^N + \epsilon_t^N + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \max\{V_{t+1}^N(\mathcal{S}_{t+1}^N, N_{t+1}^N), 0\}\right], \tag{3.5}$$

subject to constraints (3.3)-(3.4). Here, $\mathcal{M}_{t,t+1}$ denotes the stochastic discount factor, and $\mathcal{S}_t^N$ encapsulates relevant state variables at time t.

3.4 Banks

Banks provide debt financing to the corporate sector by investing in corporate Lucas treeslong-lived assets that yield stochastic dividends over time. Banks differ from nonbank lenders (NBLs) in two fundamental respects:

1. Capital Regulation: Banks are subject to capital requirements, which limit their ability to expand balance sheets in certain states of the world. In contrast, NBLs are unregulated and face no such constraints.

2. Funding Structure: Banks have access to short-term deposits from households, which provide a funding cost advantage. These deposits carry a convenience yieldhouseholds are willing to accept lower returns in exchange for liquidityallowing banks to fund themselves at rates below the market risk-free rate. NBLs do not have access to such deposit funding.

These institutional differences lead to important economic implications.

First, capital regulation creates market segmentation. However, bank credit-lines to NBLs, by nature of being options, help complete markets. These credit lines act as contingent liquidity sources, offering insurance and promoting risk-sharing across institutions. This mechanism enhances market completeness in the presence of regulatory frictions.

Second, access to household deposits enables banks to supply credit more cheaply than NBLs. This liquidity advantage would, in the absence of capital requirements, allow banks to dominate the entire market for corporate lending. However, capital constraints generate a non-corner solution in equilibrium, resulting in the coexistence of both banks and NBLs.

Thus, while regulation creates segmentation between banks and NBLs, the option-like nature of credit lines helps bridge this divide by reallocating liquidity. This risk-sharing role is empirically supported by data from Dealscan Legacy and LSEG LoanConnector (Appendix Figure B.1.1), which show that NBLs rely heavily on banks for funding. These patterns are consistent with findings by Acharya et al. (2024a) that document similar “interlinkages.”

Banks' Balance Sheet Structure. Banks invest in corporate Lucas trees with share A_t^B and offer credit lines L_t to NBLs. When NBLs draw from these credit lines, banks fulfill the requested drawdown $c(L_t)$, up to credit line limit L_t. Banks have access to short-term deposits, D_t, supplied by households, and banks pay deposit insurance fee κ per unit of deposit. Banks are subject to capital requirements. On top of that, current Basel regulation assigns different risk-weights to corporate loans vs. credit lines. In the model, ω^C is the debt-adjusted risk-weight for drawn credit lines, and ω^U is the debt-adjusted risk-weight for undrawn credit lines. These two parameters reflect the Basel requirement on credit line conversion factor for drawn and undrawn credit lines. Details are in the next section on model calibration and also in appendix 5.4. Banks pay target dividends as a fraction (ϕ_0^B) of their net worth but can issue additional equity (e_t^B) at a convex cost $\Psi^B(e_t^B) = \frac{\phi_1^B}{2}(e_t^B)^2$. Bank net worth follows: $N_t^B = \mathscr{P}_t^A A_t^B - D_t + \mathscr{P}_t^L c(L_t) - c(L_t)$, where $\mathscr{P}_t^A$ is the loan payoff, which is the same for both bank and NBL investors. The payoff $\mathscr{P}_t^L$ on credit lines extended to NBLs is defined in the following section 3.5 on aggregation and bailouts.

Banks must satisfy Basel-type risk-weighted capital requirements, maintaining equity (E_{t+1}^B) above a proportion ($\xi^E = 7\%$ baseline) of their risk-weighted assets:

$$E_{t+1}^B \geq \xi^E (A_{t+1}^B + \omega^{C,E} c(L_{t+1}) + \omega^{U,E}(L_{t+1} - c(L_{t+1}))).$$

Institutional details on credit conversion factor of credit lines are in empirical section 2 and Appendix 5.4. Expressed in terms of deposits, this constraint [13] becomes:

$$D_{t+1} \leq \xi \left(A_{t+1}^B + \omega^C c(L_{t+1}) + \omega^U \left(L_{t+1} - c_{t+1}\left(L_{t+1}\right)\right)\right), \tag{3.6}$$

where ξ is the capital requirement parameter that governs the maximum leverage banks can take.

[13] I express the capital requirements in book-value terms, aligning with current regulatory practices. Begenau et al. (2025) demonstrate that market-value based capital requirements more accurately reflect fundamental risks. While the model can accommodate market-value accounting, it remains unclear how exactly to assess the market value of undrawn credit lines. Therefore, I adopt a conservative book-value approach. Note that using market-value accounting would amplify volatility in credit line drawdowns during crises, as asset price fluctuations directly impact the regulatory constraint.

$\xi \equiv 1-\xi^E, \omega^C \equiv \frac{1-\xi^E\omega^{C,E}}{\xi}, \omega^U \equiv -\frac{1-\xi^E\omega^{U,E}}{\xi}$. Banks can also default in my model. At the time of dividend payout, banks experience idiosyncratic profit shocks ϵ_t^B, which are independently and identically distributed with mean zero and cumulative distribution function F_ϵ^B. These shocks capture heterogeneity in credit quality and default outcomes across bank portfolios, following à la Elenev et al. (2021), and imply a constant fraction of defaulting banks each period, given by $F_{\epsilon,t}^B$. These shocks only affect dividend payouts and do not impact future net worth. To enable aggregation in the banking sector, I adopt assumptions analogous to those imposed on NBLs. The banks optimization problem is written recursively as:

$$V_t^B(\mathcal{S}_t) = \max_{A_{t+1}^B, D_{t+1}, L_{t+1}, e_t^B} \phi_0^B N_t^B - e_t^B + \epsilon_t^B + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} V_{t+1}^B(\mathcal{S}_{t+1})\right], \tag{3.7}$$

subject to bank budget constraint:

$$q_t A_{t+1}^B - \left(q_t^f - \kappa\right) D_{t+1} \leq (1-\phi_0^B)N_t^B + e_t^B - \Psi^B(e_t^B) + q_t^L L_{t+1}, \tag{3.8}$$

capital requirement:

$$D_{t+1} \leq \min_{\mathcal{S}_{t+1}|\mathcal{S}_t} \xi[A_{t+1}^B + \omega^C(c(L_{t+1})) + \omega^U(L_{t+1} - c(L_{t+1}))], \tag{3.9}$$

and no shorting constraint:

$$0 \leq A_{t+1}^B. \tag{3.10}$$

3.5 Aggregation and Bailouts

As shown in appendix A.1 that aggregation to a representative bank and a representative NBL is achieved under three assumption: (i) the intermediary objective is linear in the idiosyncratic profit shock $\epsilon_{t,i}^{\mathscr{I}}$, (ii) these shocks affect only contemporaneous payouts, not net worth, and (iii) defaulting intermediaries are replaced with new ones endowed with the same equity as survivors. By linearity, I define value functions for banks and NBLs $\tilde{V}_t^B = V_t^B - \epsilon_{i,t}^B, \quad \tilde{V}_t^N = V_t^N - \epsilon_{i,t}^N$. The bank and NBL default probabilities are defined as $F_{\epsilon,t}^B \equiv F_\epsilon^B \left(-\tilde{V}^B(N_t^B, \mathcal{S}_t)\right), F_{\epsilon,t}^N \equiv F_\epsilon^N \left(-\tilde{V}^N(N_t^N, \mathcal{S}_t)\right)$. The aggregate net dividends paid by banks and NBLs are

$$\mathscr{D}_t^B = \phi_0^B N_t^B - e_t^B + \left(1 - F_{\epsilon,t}^B\right) \epsilon_t^{B,+} - F_{\epsilon,t}^B N_t^B, \tag{3.11}$$

$$\mathscr{D}_t^N = \phi_0^N N_t^N - e_t^N + \left(1 - F_{\epsilon,t}^N\right) \epsilon_t^{N,+} - F_{\epsilon,t}^N N_t^N, \tag{3.12}$$

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

Defaulting banks are liquidated by the government. The fraction that is loss given default is ζ_t^B for defaulted banks. The government pays the aggregate bank bailout:

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

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 levied from households and the proceeds from the deposit insurance fees from banks such that the budget constraint holds:

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

Instead, the government do not bailout defaulting NBLs. However, when a NBL defaults, it affects the return on credit line that their bank lenders can obtain. In particular, the return on credit lines is:

$$\mathscr{P}^L_{t+1}(L_{t+1}) = \underbrace{(1 - F^N_{\epsilon,t+1})R^C_{t+1}}_{\text{Non-defaulting NBL repayment}} + \underbrace{F^N_{\epsilon,t+1} RV^N_{t+1} + \frac{F^N_{\epsilon,t+1}\epsilon^{N,-}_{t+1}}{c(L_{t+1}) + B^N_{t+1}}}_{\text{Default recovery on credit lines}}, \tag{3.13}$$

where the conditional expectation $\epsilon^{N,-}_t = \mathrm{E}_{\epsilon^N}\left[\epsilon^N \mid \epsilon^N \leq \tilde{V}^N\left(N^N_t, \mathcal{S}_t\right)\right]$ is the expected idiosyncratic profit of defaulting NBLs. Recovery value (RV^N_{t+1}) if NBL default occurs is:

$$RV^N_{t+1} = (1 - \zeta^N)\frac{\mathscr{P}^A_{t+1}\left(A^N_{t+1} + c(L_{t+1})\right)}{c(L_{t+1}) + B^N_{t+1}}. \tag{3.14}$$

3.6 Households

Households own equity shares of banks and nonbank lenders (NBLs), receiving aggregate dividends from banks $\mathscr{D}^B_t$ and NBLs $\mathscr{D}^N_t$. At each time t, households allocate their wealth among consumption C^H_t, bank deposits D^H_{t+1}, and NBL-issued commercial paper B^H_{t+1}. They derive liquidity benefits from holding deposits and commercial paper. The prices of one-period bank deposits and NBL commercial paper at time t are denoted by q^f_t and q^r_t, respectively.

Households choose C^H_t, D^H_{t+1}, and B^H_{t+1} to maximize their utility function U^H_t subject to the following budget constraint:

$$C^H_t + q^f_t D^H_{t+1} + q^r_t B^H_{t+1} + T_t + O_t + \leq W^H_t, \tag{3.15}$$

where household wealth, W^H_t, consists of dividends from firms Div^A_t , maturing bank deposits D^H_t dividends from banks and nonbanks $\mathscr{D}^B_t + \mathscr{D}^N_t$, and returns from maturing commercial paper:

$$\begin{aligned} W^H_t &= Div^A_t + D^H_t + \mathscr{D}^B_t + \mathscr{D}^N_t \\ &\quad + B^H_t\left[\left(1 - F^N_{\epsilon,t}\right) + F^N_{\epsilon,t}\left((1-\zeta^N)\frac{\mathscr{P}^A_t\left(A^N_t + c(L_t)\right)}{B^N_t + c(L_t)}\right) + F^N_{\epsilon,t}\frac{\epsilon^{N,-}_t}{B^N_t + c(L_t)}\right]. \end{aligned} \tag{3.16}$$

To close the model and ensure the aggregate resource constraint holds, any residual loan demand generated by investment shocks that exceeds the nonbank lenders credit limit is offloaded to households.[14] O_t represents how much funding is required -beyond rollover of existing assets and credit line proceeds - to originate and service loans in response to the investment uncertainty shock, with detailed derivations in appendix.

In the above expression, $F_{\epsilon,t}^N$ represents the probability of NBL default at time t, and ζ^N is the fractional haircut incurred when NBLs default. $\mathscr{P}_t^A$ denotes the payoff on NBL assets at time t. B_t^N is the total outstanding NBL commercial paper debt at time t, and the conditional expectation $\epsilon_t^{N,-} = \mathrm{E}_\epsilon\left[\epsilon \leq \tilde{V}^N\left(N_t^N, \mathcal{S}_t\right)\right]$ is the expected idiosyncratic profit of defaulting NBLs.

3.7 Equilibrium

Given a sequence of aggregate shocks$\{Z_t\}$, and a government policy $\Theta_t = \{\xi, \omega^C, \omega^U\}$, a competitive equilibrium is an allocation $\{e_t^B, A_{t+1}^B, L_{t+1}\}$ for banks, $\{e_t^N, A_{t+1}^N, B_{t+1}^N, c_{t+1}, L_{t+1}\}$ for non-banks, $\{C_t^H, D_{t+1}^H, B_{t+1}^H\}$ for households, and a price vector $\{q_t, q_t^L, q_t^f, q_t^r, R_t^C\}$, such that given the prices, households maximize life-time utility, banks and nonbanks maximize shareholder value, the government satisfies its budget constraint, and markets clear. The market-clearing conditions are:

$$\text{Deposits:} \quad D_{t+1} = D_{t+1}^H \ , \tag{3.17}$$

$$\text{Non-bank Debt:} \quad B_{t+1}^N = B_{t+1}^H \ , \tag{3.18}$$

$$\text{Loans:} \quad 1 = A_{t+1}^B + A_{t+1}^N + \mathcal{I}_{t+1} \ , \tag{3.19}$$

$$\text{ARC:} \quad \exp(Z_t - \zeta d_t) = C_t^H + \Psi^B\left(e_t^B\right) + \Psi^N\left(e_t^N\right) + DWL_t \ . \tag{3.20}$$

The last equation is the economys resource constraint. It states that total output equals the sum of aggregate consumption including equity issuance costs and deadweight losses. During the bankruptcy processes, ζ^N are losses given default (in proportion to total assets) of nonbanks. Hence, dead-

[14]We can think of households as loan mutual funds in this model.

weight losses are defined as

$$DWL_t = \zeta^B F^B_{\epsilon,t}\left(\mathscr{P}^A_t A^B_t + \mathscr{P}^L_t c(L_t)\right) + \zeta^N F^N_{\epsilon,t}\mathscr{P}^A_t (A^N_t + c_t(L_t)). \tag{3.21}$$

4 The Economics of the Credit Line Contract

This section elucidates the economic mechanisms underlying the credit line model. Detailed derivations are provided in the Model Appendix A. To understand the private value of credit lines to banks and nonbank financial institutions (NBLs) at the micro level, this section analyzes the individual trade-offs each party faces by examining the first-order conditions of their respective maximization problems with respect to the credit line.

The Value of Credit Lines to Nonbank Lenders (NBLs). Credit lines grant nonbank financial institutions (NBLs) partial flexibility to fund investment opportunities. NBLs weigh the net marginal costs of credit lines against their marginal benefits, captured by the NBL's first-order condition with respect to the credit limit L_{t+1}:

$$\underbrace{q^L_t}_{\text{Upfront fee}} \underbrace{-\overbrace{\frac{\partial q^r_t}{\partial L_{t+1}}}^{<0} B^N_{t+1}}_{\substack{>0,\text{Marginal cost from} \\ \text{increased NBL risk}}} = \underbrace{\mathrm{E}_t\left[\mathcal{M}^N_{t,t+1}\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right)\frac{\partial c(L_{t+1})}{\partial L_{t+1}}\right]}_{\text{Net marginal benefit of credit line}} \tag{4.1}$$

$$= \frac{1}{R^N_t}\left[\mathrm{E}^{Q^N}_t\left[\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right)\right]\mathrm{E}^{Q^N}_t\left[\frac{\partial c(L_{t+1})}{\partial L_{t+1}}\right] + \mathrm{Cov}^{Q^N}_t\left(\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right), \frac{\partial c(L_{t+1})}{\partial L_{t+1}}\right)\right] \tag{4.2}$$

where I define Q^N as the risk-neutral measure associated with the nonbank SDF $\mathcal{M}^N_{t,t+1}$. The full derivation of $\mathcal{M}^N_{t,t+1}$ is in equation (A.6) under Appendix A.2. Under Q^N all cash flows are discounted at the gross rate $R^N_t \equiv \left(\mathbb{E}_t\left[\mathcal{M}^N_{t,t+1}\right]\right)^{-1}$.

There are two key costs associated with credit lines. The first term on the left-hand side (LHS) of equation (4.1), denoted by q^L_t, is the upfront fee that NBLs pay to banks in exchange for the right to draw down from a committed credit line. This fee is analogous to an option premium. The second term on the LHS is an indirect cost that arises from a deterioration in the NBLs perceived creditworthiness. Specifically, the derivative $\frac{\partial q_t^r}{\partial L_{t+1}}$ captures how the price q_t^r of NBL-issued commercial paper responds to a change in the future credit line limit L_{t+1}, and B_{t+1}^N is the total amount of commercial paper issued by NBLs in period $t+1$. The term $\frac{\partial q_t^r}{\partial L_{t+1}}$ is negative: a larger credit limit encourages greater drawdown, which increases NBL leverage, raises perceived default risk, and thus increases the yield (i.e., lowers the price) required by investors on NBL-issued commercial paper. The resulting higher funding cost imposes a marginal cost on the NBL.

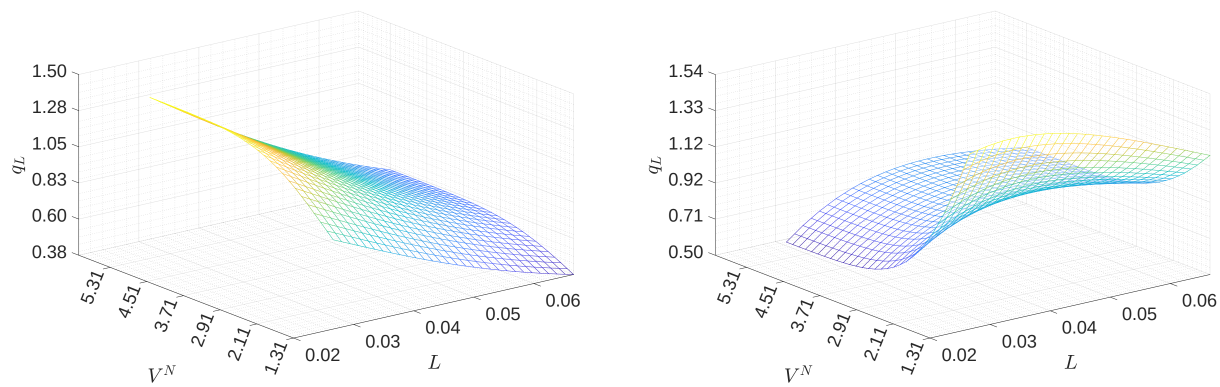
These costs are weighed against the net marginal benefit on the right-hand side (RHS) of equation (4.1). This benefit reflects the net financial gain from an incremental increase in the credit limit seeking *ex ante* credit line funding enable NBLs to seize investment opportunities and to hedge liquidity risks. In particular $\mathscr{P}_{t+1}^A$ is the gross return on newly funded investment opportunities. R_{t+1}^C is the per-unit interest rate charged by the bank on any drawn amount of the credit line. These cash flows are discounted using the NBL's stochastic discount factor $\mathcal{M}_{t,t+1}^N$. Finally, as the credit limit L_{t+1} increases, the expected drawdown c_{t+1} also rises, i.e., $\frac{\partial c(L_{t+1})}{\partial L_{t+1}} > 0$. This derivative captures the sensitivity of utilization to changes in the credit limit.

We can also decompose the expression in equation (4.1) into mean and covariance terms in equation (4.2). Empirically, I have shown in 4(a), in crisis, nonbank share of loans increases. Mapping onto the model, when the loan payoffs are low $\mathscr{P}_{t+1}^A$ due to shocks to collateral value, $\frac{\partial c(L_{t+1})}{\partial L_{t+1}} = 1 - F(L_{t+1})$ as shown in (4.3) increases. This means that when firm collateral value is low (bad aggregate shock), the variance of investment shock is high, given any credit limit $L < \mathcal{I}$, with less dispersion, more mass lies closer to the meanand hence above a low cutoff $F(L)$. As shown in Figure 4(a), in crisis, the share of nonbank origination counter-cyclically goes up. This covariance is negative, which means, exactly in the bad states of the worst is the drawdown the most severe.

To visualize the price schedule, Figure 7(a) plots the nonbank lenders (NBLs) first-order condition with respect to the credit limit L_{t+1}. From the NBL's perspective, the price per unit of credit line option, q_L, decreases with the amount of credit limit demanded. This downward slope reflects the monopolistic position of banks in supplying credit lines: in monopolistic settings, the buyers marginal willingness to pay typically declines with quantity. As the credit limit increases, each additional unit of liquidity delivers lower marginal value to the NBL, reflecting diminishing returns to liquidity insurance. At the same time, q_L increases in the NBLs net worth V^N. Higher net worth reduces the likelihood of default, so NBLs place greater value on the flexibility that credit lines offer and are willing to pay more for them. In my model, default is both costly and endogenous, and credit lines serve not merely as emergency funding but as a source of financial flexibility. The willingness to pay per unit (i.e., the price schedule) rises in net worth V^N, because only when the NBL is sufficiently solvent does the option to draw on credit have real valuei.e., it won't just trigger default. Therefore, high-V^N NBLs can afford to pay more and get more out of the credit line, much like wealthier consumers derive more utility from flexible financial instruments. In that narrow sense, the price sensitivity resembles a "luxury" good, though the underlying demand for liquidity is still precautionary in nature. It is important to distinguish this borrower-side logic from that of the lender. From the banks perspective, a higher NBL net worth reduces default risk, lowering expected losses and making credit lines cheaper to supply. But in this figure, we are focusing on the NBLs willingness to paynot the banks cost of provision, which I discuss in detail in the next paragraph.

The Value of Credit Lines to Banks. Banks receive an upfront fee q_t^L when extending credit lines to nonbank financial institutions (NBLs). In setting the optimal credit limit, banks weigh the marginal benefitssuch as improved risk-sharing with NBLs and regulatory advantages over term loansagainst the marginal costs, primarily stemming from a potential increase in NBL default risk. Crucially, this risk materializes on bank balance sheets only if the credit line is drawn. As a result, a central consideration is how drawdowns respond to changes in the committed credit limit.

Figure 7: Credit Line Pricing Schedule



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

Notes. The surface in panel (a) shows the NBLs first-order condition (4.1) for choosing the credit limit L_{t+1}, with q_L (z-axis) denoting the NBL willingness to pay per unit of credit, L_{t+1} (x-axis) the chosen limit, and the continuation value (y-axis) the NBLs state-value function. Panel (b) depicts the banks first-order condition (4.4) for pricing the credit line, where the z-axis shows the upfront fee bank demands (option premium), the x-axis is L_{t+1}, and the y-axis is the NBLs net worth V^N.

$$\frac{\partial c(L_t)}{\partial L_t} = \frac{\partial}{\partial L_t}\left(\int_0^{L_t} \iota_t \, dF(\iota_t) + \int_{L_t}^{\infty} L_t \, dF(\iota_t)\right) = 1 - F(L_t). \tag{4.3}$$

In this expression, $F(\cdot)$ denotes the cumulative distribution function (CDF) of the investment uncertainty shocks ι_t faced by NBLs. Equation (4.3) shows that the marginal drawdown from increasing the credit limit L_t equals the probability that the investment shock exceeds the existing limit. Consequently, banks internalize NBLs expected response when selecting L_{t+1}, which acts as an endogenous deterrent against offering excessively large credit limits *ex ante*. This consideration enters the banks optimization via the following first-order condition for credit line extension, shown in equation (4.4).

$$\underbrace{-\overbrace{\frac{\partial q_t^L}{\partial L_{t+1}}}^{<0} L_{t+1}}_{\text{Monopolistic}} \underbrace{-\tilde{\lambda}_t^B \xi \overbrace{\omega^U}^{<0}}_{\text{Space cost}} \underbrace{-\mathbb{E}_t\Big[\mathcal{M}^B_{t,t+1} c(L_{t+1}) \overbrace{\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}}}^{<0 \text{ in bad agg.}}\Big]}_{\text{NBL repayment risk}}$$

$$= \underbrace{q_t^L}_{\text{premium}} + \underbrace{\tilde{\lambda}_t^B \xi(\omega^C-\omega^U)\frac{\partial c(L_{t+1})}{\partial L_{t+1}}}_{\text{Regulatory benefit}} + \underbrace{\mathbb{E}_t\left[\mathcal{M}^B_{t,t+1}\frac{\partial c(L_{t+1})}{\partial L_{t+1}}\left(\mathscr{P}^L_{t+1}-1\right)\right]}_{\text{MB on risk-sharing}} \tag{4.4}$$

The left-hand side (LHS) of equation (4.4) captures the expected marginal cost to the bank from extending credit lines. Because banks are monopolistic in providing credit lines due to their unique liquidity advantage (e.g., access to stable deposit funding), they internalize how increasing the credit limit affects the price per unit of credit line. In particular, the derivative of q_t^L with respect to L_{t+1} is given by:

$$\frac{\partial q_t^L}{\partial L_{t+1}} = \mathrm{E}_t\left[\mathcal{M}^N_{t,t+1}\left[-\left(\mathscr{P}^A_{t+1} - R^C_{t+1}\right) f(L_{t+1})\right]\right]. \tag{4.5}$$

Price per unit of credit is decreasing in the limit, $\partial q_t^L/\partial L_{t+1} < 0$, which deters banks from offering unbounded credit limit. Second, while credit lines become assets for banks when drawn, they are liabilities prior to drawdown. As such, from a regulatory perspective, credit lines impose an *ex ante* costeffectively occupying balance sheet space as contingent liabilities. Third, by lending to NBLs, banks are exposed to repayment risk, particularly in adverse aggregate states. I show in Appendix A.3.4 that $\partial \mathscr{P}^L_{t+1}/\partial L_{t+1} < 0$ in such states, reflecting the increasing credit risk borne by banks as they extend larger credit lines to NBLs.

Banks weigh these three aforementioned costs against the associated benefits. First, banks receive an upfront fee $q_t^L(L_{t+1})$ per unit of committed credit, so the total premium depends on both the price and the size of the credit limit. Second, the regulatory benefitcaptured by the second term on the right-hand side (RHS)arises from the differential capital treatment of drawn and undrawn exposures under Basel regulation. Specifically, $\tilde{\lambda}_t^B$ denotes the banks shadow cost of regulatory capital, ξ is the regulatory weight, and the expression includes $\frac{\partial c(L_{t+1})}{\partial L_{t+1}}$, the sensitivity of expected drawdown to the credit limit. The capital treatment differentiates between the risk weights on drawn (ω^C) and undrawn (ω^U) exposures and applies a credit conversion factor (CCF) to convert undrawn limits into risk-weighted assets. A detailed explanation of this regulatory treatment is given in Section 3.4, with empirical implementation in Section 2 and Appendix 5.4. Third, the final term on the RHS reflects the risk-sharing benefit: by offering credit lines, banks obtain partial access to NBL investment returns. In effect, banks are "renting" balance sheet capacity from NBLs and sharing in the upside of their investments. The variable $\mathscr{P}^L_{t+1}$ denotes the expected payoff on credit lines, inclusive of repayments from solvent NBLs and recovery values in default states. A full derivation of $\mathscr{P}^L_{t+1}$ is provided in equation (3.13).

Figure 7(b) illustrates how banks internalize the marginal pricing of each additional dollar committed. As L_{t+1} increases from 0.035 to 0.05, the option premium q^L_t rises, reflecting increased expected drawdown and default risk. Beyond $L_{t+1} = 0.05$, the derivative $\frac{\partial q^L_t}{\partial L_{t+1}}$ declines in magnitude, leading to a flattening of the surface. q^L_t is shown to decrease with NBL net worth V^N. Higher net worth lowers default probabilities and thereby reduces the required upfront premium that banks require. Overall, credit lines offer NBLs partial funding flexibility, while banks endogenously adjust credit limits to balance profitability against risk exposure.

5 Calibration

I calibrate the model to U.S. syndicated loan data from 1990 to 2023, with each model period corresponding to one year. There are two groups of parameters, the externally calibrated and the internally calibrated. Externally calibrated parameters (Table 1) are calculated directly from data or sourced from existing literature. Internally calibrated parameters (Table 2) are chosen to align the model with targeted moments observed in the data. In the subsections below, I discuss these parameters for credit risk, financial intermediation, preferences, and regulation[15], presenting externally calibrated parameters first, followed by internally calibrated ones. Additional institutional details

[15]The regulation section includes only externally calibrated parameters estimated from institutional details.

are provided in Calibration Appendix C.

Table 1: Pre-Set Parameters

Parameter	Description	Value	Source
		Credit Risk	
π^d	Annual prob. of disaster	3.97%	Exp. ann. disaster prob. (Moody's)
π^s	Annual prob. of staying in disaster	32%	Exp. disaster length 1 year
		Financial Intermediation	
s	Credit line spread	88 bps	Dealscan Legacy and LSEG LoanConnector, Appendix C.1
δ	Corporate loan average life	0.928	FRED, Bloomberg, Appendix C.3
ϕ_0^B	Target bank dividend	0.068	Elenev et al. (2021)
ϕ_0^N	Target nonbank dividend	0.072	Avg. NBL dividend
κ	Bank deposit insurance fee	0.00142	Begenau and Landvoigt (2022)
π	Non Bank 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	1.007	Basel CCF details in Appendix 5.4
ω^U	Undrawn portion adjustment	1.047	Basel CCF details in Appendix 5.4

5.1 Credit Risk

I calculate the probability of transitioning into a disaster, $\pi_d = 3.97\%$ from the expected annual rare 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 within one year for non-financial corporations in the US. My calculation is similar to the unconditional annual disaster probability of 3.55% in Wachter (2013). π_s is the probability of remaining in disaster state. Spells of the disaster state are geometrically distributed with $\Pr(\text{ duration } = n) = \pi_s^{n-1}(1-\pi_s)$. Their mean length (in quarters) is $\mathrm{E}[\text{duration}] = \sum_{n=1}^{\infty} n\pi_s^{n-1}(1-\pi_s) = \frac{1}{1-\pi_s}$. Setting this equal to 4 quarters (one year) gives $\pi_s = 1 - \frac{1}{4} = 0.75$. Over four consecutive quarters,

Table 2: Calibrated Parameters

Par	Description	Value	Target	Model	Data
			Credit Risk		
ρ	Persistence of dividends	0.95	AC(1) corporate default rate	0.57	0.68
σ	Volatility of dividends	0.04	Volatility of corp. default rate	0.59%	0.54%
σ^i	Volatility of idiosyncratic shocks	0.11	Moody's EDF within 1 yr for US non-financial firms	0.63%	0.62%
c^A	Corporate loan coupon	0.3	Corporate loan loss given default (Elenev et al., 2021)	63.84%	51.40%
ζ	Disaster multiple	0.11	Corporate default conditional on disaster	2.35%	2.4%
			Financial Intermediation		
μ_ι	Mean of investment uncertainty (IU) shocks	0.065	NBL loan share	48%	44%
σ_ι	Dispersion of IU shocks	0.055	Credit line utilization ratio	82%	81.31%
ϕ_1^B	Bank equity issu. cost	5	Bank equity issu. ratio	1.0%	1.0%
ϕ_1^N	NBL equity issu. cost	1	NBL equity issu. ratio	2%	4.5%
ζ^B	Bank loss given default	0.86	Bank debt recovery (Begenau and Landvoigt, 2022)	47%	48.1%
ζ^N	NBL loss given default	0.83	Unsec. and sub. debt recovery (Begenau and Landvoigt, 2022)	35%	38%
$\sigma_{\epsilon,B}$	Cross-sect. dispersion ϵ_t^B	3.2	Bank default (Elenev et al., 2021)	0.5%	0.5%
$\sigma_{\epsilon,N}$	Cross-sect. dispersion ϵ_t^N	1.25	Nonbank bond default rate	0.05%	0.2%
θ^C	CP buy back cost	0.005	Commercial Paper/ Credit Line	3.5	3.1
			Preferences		
β_H	Time discount factor	0.99	Risk-free rate	0.96%	1%
ς	Weight btw. dep. vs. cons.	0.005	Deposit rate (Begenau et al., 2024)	0.24%	0.3%
θ	Weight btw. dep. vs. CP	0.75	3-month GC-repo/T-bill spread (Upperbound [16]) (Nagel, 2016)	0.19%	0.24%

the probability of never exiting the disaster state is $0.75^4 \approx 0.32$, assuming each quarter has equal probability of staying in the disaster. Having "disaster" as a rare, big-move with persistence[17], is aimed only at matching the depth of financial crises.

Aggregate shocks to the borrowers collateral values, denoted as Z_t, follow an autoregressive process of order 1, AR(1). This process is characterized by a persistence parameter ρ and a volatility parameter σ. 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 $\rho = 0.95$ and $\sigma = 2\%$ are chosen to match the persistence (autocorrelation of order (1)) of the average corporate default rate, which is 0.68, and the volatility of the corporate default rate, which is 0.54%, in the data. I use the volatility of idiosyncratic shocks σ^i 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 0.67%. An alternative for corporate loan default rate is to use Elenev et al. (2021)'s target [18] of corporate loan default. However, Elenev et al. (2021) only have the corporate loan default rate for loans on bank balance sheet. Since my paper includes both bank and nonbank loans, I use Moody's EDF instead. The corporate loan coupon payment c^A is set to match corporate loan severities of 51.40% as in Elenev et al. (2021). Finally, I use the disaster multiple ζ to match the corporate default probability conditional on disaster, which is 2.4% in the data.

[17] In the discretetime, twostate Markovchain disaster model, a shock has duration: once $d = 1$, the economy remains in the disaster state for a geometrically distributed number of periods. By contrast, in a continuoustime jumpdiffusion each jump is instantaneousthere is no separate state that the process lingers in. I therefore use the term disaster in my model to distinguish it from jumpdiffusion terminology, not to imply any particular interpretation of the word "disaster." Although both frameworks introduce rare, large shocks, they differ in timing and persistence.

[18] A brief description of their target calculation is as follows: The first dataset is sourced from the Federal Reserve Board of Governors, provides delinquency and charge-off rates for Commercial and Industrial loans as well as Commercial Real Estate loans issued by U.S. Commercial Banks from 1991 to 2015, with an average delinquency rate of 3.1%. The second dataset from Standard & Poors reports default rates on publicly-rated corporate bonds spanning 1981 to 2014, with an average default rate of 1.5%0.1% for investment-grade bonds and 4.1% for high-yield bonds. The results of the model align between these two figures.

5.2 Financial Intermediation

Credit line spread. I calculate from Dealscan and LSEG LoanConnector the average fixed spread [19] of credit lines from banks to nonbank lenders (NBLs). The average[20] spread is 88 bps. Appendix Figure C.1 has detailed credit line all-in-drawn and all-in-undrawn spread (in Dealscan and LSEG language) for credit lines of different maturities.

Corporate loan average life. In my model, all corporate loans are modeled as geometrically declining perpetuities, where the borrower promises payments of δ^{t-1} over time, for all $t \in \mathbb{N}^+$. To align the model with real-world data, I construct an aggregate bond index using investment-grade and high-yield bonds from Bank of America Merril Lynch (BofAML) and Barclays Capital (BarCap) from 1997 to 2023, weighting them by market value to calculate key characteristics like weighted-average maturity (WAM) and weighted-average coupon (WAC). I then compare the price of a standard bond with WAM = 10 years and WAC = 5.93% to a theoretical bond model, calibrating the decay rate $\delta = 0.928$ to match the observed duration of corporate loans. For details, see Calibration Appendix C.3. The implied average duration of corporate loans in the model is 7.01 years.

Target dividends. I use the bank target dividend parameter from Elenev et al. (2021), set at 6.8% of bank net worth. For nonbank lenders (NBLs), I am able to match a subset, 193 out of 371 firms in the Dealscan data to their Global Company Keys (GVKEYs) using the Roberts Dealscan-Compustat Linking Database (Chava and Roberts, 2008). 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. This result is expected, as my sample includes only

[19] In Dealscan and LSEG LoanConnector, All-in-spread drawn (AISD) "describes the amount the borrower pays in basis points over LIBOR for each dollar drawn down. It adds the spread of the loan with any annual (or facility) fee paid to the bank group." See, Dealscan dictionary. Unfortunately, DealScan does not disaggregate the fixed spread from other fees; it reports a single allin spread that bundles the fixed margin with all associated fees. And although DealScan itemizes certain fee components occasionally, the coverage and format are too inconsistent for us to reliably isolate the standalone fixedspread element. We traditionally think of "all-in-drawn spread" as the total rate, which includes the upfront fee, the LiBOR/SOFR risk-free base rate, fixed spread, and annual fee, etc, as explained inIvashina (2005).

[20] The facility-amount weighted average spread on top of the risk-free rate is 63 basis points.

those NBLs with identifiable GVKEYs and available dividend data in Compustat. I do not use data from Damodaran (2024) since my sample contains very few insurance firms, which tend to have higher payout ratios.

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

Investment uncertainty. The investment uncertainty shocks are distributed log-normally with mean μ_ι and standard deviation σ_ι. I use the mean μ_ι to target NBL loan share, which equals 43.48%. 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 LoanConnector. Details are in Appendix C.2. Then, I use σ_ι to target a credit line utilization ratio of 81%.

Equity funding. The equity issuance costs for banks and nonbank lenders (NBLs) are used to target their equity issuance ratios in the data, calculated as equity issuance divided by book equity. Drawing on calculations from Elenev et al. (2021), banks, on average, distributed 6.8% of their book equity annually as dividends and share repurchases between 1974 and 2018. Additionally, the financial sector's payout ratio, defined as dividends plus share repurchases minus equity issuances divided by book equity, is reported as 5.75% in Elenev et al. (2021). The difference between these two figures yields the bank equity issuance ratio, calculated to be 1.05%. I use bank equity issuance cost parameter $\phi_1^B = 7$ to match the bank equity issuance ratio. I calculate from CRSP the equity issuance ratio of NBL to be 4.5%. I use NBL equity issuance cost parameter $\phi_1^N = 5$ to match the NBL equity issuance ratio.

Default. I set the loss given default on nonbank loans to 0.25 to align with Moodys estimated recovery rate of 38.2% for unsecured and subordinated debt, following Begenau and Landvoigt (2022). To match the average leverage of nonbank lenders (NBLs), I use the cross-sectional dispersion of NBL profitability shocks, ϵ_t^N. The target NBL leverage is calculated using Compustat - Financial Ratios data. Among the 371 firms in the Dealscan database, I successfully match 123 GVKEYs to Compustat - Financial Ratios data from 1990-01-01 to 2023-12-31. I then compute the average leverage ratio, defined as total debt to total assets, across all firms and time, obtaining an estimate of 0.65 for U.S. NBLs. This estimate is consistent with regulatory constraints such as the 1940 Investment Company Act, which limits the maximum debt-to-equity ratio to 2:1 for business development companies. My sample includes not only business development companies but also investment funds, institutional investors, and other financial entities. Given the broad range of NBLs in my sample, a leverage ratio of 0.65 remains broadly aligned with NBL leverage levels. I use the cross-sectional dispersion of bank profitability shocks ϵ_t^N to match the bank default probability of 0.5% as in Elenev et al. (2021). I use the cross-sectional dispersion of nonbank lender (NBL) profitability shocks ϵ_t^N to match the nonbank bond default rate, which is also used in Begenau and Landvoigt (2022) as their shadow bank (S-bank) bond default rate target, 0.28%.

5.3 Preferences

Households derive utility from consumption C_t and deposit services D_t. Household risk aversion and inter-temporal elasticity of substitution are set to 1 for log utility. I choose the subjective discount factor $\beta_H = 0.991$ to match a risk-free rate of about 1% in the data (model-implied: 0.99%). The deposit-service weight relative to consumption $\varsigma = 0.005$ is calibrated to target two moments from Begenau et al. (2024): a net transaction deposit rate of 0.3%, measured by subtracting interest on time deposits from total deposit interest expenses and dividing by the beginning-of-period balance of transaction deposits (excluding time deposits). The utility weight between deposit and commercial paper is set to 0.75 to match liquidity premium of 24 bps, equal to the three-month general collateral (GC)-repo/T-bill spread. Since Treasury bills are more money-like than commercial paper, the 24 bps spread is an upper bound on commercial-paper liquidity services.

5.4 Regulation

I externally calibrate the maximum bank leverage $\xi = 0/93$ to fit a 7% capital requirement. The Credit Conversion Factor (CCF) under the Basel framework is a key metric used to assess the credit risk of off-balance sheet exposures, such as letters of credit and guarantees. It calculates the percentage of the off-balance sheet exposure potentially converted into an actual on-balance sheet equivalent exposure. This metric is vital for banks and financial institutions to estimate and manage the risk associated with these exposures. In Basel I and II Part 2: The First Pillar- Minimum Capital Requirements published by Basel Committee on Banking Supervision (2020), item 599 specifies for any committed retail credit line, the credit conversion factor is 90%. According to item 83, "Commitments with an original maturity up to one year and commitments with an original maturity over one year will receive a CCF of 20% and 50%, respectively. However, any commitments that are unconditionally cancellable at any time by the bank without prior notice, or that effectively provide for automatic cancellation due to deterioration in a borrowers creditworthiness, will receive a 0% CCF." Basel III has further refined the regulatory framework for off-balance sheet items. It introduces more risk-sensitive credit conversion factors (CCFs), which are essential for determining the risk-weighted exposure amounts. It includes the implementation of positive CCFs for unconditionally cancellable commitments (UCCs), enhancing the precision of risk assessment. To estimate the relative capital risk weight on credit line, I take a weighted average of CCF based on drawn and undrawn credit lines from banks to NBLs. year. The required regulatory capital in terms of equity is

$$E_{t+1}^{B} \geq \xi^{E}\left(A_{t+1}^{B} + \omega_{drawn}^{CCF} c(L_{t+1}) + \omega_{undrawn}^{CCF}\left(L_{t+1} - c(L_{t+1})\right)\right)$$

This means,

$$
\begin{aligned}
D_{t+1} \leq\, & A^B_{t+1} + c_{t+1} - \xi^E \left(A^B_{t+1} + \omega^{CCF}_{drawn} c\left(L_{t+1}\right) + \omega^{CCF}_{undrawn}\left(L_{t+1} - c\left(L_{t+1}\right)\right)\right) \\
=& (1-\xi^E) A^B_{t+1} + (1 - \xi^E \omega^{CCF}_{drawn}) c\left(L_{t+1}\right) - \xi^E \omega^{CCF}_{drawn}\left(L_{t+1} - c\left(L_{t+1}\right)\right)
\end{aligned}
$$

Writing this in terms of the maximum leverage that banks can take results in

$$
D_t \leq \xi \left(A^B_{t+1} + \omega^C c_{t+1} + \omega^U \left(L_{l+1} - c_{t+1}\right)\right)
$$

where I denote $\xi := 1 - \xi^E, \omega^C := \left(1 - \xi^E \omega^{CCF}_{drawn}\right)/\xi, \omega^U := -\xi^E \omega^{CCF}_{undrawn}/\xi$. Therefore, I can calculate,

$$
\begin{aligned}
&\xi = 1 - 0.07 = 0.93 \\
&\omega^C = \left(1 - \xi^E \omega^{CCF}_{drawn}\right)/\xi = (1 - 0.07 * 0.90)/0.93 = 1.0075
\end{aligned}
$$

Note that for the capital weight on the undrawn, we need to separate the undrawn credit line of maturity less than 1 year, versus those that are more than 1 year. Undrawn commitment with less than 1 year of maturity receives conversion factor 20%, and those more than 1 year receives conversion factor 50%. According to Figure 2, we know that 364-day facility and revolver/line < 1 year altogether account for $43.14\% + 1.76\% = 44.9\%$ of all credit lines from banks to nonbank lenders (NBLs). Revolver/Line > 1 Yr account for 52.46% and the rest account for 2.64% and I count them as >1 year of maturity. Therefore, I calculate

$$
\omega^U = -\xi^E \omega^{CCF}_{undrawn}/\xi = -0.07 * (20\% * 44.9\% + 50\% * 55.1\%)/0.93 = -0.0275
$$

6 Results

This section presents three sets of results from the calibrated model, highlighting three key contributions.

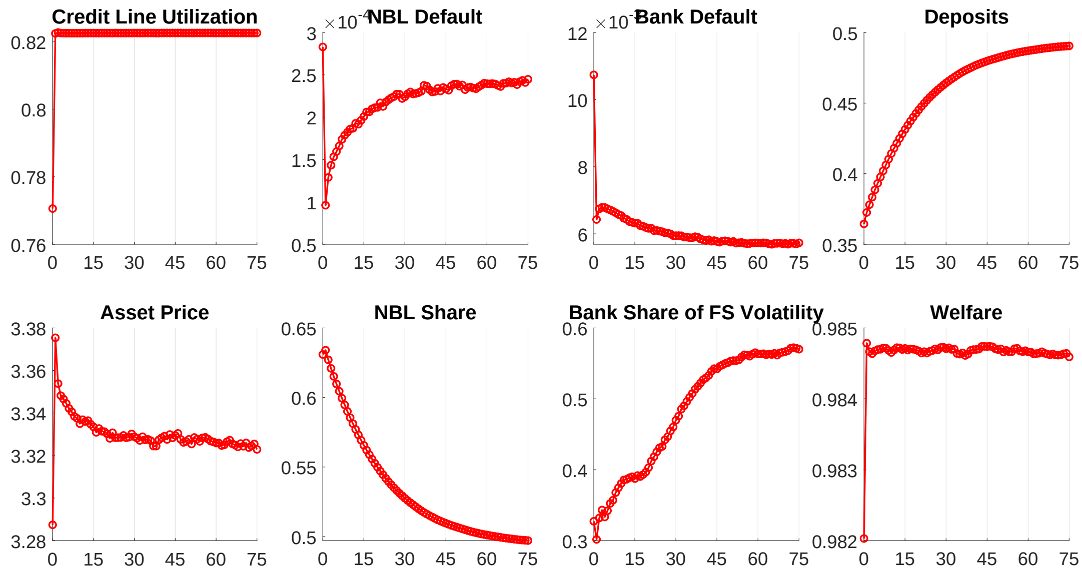
First, the model allows me to isolate the value of contingent liquidity for the demand side (nonbank lenders, or NBLs) and the supply side (banks). Second, the model enables a set of counterfactual analyses to evaluate how alternative contract structures perform. By comparing credit lines to cash or term loan, I show why credit lines is special in its flexibility and optionality. Third, the model provides a framework for studying the welfare implications of regulation, including: (1) the spillover effects of bank capital regulation on NBLs, and (2) the impact of off-balance sheet regulation on undrawn credit lines.

The first set of results examines the demand side. I show how variation in NBL demand for credit lines affects financial stability. The second set compares credit lines to two counterfactual financing contracts: (1) cash, and (2) debt. I demonstrate that holding parameters across economies the same, credit lines offer greater flexibility than cash, and provide insurance benefits with lower deadweight loss relative to term loans. The third set of results turns to the supply side, using policy counterfactuals to assess: (1) how bank regulations spill over to NBLs, and (2) how regulatory treatment of undrawn credit lines affects bank behavior and market outcomes.

6.1 Credit Line Demand and Financial Stability

This section examines how variation in nonbank demand for credit lines affects financial stability. Demand for credit lines is increasing in the level of investment uncertainty: when uncertainty is high, NBLs place greater value on contingent liquidity. To explore the implications for financial stability, I study the economys transition from a low-uncertainty regime to a high-uncertainty regime. As investment uncertainty rises, demand for credit lines increases, prompting banks to extend more credit to NBLs. I then assess how this demand-driven expansion in credit lines impacts key outcomesnamely, NBL default rates, bank default risk, deposit creation, asset pricesboth in the short run and in the long run.

Figure 8: Transition Paths



Notes. The plots illustrate the transition from an economy with lower investment uncertaintywhere nonbanks demand fewer credit lines from banks ($\mu = 0.055$; banks absorb 28.2% and NBLs 71.8% of financial-system volatility)to one with higher investment uncertainty, in which nonbank demand for credit lines rises ($\mu = 0.065$; banks absorb 59.4% and NBLs 40.6% of volatility).

Transition Paths. Figure 8 illustrates the transition dynamics, driven by a gradual increase in investment uncertainties and hence volume of credit lines extended by banks to NBLs. The horizontal axis in each panel denotes transition periods (e.g., quarters), while the vertical axes measure key macro-financial variables. The simulation starts from a steady state with minimal credit-line provisioncalibrated by setting the mean of investment shocks to $\mu = 0.055$, such that banks absorb only 28.2% of total financial system volatility, while NBLs absorb 71.8%. The economy then transitions toward the baseline interconnected calibration, where $\mu = 0.065$, resulting in banks shouldering 59.4% and NBLs 40.6% of system-wide volatility.

When the investment uncertainty increases, credit line utilization jumps immediately and remains persistently high. The probability of NBL default declines sharply early in the transition and stabilizes at a lower level in the long run. This decline reflects the disciplining role of banks, which internalize drawdown risk and monitor NBL risk-taking more effectively. Bank default risk also decreases as the transition unfolds. The rise in bank net worthfueled by credit-line profitabilityenables banks to support higher levels of deposits, improving their solvency and resilience. Bank deposits rise steadily throughout the transition, reflecting the expansion of the regulated sectors funding base. Asset prices experience a sharp increase at the onset of the transition, then stabilize at a higher level. This upward shift reflects both improved risk-sharing and greater investor confidence as credit lines reduce systemic fragility. Meanwhile, the NBL sectors share of overall financial intermediation declines steadily. As banks expand their balance sheets and funding capacity, they regain dominance in credit allocation. This rebalancing marks a structural shift towards the regulated banking sector. Taken together, these dynamics show that expanding contingent credit from banks to NBLs improves risk-sharing, lowers systemic default risk, and reconfigures the financial system toward a larger, more stable banking sector relative to nonbanks.

6.2 Unique Features of Credit Lines

To clarify the mechanisms behind these results, I now conduct counterfactual comparisons between credit lines, cash, and debt contracts. To make this a valid comparison, parameters are held the same across economies. This exercise highlights the distinctive features of credit linesnamely, their flexibility and insurance provision.

Flexibility. Credit lines are flexible funding instruments, and this flexibility plays a central role in lowering funding costsnot only for nonbank lenders (NBLs), but also for banks. By reducing these costs, credit lines help support the creation of safe, money-like assets. These advantages become especially salient when compared to simpler contractual arrangements, such as cash lending. I refer to the economy in which banks fund nonbanks with cash as the *cash economy*.

Consider a counterfactual in which banks fund nonbank lenders (NBLs) directly with cash rather than through credit lines. The full specification of the cash contract is provided in Appendix D. Under a credit line, the nonbank pays a small upfront fee to secure access to funding and incurs additional costs only upon drawdown. From the banks perspective, the credit line becomes an interest-earning asset only when funds are disbursed. This contingent structure enables nonbanks to economize on funding: they pay for liquidity only when investment opportunities actually arise.

To quantify this advantage, I compare the weighted average cost of capital (WACC) under the baseline credit line economy and the counterfactual cash economy.

In the baseline model with credit lines, the WACC for nonbanks is:

$$\text{WACC}_t^N = \frac{V_t^N}{V_t^{N,TOT}} \cdot \mathscr{R}_t^{N,E} + \frac{q_t^r B_t}{V_t^{N,TOT}} \left(\frac{\mathbb{E}_t[\mathscr{P}_{t+1}^N]}{q_t^r} - 1 \right) + \frac{q_t^C c(L_t)}{V_t^{N,TOT}} \left(R_t^C - 1 \right), \tag{6.1}$$

where $q_t^C = \mathscr{P}_t^A / R_t^C$ is the price of drawn credit, and total nonbank value is $V_t^{N,TOT} = V_t^N + q_t^r B_t + q_t^C c(L_t)$. The expected return on nonbank equity is:

$$\mathscr{R}_t^{N,E} = \frac{\mathbb{E}_t \left[\max \left\{ V_{t+1}^N - \epsilon_{t+1}^N, 0 \right\} \right]}{V_t^N - \text{Div}_t^N},$$

where V_t^N is the cum-dividend equity value (see equation 3.5).

The WACC for banks under the credit line contract is:

$$\text{WACC}_t^B = \frac{V_t^B}{V_t^{B,TOT}} \cdot \mathscr{R}_t^{B,E} + \frac{q_t^f D_t}{V_t^{B,TOT}} \left(\frac{1}{q_t^f} - 1 \right) + \frac{q_t^L (L_t - C(L_t))}{V_t^{B,TOT}} \left(\frac{\mathscr{P}_t^L}{q_t^L} - 1 \right), \tag{6.2}$$

with total bank value $V_t^{B,TOT} = V_t^B + q_t^f D_t$ and expected bank equity return:

$$\mathscr{R}_t^{B,E} = \frac{\mathbb{E}_t \left[\max \left\{ V_{t+1}^B - \epsilon_{t+1}^B, 0 \right\} \right]}{V_t^B - \text{Div}_t^B}.$$

In the counterfactual cash economy, total intermediary values are:

$$\begin{aligned} V_{cash,t}^{B,TOT} &= V_t^B + q_t^f D_t + q_t^L L_t, \\ V_{cash,t}^{N,TOT} &= V_t^N + q_t^r B_t. \end{aligned}$$

The corresponding WACC for banks becomes:

$$\text{WACC}^{B}_{cash,t} = \frac{V^{B}_{t}}{V^{B,TOT}_{cash,t}} \cdot \mathscr{R}^{B,E}_{t} + \frac{q^{f}_{t} D_{t}}{V^{B,TOT}_{cash,t}} \left(\frac{1}{q^{f}_{t}} - 1 \right) + \frac{q^{L}_{t} L_{t}}{V^{B,TOT}_{cash,t}} \left(\frac{\mathscr{P}^{L}_{t}}{q^{L}_{t}} - 1 \right),$$

and for nonbanks:

$$\text{WACC}^{N}_{cash,t} = \frac{V^{N}_{t}}{V^{N,TOT}_{cash,t}} \cdot \mathscr{R}^{N,E}_{t} + \frac{q^{r}_{t} B_{t}}{V^{N,TOT}_{cash,t}} \left(\frac{\mathbb{E}_{t}[\mathscr{P}^{N}_{t+1}]}{q^{r}_{t}} - 1 \right).$$

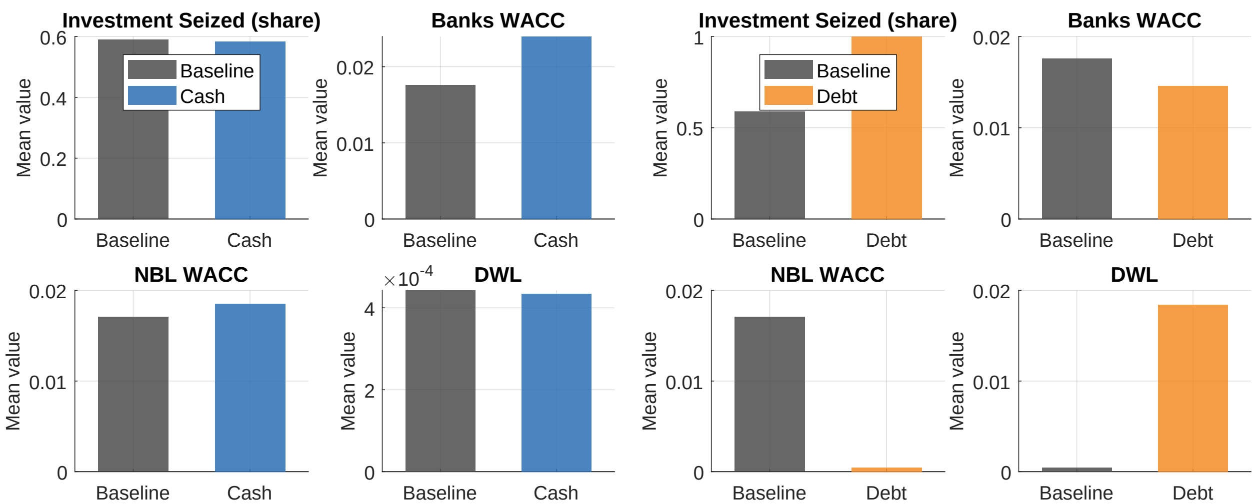
Comparing these outcomes, credit lines reduce funding costs for both banks and nonbanksespecially for banks, as illustrated in Panel 9(a). The key distinction lies in the nature of the liability: under a credit line, drawn amounts become liabilities only when utilized, whereas under the cash contract, the full amount sits as a fixed asset on the nonbanks balance sheet from inception. This is reflected in the evolution of nonbank net worth under cash funding:

$$N^{N}_{cash,t} = \mathscr{P}^{A}_{t} \left[A^{N}_{t} + \mathcal{I}^{\text{seized}}(L^{\text{cash}}_{t}) \right] + \max \left\{ L^{\text{cash}}_{t} - \mathcal{I}^{\text{seized}}(L^{\text{cash}}_{t}), 0 \right\} - B^{N}_{t},$$

where the second term captures idle excess cash $\max \left\{ L^{\text{cash}}_{t} - \mathcal{I}^{\text{seized}}(L^{\text{cash}}_{t}), 0 \right\}$ as a risk-free asset. Because credit lines impose funding costs only when investment opportunities materializeand require only a modest upfront premiumthey allow nonbanks to flexibly respond to shocks. This flexibility enables nonbanks to realize a greater share of valuable investment opportunities, whereas the rigidity of cash lending forces them to overpay for liquidity, raising their average funding cost.

Insurance. To illustrate the insurance function of credit lines, I compare them to simple debt contracts (referring to the associated environment as the *debt economy*). While both banks and nonbanks face lower weighted average costs of capital (WACC) under the debt contract, the financial system suffers from substantially higher deadweight losses (DWL). This contrast highlights the stabilizing role of credit lines: they reduce default risk across institutions, even at a higher funding cost.

Figure 9: Credit Line Contract vs. Cash vs. Debt



Credit Line Contract vs. Cash

Credit Line Contract vs. Debt

Notes. This figure compares credit line contracts with cash and standard debt contracts. The baseline case (in gray) represents the credit line contract in the calibrated model. The blue bar corresponds to a cash contract, and the orange bar to a debt contract. Panel 9(a) compares the share of investment realized (as a proportion of total investment uncertainty), the weighted average cost of capital (WACC) for banks and nonbanks, and the overall deadweight loss in an economy where banks lend to NBLs via credit lines versus directly via cash. Panel 9(b) presents the same comparison between credit line and debt contracts.

In the debt economy, banks lend to nonbanks through fixed-term loans. Holding parameters constant across economies, 100% of corporate term loans are held by nonbanks. This outcome arises because, under identical pricing terms, banks find it more profitable to lend to nonbanks than to firms directly. The corresponding WACC expressions are:

$$\begin{aligned}
\text{WACC}^{B}_{debt,t} &= \frac{V^{B}_{debt,t}}{V^{B,TOT}_{debt,t}} \cdot \mathscr{R}^{B,E}_{t} + \frac{q^{f}_{t} D_{t}}{V^{B,TOT}_{debt,t}} \left(\frac{1}{q^{f}_{t}} - 1 \right), \\
\text{WACC}^{N}_{debt,t} &= \frac{V^{N}_{debt,t}}{V^{N,TOT}_{debt,t}} \cdot \mathscr{R}^{N,E}_{t} + \frac{q^{r}_{t} B^{N}_{t}}{V^{N,TOT}_{debt,t}} \left(\frac{\mathbb{E}_t[\mathscr{P}^{N}_{t+1}]}{q^{r}_{t}} - 1 \right) + \frac{q^{L}_{t} L_{t}}{V^{N,TOT}_{debt,t}} \left(\frac{\mathbb{E}_t[\mathscr{P}^{L}_{t+1}]}{q^{L}_{t}} - 1 \right),
\end{aligned}$$

where the total market values for each sector are: $V^{B,TOT}_{debt,t} = V^{B}_{debt,t} + q^{f}_{t} D_{t}$, $\quad V^{N,TOT}_{debt,t} = V^{N}_{debt,t} + q^{r}_{t} B^{N}_{t} + q^{L}_{t} L_{t}$. In this setting, nonbanks are unconstrained and hold all corporate loans, resulting in high net worth ($N^{N}_{debt,t} = 1.77$). Banks, however, remain severely constrained with net worth just $N^{B}_{debt,t} = 0.03$, leading to elevated bank defaults of 4.01%while nonbanks experience no defaults.

In contrast, the credit line economy facilitates a reallocation of exposures and risk. Bank net worth rises to $N^{B}_{t} = 0.73$ while nonbank net worth falls to $N^{N}_{t} = 0.48$. Default rates for both sectors drop dramatically: 0.004% for banks and 0.001% for nonbanks. System-wide deadweight loss is given by:

$$DWL_t = \zeta^{B} F^{B}_{\epsilon,t} \left(\mathscr{P}^{A}_{t} A^{B}_{t} + \mathscr{P}^{L}_{t} c_t(L_t) \right) + \zeta^{N} F^{N}_{\epsilon,t} \mathscr{P}^{A}_{t} \left(A^{N}_{t} + c_t(L_t) \right). \tag{6.3}$$

DWL is significantly higher in the debt economy, primarily due to elevated bank default, which arises from weak capital accumulation. As shown in equation D.7, the payoffs $\mathscr{P}^{debt}_{t}$ that banks earn on loans to nonbanks are low. This reflects a narrow-banking equilibrium: banks hold only the safest, lowest-return claims, which limits their upside and renders them fragile due to thin buffers.

While banks in both economies lend only when profitable, a key difference lies in the degree of control. In the debt economy, banks lend to nonbanks only when doing so is profitable. In the credit line economy, banks also extend credit limits based on profitability, but drawdowns is outside their control. This lack of control makes banks more cautious: they recognize that a marginal increase in the credit limit raises future drawdown exposure. As a result, compared to the debt contract, the credit line contract leads banks to internalize not just the marginal impact of additional lending on loan prices, $\partial q_t^L/\partial L_{t+1}$, as shown in equation (4.5) (analogous to the effect of $\partial q_t^{debt}/\partial L_t^{debt}$ in the debt contract, fully derived in Appendix E.2.3), but also the effect of greater limit issuance on drawdown propensity, $\partial c(L_{t+1})/\partial L_{t+1}$, as discussed in Section 4. The credit limit thus emerges a crucial design margin in the credit line contractintroduced precisely because banks cannot control the drawdown timing.

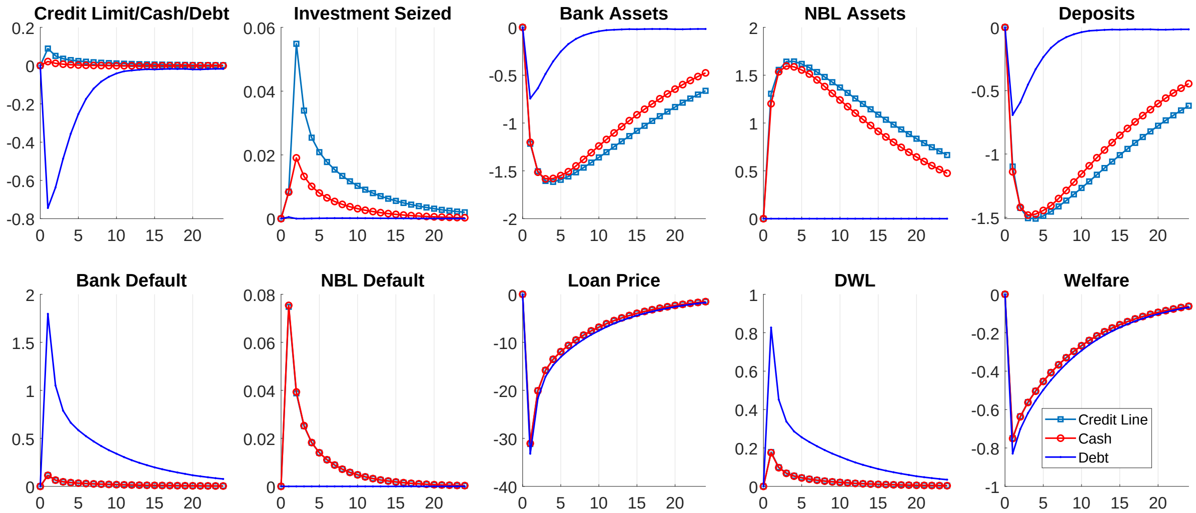
The credit line structure supports both intertemporal and cross-institutional risk-sharing: it allows banks to hold more diversified, state-contingent exposures, reduces default risk across sectors, and ultimately lowers system-wide deadweight losses. It is also because that banks and nonbanks do not internalize the higher deadweight loss in the debt economy that creates a rationale for the current regulation to subsidize credit lines.

6.3 Financial Stability Implications of the Credit Line Contract

The previous sections illustrates the unique features of credit lines. Now, let's see the financial stability implications of credit lines given their unique features, by comparing how the credit-line, the cash and the debt economy responds to crisis at the business-cycle frequency. To understand how the model propagates in crisis (a sudden deterioration in collateral quality of loans), I compute impulseresponse functions (IRFs) conditional on the economys state. The analysis begins in year 0 , where collateral values are set at their average state ($Z_t = 0$), and the four endogenous state variables are initialized at their respective ergodic averages. In period 1, I introduce a shock where Z_t declines by two standard deviations (depicted by the yellow line). From period 2 onward, the exogenous state variable evolves according to its stochastic laws of motion. To estimate the dynamics, I simulate 50,000 sample paths over a 25-year horizon and calculate the average behavior across these paths.

Figure 10 displays the dynamic responses of banks and nonbank lenders (NBLs) to a financial crisis shock, comparing three institutional arrangements: the credit line economy (baseline), the cash economy (counterfactual 1), and the debt economy (counterfactual 2). In both the credit

Figure 10: Crisis Dynamics



*Notes.*These plots show impulse responses to a crisis under three scenarios: the credit line economy (baseline), the cash economy (counterfactual 1), and the debt economy (counterfactual 2). The blue square-marked line represents the credit line economy, the red circle-marked line corresponds to the cash economy, and the solid blue line denotes the debt economy. The y-axis reports percentage deviations from the steady state, while the x-axis measures time in periods (years).

line and cash economies, corporate term loans are shared between banks and nonbanks in interior proportions. By contrast, in the debt economyunder the same parameterization100% of corporate loans are held by nonbanks, as banks find it more profitable to lend to nonbanks rather than directly to firms.

At the onset of the crisis, both credit line limits and cash holdings increase, with a larger rise in credit line limits. In contrast, term debt contracts decline. The countercyclicality of credit lines versus the procyclicality of debt highlights the insurance role of credit lines. This pattern is consistent with empirical evidence: as shown in Figure 4(a), investment uncertainty rises during downturns, especially for nonbanks. Because credit lines offer lower WACC through contingent access, nonbanks are able to seize a larger share of investment opportunities during crises. The balance sheet treatment differs across contracts. Before drawdown, credit lines are assets for nonbanks (liabilities for banks); after drawdown, they become liabilities for nonbanks (assets for banks). Cash remains an asset for nonbanks throughout, while debt is always a liability. In the credit line economy, bank assets consist of corporate loans and drawn credit. In the cash economy, banks hold corporate loans and cash extended to nonbanks. In the debt economy, all corporate loans end up on nonbank balance sheets, leaving banks with only loans to nonbanks as assets.

In all three economies, bank assets decline during the crisis, leading to a drop in deposits. Nonbank assets increase in both the credit line and cash economies but remain flat in the debt economy, since nonbanks already hold the entire corporate loan portfolio. Bank defaults rise most sharply in the debt economy, reflecting the higher deadweight losses emphasized in the previous section.

While banks lend based on profitability in all environments, a crucial difference lies in control. Under credit lines, drawdowns are initiated by nonbanks, not banks. This lack of control forces banks to internalize both the marginal effect of extending credit limits on loan pricing and the impact on drawdown behavior (see the previous paragraph on insurance provision and Section 4 on credit line mechanism). The credit limit thus emerges as a key design margin, precisely because drawdown timing is outside the banks control.

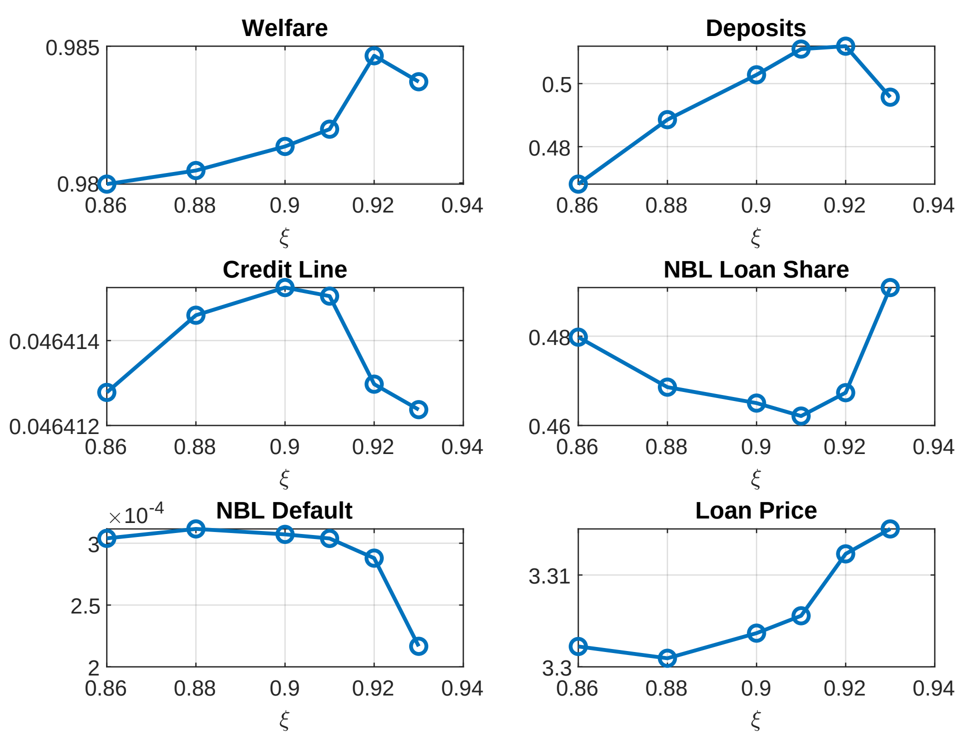
Nonbank defaults increase only slightly more in the credit line economy, and remain minimal compared to the sharp rise in bank defaults in the debt economy. As a result, deadweight losses are substantially higher in the debt regime. Loan prices also decline more sharply in the debt economy, and household welfaremeasured by the value functionfalls further than in the credit line economy. These crisis dynamics reinforce the dual value of credit lines as instruments of flexibility and insurance provision.

6.4 Credit Line Supply and Regulation

While the previous section highlights how a demand-driven increase in credit lines enhances financial stability, I now turn to the supply side. Regulatory constraints shape banks willingness to extend credit linesparticularly rules that govern maximum leverage and the relative treatment of credit lines versus term loans. In this section, I use the calibrated model as a laboratory to conduct policy experiments. The current draft includes two such experiments: the first examines the spillover effects of bank capital regulation on nonbank lenders (NBLs), and the second evaluates the impact of off-balance-sheet regulation on the provision of credit lines.

Spillover of Bank Regulation. I show that tightening bank capital requirements can have non-monotonic effects over the entire policy space. There are two forces. On the one hand, tightening capital requirements reduces bank leverage, lowering total deposits and therefore increases bank funding costs, which makes nonbanks bear a higher loan share of. On the other hand, tightening capital requirements makes deposit more scarce (Begenau, 2020), which increases the convenience yield banks earn on deposits, further emphasize bank's comparative advantage in cred it extension to the real non-financial corporate sector. Now I show results on the policy spillover effects across the entire financial system, including the nonbank sector.

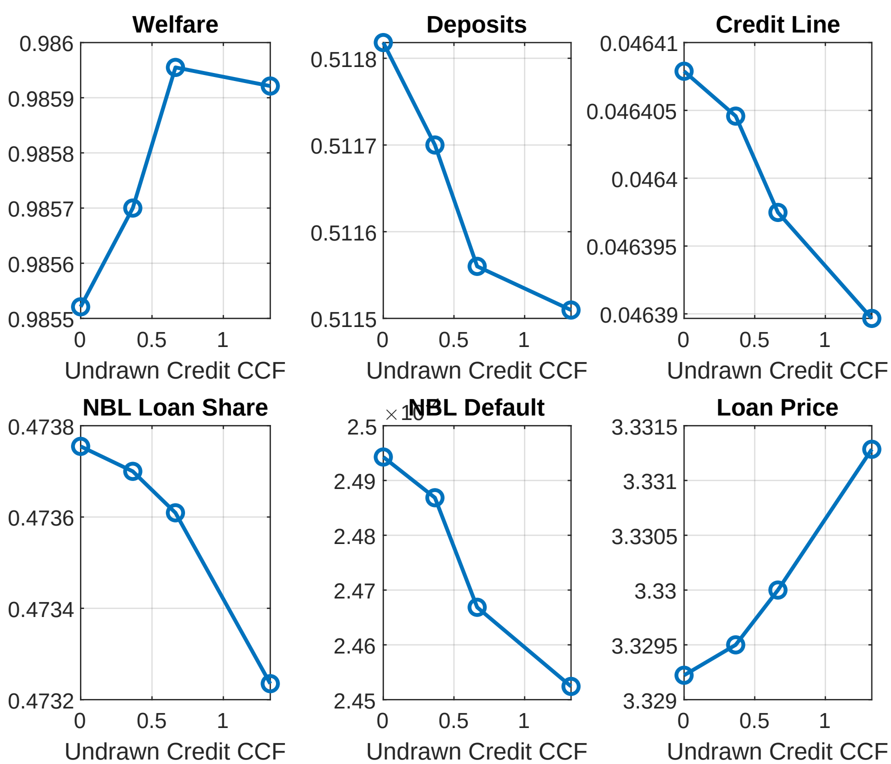
Figure 11: Spillover of Bank Capital Regulation on NBLs



Under the baseline scenario, a 7% bank capital requirement translates to a maximum leverage of 93% for banks. An increase in this requirement from 4% to 12% results in a reduced maximum leverage from 96% to 88% for banks, which is represented in the westward movement in the subsequent figure. Tightened bank capital regulations limit banks' ability to issue deposits. Due to the regulated nature of banks, their deposits remain highly sought after by households. Although this reduction in the supply of bank deposits may lead to an increase in the convenience yield for bank deposits, the increase in convenience yield does not offset the reduction in total deposit supply, at least in the current policy spectrum. As a result, banks have less funding and extend fewer corporate loans, but nonbank loan share rises. Bank credit line to NBLs also decreases, but the utilization rate of credit line increases to make sure that NBLs have enough funding to invest in a larger share of loans in the total economy. Heavier utilization makes NBLs more prone to default. Credit line option fee rises because banks are now more constrained and credit line supply becomes scarce.

Off-balance Sheet Regulation. I show that off-balance sheet regulation on undrawn credit lines tradesoff safe-asset creation against financial risk, especially NBL default risk.

Figure 12: Off-balance sheet regulation.



In my model, ω^U governs collateral benefit of the undrawn credit line. In the baseline calibration is a weghted average based on the relative portion of credit lines less than a year (44.9%) and credit lines over a year (55.1%), i.e., $20\% * 44.9\% + 50\% * 55.1\% = 36.53\%$, where the credit conversion factor for undrawn commitment with less than 1 year of maturity receives conversion factor 20%, and those more than 1 year receives con- version factor 50%. Welfare is measured by household value function. The maximum welfare is achieved when the weighted average credit conversion factor at 63%. Loosening (from right to left of the graph) the off-balance sheet regulation increases bank credit line extension, by making the capital cost on the undrawn portion of credit lines lower. This increases bank's ability to generate more deposits. However NBL Default increases because a higher credit limit is extended. Because more share of the economy is held by NBLs, more loans are priced by the NBL pricing kernel, which makes the loan price lower. Optimal off-balance sheet regulation tradesoff higher safe asset creation against increased risk of nonbank lenders.

7 Conclusion

This paper studies the private and social value of contingent liquidity provided by banks to nonbank lenders (NBLs). In the modern financial system, banks and NBLs are tightly connected through credit lines, which account for 96% of bank funding to NBLs and serve as a central mechanism for contingent liquidity provision. While these arrangements offer clear private benefitsproviding NBLs with insurance against investment uncertainty and enabling banks to profit from their liquidity advantagethey also shape broader macroeconomic outcomes.

To evaluate these effects, I develop and calibrate a dynamic general equilibrium model of banknonbank intermediation. Grounded in empirical evidence from the syndicated loan market, the model allows me to delineate the demand and supply forces behind credit line contract and allows for counterfactual analyses across contract types and regulatory regimes.

Three main findings emerge. First, demand-driven expansions of credit linesprompted by rising investment uncertaintyenhance financial stability by reallocating risk to the regulated banking sector, lowering default rates, and supporting asset prices. Second, credit lines outperform alternative financing contracts, such as cash and debt contracts, by offering flexibility and insurance, especially in crises. Notably, it is not just that banks lend to NBLs, but that the specific form of the contract-credit lines versus fixed lendingshapes systemic outcomes. Third, regulatory constraints on banks, including capital requirements and off-balance sheet treatment, materially influence the supply of credit lines and the resilience of the financial system. The model highlights regulatory trade-offs and offers a framework to assess how banking regulation spills over to nonbanks, affecting both credit availability and risk allocation.

Together, these results underscore the dual role of credit lines as both privately optimal contracts and socially valuable instruments for macro-financial stability. They also point to the need for regulatory frameworks that preserve the stabilizing features of contingent liquidity.

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A Model Appendix

A.1 Aggregation

Let $\mathscr{I} = \{B, N\}$ be the intermediary set that contains banks (B) and NBLs (N). Aggregation to a representative bank and a representative nonbank lender (NBL) requires three assumptions: (i) the intermediary objective is linear in the idiosyncratic profit shock $\epsilon_{t,i}^{\mathscr{I}}$, (ii) these shocks affect only contemporaneous payouts, not net worth, and (iii) defaulting intermediaries are replaced with new ones endowed with the same equity as survivors.

The recursive problem of a non-defaulting bank is:

$$\begin{aligned} V_t^B(\epsilon_{i,t}^B, \mathcal{S}_t) = & \max_{a_{i,t+1}^B, b_{i,t+1}^B, l_{i,t+1}, e_{i,t}^B} \phi_0^B n_t^B - e_{i,t}^B + \epsilon_{i,t}^B \\ & + \mathbb{E}_t \left[\mathcal{M}_{t,t+1}^B \max \left\{ V_{t+1}^B(\epsilon_{i,t+1}^B, \mathcal{S}_{t+1}), 0 \right\} \right], \end{aligned}$$

and for an NBL:

$$\begin{aligned} V_t^N(\epsilon_{i,t}^N, \iota_{i,t}, \mathcal{S}_t) = & \max_{a_{i,t+1}^N, b_{i,t+1}^N, l_{i,t+1}, e_{i,t}^N} \phi_0^N n_t^N - e_{i,t}^N + \epsilon_{i,t}^N \\ & + \mathbb{E}_t \left[\mathcal{M}_{t,t+1}^N \max \left\{ V_{t+1}^N(\epsilon_{i,t+1}^N, \iota_{i,t+1}, \mathcal{S}_{t+1}), 0 \right\} \right]. \end{aligned}$$

Given linearity in $\epsilon_{i,t}^{\mathscr{I}}$, define shock-independent value functions: $\tilde{V}_t^B = V_t^B - \epsilon_{i,t}^B, \quad \tilde{V}_t^N = V_t^N - \epsilon_{i,t}^N$, which yield:

$$\begin{aligned} \tilde{V}_t^B(\mathcal{S}_t) &= \max_{a_{i,t+1}^B, b_{i,t+1}^B, l_{i,t+1}, e_{i,t}^B} \phi_0^B n_t^B - e_{i,t}^B + \mathbb{E}_t \left[\mathcal{M}_{t,t+1}^B \max \left\{ \tilde{V}_{t+1}^B(\mathcal{S}_{t+1}) + \epsilon_{i,t+1}^B, 0 \right\} \right], \\ \tilde{V}_t^N(\iota_{i,t}, \mathcal{S}_t) &= \max_{a_{i,t+1}^N, b_{i,t+1}^N, l_{i,t+1}, e_{i,t}^N} \phi_0^N n_t^N - e_{i,t}^N + \mathbb{E}_t \left[\mathcal{M}_{t,t+1}^N \max \left\{ \tilde{V}_{t+1}^N(\iota_{i,t+1}, \mathcal{S}_{t+1}) + \epsilon_{i,t+1}^N, 0 \right\} \right]. \end{aligned}$$

Since optimal choices are independent of current $\epsilon_{i,t}^{\mathscr{I}}$, a representative bank and NBL exist. Defaulting intermediaries are replaced with new ones endowed with the same equity, ensuring all have the same initial wealth. Aggregation follows.

A.2 NBLs

A.2.1 Credit Line Utilization

Nonbank lenders (NBLs) face investment uncertainty shocks on their loan portfolio, denoted as $\iota_{i,t}$, which are independent and identically distributed (i.i.d.) with cumulative distribution function (CDF) $F(\iota_{i,t})$ with support over $[0, \infty]$.

NBLs can draw on their credit line facility when investment opportunities arise. Specifically, the investment uncertainty shock is sustainable if the credit line limit at time t is larger than the the new investment amount commensurate to the shock. The individual drawdown policy is therefore

$c_{t,\iota} = \min(\iota, L_t)$. The aggregate drawdown amount is then

$$c(L_t) = \int_0^\infty \min(\iota, L_t) dF(\iota)$$
$$= \int_0^{L_t} \iota dF(\iota) + \int_{L_t}^\infty L_t dF(\iota) \,.$$

Hence, nonbank lenders diversify away idiosyncratic investment shocks. Per unit of drawn credit, NBLs pay the required rate of return

$$R_t^C = \underbrace{s^C}_{\text{fixed spread}} + \underbrace{\frac{1}{\mathrm{E}[\mathcal{M}_{t,t+1}]}}_{\text{risk-free rate}} \,.$$

A.2.2 Optimization Problem

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

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

The recursive problem of a nonbank is:

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

subject to nonbank budget constraint

$$q_t A_{t+1}^N + q_t^L L_{t+1} \leq (1 - \phi_0^N) N_t^N + e_t^N - \Psi^N\left(e_t^N\right) + q_t^r B_{t+1}^N \,, \tag{A.2}$$

and nonbank no-shorting constraint

$$0 \leq A_{t+1}^N \,, \tag{A.3}$$

and nonbank credit line limit

$$0 \leq L_{t+1} \,, \tag{A.4}$$

where

$$\Psi^N\left(e_t^N\right) = \frac{\phi_1^N}{2}\left(e_t^N\right)^2 \,.$$

A.2.3 First-order Conditions

Attach Lagrange multiplier μ_t^N to the nonbank no-shorting constraint on loans to firms (A.3), and $\mu_{t,L}^N$ for the nonbank credit limit constraint (A.4) and ν_t^N to the budget constraint (A.2).

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

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

Nonbank Loans. The FOC for loans A_{t+1}^N is

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

Nonbank Debt. The FOC for loans B_{t+1}^N is

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

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

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

where

$$\begin{aligned}\frac{\partial c(L_t)}{\partial L_t} =& \frac{\partial}{\partial L_t}\left(\int_0^{L_t} \iota_t dF(\iota_t) + \int_{L_t}^{\infty} L_t dF(\iota_t)\right) \\ =& f(L_t)L_t - L_t f(L_t) + \int_{L_t}^{\infty} dF(\iota_t) \\ =& 1 - F(L_t)\,. \end{aligned} \tag{A.5}$$

A.2.4 Euler Equations

First take the envelope condition:

$$\tilde{V}_{N,t}^N = \phi_0^N + \left(1 - \phi_0^N\right) \nu_t^N \,.$$

Combining this with the FOC for equity issuance above to eliminate ν_t^N 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 nonbank lender as

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

I can organize the FOCs as:

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

$$q_t^r + \frac{\partial q_t^r}{\partial B_{t+1}^N} B_{t+1}^N = \mathrm{E}\left[\mathcal{M}_{t,t+1}^N \left(1 - \theta \Lambda\left(c(L_{t+1})\right)\right)\right] \ , \tag{A.8}$$

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

where I plug in equation (A.5) and define $\tilde{\mu}_t^N \equiv \mu_t^N / \nu_t^N$ and $\tilde{\mu}_{t,L}^N \equiv \mu_{t,L}^N / \nu_t^N$.

A.2.5 Partial Derivative

Derivative of q_t^L with respect to L_{t+1}.

$$\frac{\partial q_t^L}{\partial L_{t+1}} = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^N \left[-\left(\mathscr{P}_{t+1}^A - R_{t+1}^C\right) f(L_{t+1})\right]\right] \ .$$

Banks internalize the effect of credit limit extension on the price of credit line through the behavior of nonbank credit line utilization when nonbanks are extended an additional unit of credit line.

A.3 Banks

Bank net worth is given by

$$N_t^B = \mathscr{P}_t^A A_t^B - D_t + \mathscr{P}_t^L c(L_t) - c(L_t), \tag{A.10}$$

where the payoff on credit line is

$$\mathscr{P}_{t+1}^L = \left(1 - F_{\epsilon,t+1}^N\right) R_{t+1}^C + F_{\epsilon,t+1}^N R V_{t+1}^N + \frac{F_{\epsilon,t+1}^N \epsilon_{t+1}^{N,-}}{B_{t+1}^N + c(L_{t+1})} \ , \tag{A.11}$$

where the recovery value of nonbank default is

$$R V_{t+1}^N = (1 - \zeta^N) \cdot \frac{\mathscr{P}_{t+1}^A \left(A_{t+1}^N + c(L_{t+1})\right)}{B_{t+1}^N + c(L_{t+1})} \ . \tag{A.12}$$

A.3.1 Optimization Problem

Bank's problem is characterized recursively as

$$V_t^B\left(\mathcal{S}_t\right) = \max_{A_{t+1}^B, S_{t+1}, D_{t+1}, L_{t+1}, e_t^B} \phi_0^B N_t^B - e_t^B + \epsilon_t^B + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} V_{t+1}^B\left(\mathcal{S}_{t+1}\right)\right] \ , \tag{A.13}$$

subject to bank budget constraint

$$q_t A_{t+1}^B - \left(q_t^f - \kappa\right) D_{t+1} \leq (1-\phi_0^B) N_t^B + q_t^L L_{t+1} + e_t^B - \Psi^B\left(e_t^B\right) \,, \tag{A.14}$$

bank capital requirement,

$$D_{t+1} \leq \xi\big(A_{t+1}^B + \omega^C c(L_{t+1}) + \omega^U \left(L_{t+1} - c(L_{t+1})\right)\big), \tag{A.15}$$

with $\xi = 1 - \xi^E$ and $\omega^U = -\xi^E \omega^{U,E}/\xi$ and no-shorting constraint on bank loan origination to firms,

$$0 \leq A_{t+1}^B, \tag{A.16}$$

where

$$\Psi^B\left(e_t^B\right) = \frac{\phi_1^B}{2}\left(e_t^B\right)^2 \,.$$

A.3.2 First-Order Conditions

Attach Lagrange multipliers λ_t^B to the capital requirement (A.15), μ_t^B to the no-shorting constraint on bank loans (A.16) and ν_t^B to the budget constraint (A.14). Denote $V_{N,t+1}^B = \frac{\partial V_{t+1}^B}{\partial N_{t+1}^B}$.

Equity Issuance. We can differentiate 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. The FOC for loans A_{t+1}^B

$$q_t \nu_t^B = \lambda_t^B \xi + \mu_t^B + \mathrm{E}\left[\mathcal{M}_{t,t+1} V_{N,t+1}^B \mathscr{P}_{t+1}^A\right] \,,$$

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

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

Credit Line Option. The FOC for credit line option L_{t+1} is

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

Note that equation (4.4) in the main text is a rewrite of the FOC for credit line option L_{t+1} in terms of economic forces, with terms moving to the left/right hand sides.

A.3.3 Euler Equations

First take the envelope condition:

$$V_{N,t}^{B} = \phi_0^B + \left(1-\phi_0^B\right)\nu_t^B \,.$$

Combining this with the FOC for equity issuance above to eliminate ν_t^B 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 intermediary as

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

I can organize the FOCs as:

$$q_t = \tilde{\lambda}_t^B \xi + \tilde{\mu}_t^B + \mathrm{E}\left[\mathcal{M}_{t,t+1}^{B}\mathscr{P}_{t+1}^{A}\right]\,, \tag{A.17}$$

$$q_t^f - \kappa = \tilde{\lambda}_t^B + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^{B}\right]\,, \tag{A.18}$$

$$\begin{aligned} & q_t^L + \frac{\partial q_t^L}{\partial L_{t+1}}L_{t+1} + \tilde{\lambda}_t^B \xi\left(\omega^C(1-F(L_{t+1}) + \omega^U F(L_{t+1})\right) \\ =& \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^{B}\left((1-F(L_{t+1}))\left(1-\mathscr{P}_{t+1}^{L}\right) - c(L_{t+1})\frac{\partial \mathscr{P}_{t+1}^{L}}{\partial L_{t+1}}\right)\right]\,, \end{aligned} \tag{A.19}$$

where we define $\tilde{\mu}_t^B \equiv \mu_t^B/\nu_t^B$ and $\tilde{\lambda}_t^B \equiv \lambda_t^N/\nu_t^B$.

A.3.4 Partial Derivative

Derivative of $\mathscr{P}_{t+1}^{L}$ with respect to L_{t+1}. The payoff on credit line is

$$\mathscr{P}_{t+1}^{L} = \left(1-F_{\epsilon,t+1}^{N}\right)R_{t+1}^{C} + F_{\epsilon,t+1}^{N}RV_{t+1}^{N} + \frac{F_{\epsilon,t+1}^{N}\epsilon_{t+1}^{N,-}}{B_{t+1}^{N}+c\left(L_{t+1}\right)}$$

$$\begin{aligned} \frac{\partial \mathscr{P}_{t+1}^{L}}{\partial L_{t+1}} &= -R_{t+1}^{C}\frac{\partial F_{\epsilon,t+1}^{N}}{\partial L_{t+1}} + RV_{t+1}^{N}\frac{\partial F_{\epsilon,t+1}^{N}}{\partial L_{t+1}} + F_{\epsilon,t+1}^{N}\frac{\partial RV_{t+1}^{N}}{\partial L_{t+1}} + \frac{\partial}{\partial L_{t+1}}\left(\frac{F_{\epsilon,t+1}^{N}\epsilon_{t+1}^{N,-}}{B_{t+1}^{N}+c\left(L_{t+1}\right)}\right) \\ &= \left(RV_{t+1}^{N} - R_{t+1}^{C}\right)\frac{\partial F_{\epsilon,t+1}^{N}}{\partial L_{t+1}} + F_{\epsilon,t+1}^{N}\frac{\partial RV_{t+1}^{N}}{\partial L_{t+1}} + \frac{\partial}{\partial L_{t+1}}\left(\frac{F_{\epsilon,t+1}^{N}\epsilon_{t+1}^{N,-}}{B_{t+1}^{N}+c\left(L_{t+1}\right)}\right) \end{aligned}$$

Let's first take the derivative of RV_{t+1}^{N} with respect to L_{t+1}:

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

Then we use Leibniz rule,

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

Finally, we can calculate

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

Hence,

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

Plugging each item in, we have:

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

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

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

with

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

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

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

Then

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

and, more generally,

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

Proof. We know that

$$R^C_{t+1} \;>\; RV^N_{t+1}, \qquad f^N_{\epsilon,t+1} > 0, \qquad 0 < F^N_{\epsilon,t+1} < 1, \qquad \epsilon^{N,-}_{t+1} > 0.$$

Step 1: Sign of $\mathcal{T}_1$. Because $R^C_{t+1} > RV^N_{t+1}$ and $f^N_{\epsilon,t+1} > 0$,

$$\operatorname{sign}\big(\mathcal{T}_1\big) = -\operatorname{sign}\big(\mathscr{P}^A_{t+1} - R^C_{t+1}\big).$$

Thus $\mathcal{T}_1 < 0$ exactly when $\mathscr{P}^A_{t+1} < R^C_{t+1}$.

Step 2: Sign of $\mathcal{T}_2$. All multiplicative factors preceding $(B^N_{t+1} - A^N_{t+1})$ are positive, so

$$\operatorname{sign}\big(\mathcal{T}_2\big) = \operatorname{sign}\big(B^N_{t+1} - A^N_{t+1}\big).$$

Hence $\mathcal{T}_2 \le 0$ when $B^N_{t+1} \le A^N_{t+1}$.

Step 3: Sign of $\mathcal{T}_3$. Write $\mathcal{T}_3 = (X - \epsilon^{N,-}_{t+1} F^N_{\epsilon,t+1})/(B^N_{t+1} + c)^2$ with

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

Since the denominator is positive, $\operatorname{sign}(\mathcal{T}_3) = \operatorname{sign}(X - \epsilon^{N,-}_{t+1} F^N_{\epsilon,t+1})$.

- If $\mathscr{P}^A_{t+1} < R^C_{t+1}$, then $X < 0$, so $\mathcal{T}_3 < 0$ *regardless* of the size of $\epsilon^{N,-}_{t+1} F^N_{\epsilon,t+1}$.
- If $\mathscr{P}^A_{t+1} > R^C_{t+1}$, the sign of $\mathcal{T}_3$ flips when

$$\epsilon^{N,-}_{t+1} F^N_{\epsilon,t+1} \;=\; X.$$

Step 4: Sufficient region for negativity. Under the joint conditions

$$\mathscr{P}^A_{t+1} < R^C_{t+1}, \qquad B^N_{t+1} \le A^N_{t+1},$$

we have $\mathcal{T}_1 < 0,\ \mathcal{T}_2 \le 0,\ \mathcal{T}_3 < 0$, so their sum is negative. Because $\dfrac{\partial c_{t+1}}{\partial L_{t+1}} > 0$, the derivative itself is negative.

Step 5: General sign criterion. Removing the inequalities on $\mathscr{P}^A_{t+1}$ and B^N_{t+1} yields

$$\operatorname{sign}\!\left(\frac{\partial \mathscr{P}^L_{t+1}}{\partial L_{t+1}}\right) = \operatorname{sign}\!\big(\mathcal{T}_1 + \mathcal{T}_2 + \mathcal{T}_3\big),$$

whence the stated equivalence $\mathcal{T}_2 < -(\mathcal{T}_1 + \mathcal{T}_3)$. ■

A.4 Households

A.4.1 The Optimization Problem

The problem of the representative household is

$$V^H\left(W^H_t, \mathcal{S}_t\right) = \max_{\{C^H_t, D^H_{t+1}, B^H_{t+1}\}} \left\{ (1-\beta_H)\left(u^H_t\right)^{1-1/\nu_H} + \beta_H \left(\mathrm{E}_t\left[\left(V^H\left(W^H_{t+1}; \mathcal{S}_{t+1}\right)\right)^{1-\sigma_H}\right]\right)^{\frac{1-1/\nu_H}{1-\sigma_H}} \right\}^{\frac{1}{1-1/\nu_H}}$$

subject to

$$u^H_t = \left(C^H_t\right)^{1-\varsigma}\left(\left(D^H_{t+1}\right)^{\theta}\left(B^H_{t+1}\right)^{1-\theta}\right)^{\varsigma}$$

$$C^H_t = W^H_t + Y_t - q^f_t D^H_{t+1} - q^r_t B^H_{t+1} + O_t \tag{A.20}$$

$$W^H_t = D^H_t + \mathscr{D}^B_t + \mathscr{D}^N_t + B^H_t \mathscr{P}^N_t \tag{A.21}$$

where payoff on nonbank debt is

$$\mathscr{P}^N_t = \left[\left(1 - F^N_{\epsilon,t}\right) + F^N_{\epsilon,t}\left((1-\zeta^N)\frac{\mathscr{P}^A_t(A^N_t + c(L_t))}{B^N_t + c(L_t)]}\right) + F^N_{\epsilon,t}\frac{\epsilon^{N,-}_t}{B^N_t + c(L_t)}\right], \tag{A.22}$$

If the nonbank does not default, they payoff 1. If the nonbank defaults, then it uses it assets, which has a per unit payoff of $\mathscr{P}^A_t$ to service its debt. Rebate to household is $O_t = q^A_t \mathcal{I}_{t+1} - \mathscr{P}^A_t \mathcal{I}_t - c_t\big(\mathscr{P}^A_t - 1\big) = q^A_t \mathcal{I}_{t+1} - \big[\mathscr{P}^A_t(\mathcal{I}_t - c_t) + c_t\big]$ where $q^A_t \mathcal{I}_{t+1}$ is the expense of funding new loans at price q^A_t, $\mathscr{P}^A_t \mathcal{I}_t$ is the payoff on last periods loan investment $\mathcal{I}_t$, and $c_t(\mathscr{P}^A_t - 1)$ captures the immediate net gain from recommitted credit lines. Equivalently, $\mathcal{I}_t - c_t$ measures the residual loan demand that nonbank lenders cannot satisfy due to credit limits and thus must offload to households.

Denote the value function and the marginal value of wealth as

$$V_t^H \equiv V_t^H \left(W_t^H, \mathcal{S}_t\right),$$
$$V_{W,t}^H \equiv \frac{\partial V_t^H \left(W_t^H, \mathcal{S}_t\right)}{\partial W_t^H}.$$

Denote the certainty equivalent of future utility as

$$CE_t^H = \mathrm{E}_t \left[\left(V_{t+1}^H\right)^{1-\sigma_H}\right]^{\frac{1}{1-\sigma_H}}$$

A.4.2 First-Order Conditions

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

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

Non-bank Debt. The FOC for non-bank one-period bonds B_{t+1}^H is

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

A.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:

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

A.4.4 Euler Equations

$$
\begin{aligned}
q_t^f &= \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\right] + \frac{\theta\varsigma C_t^H}{(1-\varsigma)D_{t+1}^H}\,, &\text{(A.23)}\\
q_t^r &= \frac{(1-\theta)\,\varsigma C_t^H}{(1-\varsigma)B_{t+1}^H} + \mathrm{E}_t\Bigg\{\mathcal{M}_{t,t+1}\Bigg[1 - F_{\epsilon,t+1}^N \\
&\quad + F_{\epsilon,t+1}^N \underbrace{\left((1-\zeta^N)\frac{\mathscr{P}_{t+1}^A(A_{t+1}^N + c(L_{t+1}))}{B_{t+1}^N + c(L_{t+1})}\right)}_{:=\mathcal{A}_{t+1}^H} + \underbrace{\frac{\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}}{B_{t+1}^N + c(L_{t+1})}}_{:=\mathcal{B}_{t+1}^H}\Bigg]\Bigg\}. &\text{(A.24)}
\end{aligned}
$$

A.4.5 Partial Derivatives of q_t^r.

Let's first define a few terms,

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

and

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

Household choose their commercial paper at the non-banks, taking into account the risks associated with non-bank debt. Let's group some terms in the Euler Equation of the price of the nonbank debt:

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

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

$$
\frac{\partial q_t^r}{\partial A_{t+1}^N} = \mathrm{E}_t\left\{\mathcal{M}_{t,t+1}\left[\left(\mathcal{A}_{t+1}^H - 1\right)\frac{\partial F_{\epsilon,t+1}^N}{\partial A_{t+1}^N} + \frac{\partial\mathcal{A}_{t+1}^H}{\partial A_{t+1}^N}F_{\epsilon,t+1}^N + \frac{\partial\mathcal{B}_{t+1}^H}{\partial A_{t+1}^N}\right]\right\} \qquad \text{(A.25)}
$$

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

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

Then, we need to take derivative of $F_{\epsilon,t+1}^N$ with respect to A_{t+1}^N.

To do so, we first take the derivative of the default threshold $-\tilde{V}_{t+1}^N$ with respect to A_{t+1}^N, then we use Leibniz rule,

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

At last, we take the derivative of $\mathcal{B}^H_{t+1}$ with respect to A^N_{t+1}.

$$\mathcal{B}^H_{t+1} = \frac{\epsilon^{N,-}_{t+1}F_{\epsilon,t+1}}{B^N_{t+1}+c(L_{t+1})}$$

We can calculate

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

Hence,

$$\frac{\partial \mathcal{B}^B_{t+1}}{\partial A^N_{t+1}} = \frac{f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1})\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\mathscr{P}^A_{t+1}\tilde{V}^N_{t+1}}{B^N_{t+1}+c(L_{t+1})}\,.$$

We can then plug in the expressions to get the explicit form of the derivatives.

Derivative of q^r_t with respect to B^N_{t+1}. We would like to evaluate:

$$\frac{\partial q^r_t}{\partial B^N_{t+1}} = \mathrm{E}_t\left\{\mathcal{M}_{t,t+1}\left[\left(\mathcal{A}^H_{t+1}-1\right)\frac{\partial F^N_{\epsilon,t+1}}{\partial B^N_{t+1}} + \frac{\partial \mathcal{A}^H_{t+1}}{\partial B^N_{t+1}}F^N_{\epsilon,t+1} + \frac{\partial \mathcal{B}^H_{t+1}}{\partial B^N_{t+1}}\right]\right\} \tag{A.26}$$

First, we take the derivative of $\mathcal{A}^H_{t+1}$ with respect to B^N_{t+1}:

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

Then, we need to take derivative of $F^N_{\epsilon,t+1}$ with respect to B^N_{t+1}.

$$N^N_t = \mathscr{P}^A_t[A^N_t + c(L_t)] - R^C_t c(L_t) - B^N_t$$

To do so, we first take the derivative of the default threshold $-\tilde{V}^N_{t+1}$ with respect to B^N_{t+1}. Then we use Leibniz rule,

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

At last, we take the derivative of $\mathcal{B}^H_{t+1}$ with respect to B^N_{t+1}.

$$\mathcal{B}^H_{t+1} = \frac{\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}}{B^N_{t+1} + c(L_{t+1})}$$

We can calculate

$$\begin{aligned}
\frac{\partial\left(\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}\right)}{\partial B^N_{t+1}} &= \frac{\partial}{\partial B^N_{t+1}}\left(\int_{-\infty}^{-\tilde{V}^N_{t+1}} \epsilon_{t+1} f^N_{\epsilon,t+1} d\epsilon\right)\\
&= \frac{\partial(-\tilde{V}^N_{t+1})}{\partial B^N_{t+1}}(-\tilde{V}^N_{t+1}) f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1})\\
&= -f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1})\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\tilde{V}^N_{t+1}
\end{aligned}$$

Hence,

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

We can then plug in the expressions to get the explicit form of the derivatives.

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

$$\frac{\partial q^r_t}{\partial L_{t+1}} = \mathrm{E}_t\left\{\mathcal{M}_{t,t+1}\left[\left(\mathcal{A}^H_{t+1} - 1\right)\frac{\partial F^N_{\epsilon,t+1}}{\partial L_{t+1}} + \frac{\partial \mathcal{A}^H_{t+1}}{\partial L_{t+1}} F^N_{\epsilon,t+1} + \frac{\partial \mathcal{B}^H_{t+1}}{\partial L_{t+1}}\right]\right\} \tag{A.27}$$

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

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

Then, we need to take derivative of $F^N_{\epsilon,t+1}$ with respect to L_{t+1}. To do so, we first take the derivative of the default threshold $-\tilde{V}^N_{t+1}$ with respect to L^N_{t+1}. Then we use Leibniz rule,

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

At last, we take the derivative of $\mathcal{B}^H_{t+1}$ with respect to L^N_{t+1}.

$$\mathcal{B}^H_{t+1} = \frac{\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}}{B^N_{t+1} + c(L_{t+1})}$$

We can calculate

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

Hence,

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

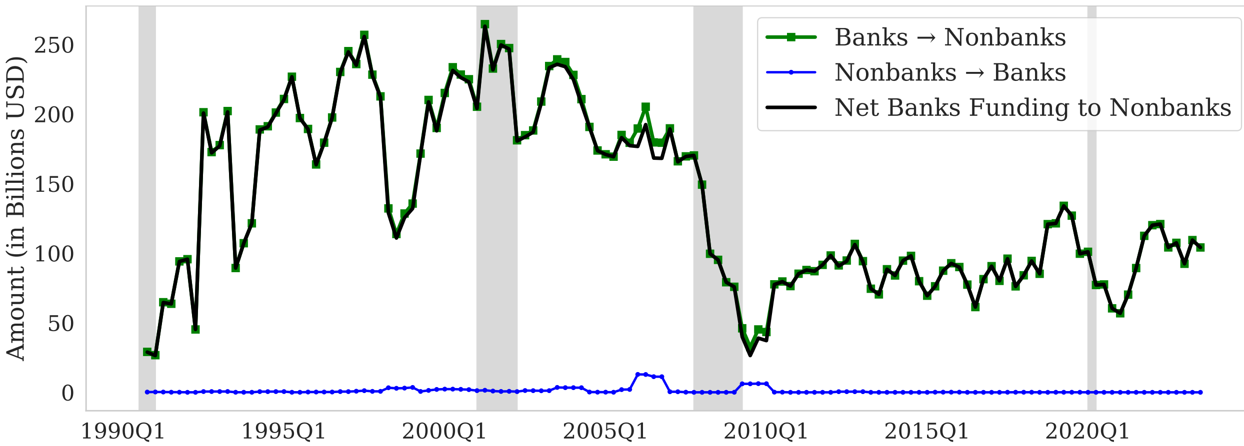
We can then plug in the expressions to get the explicit form of the derivatives.

B Empirical Appendix

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

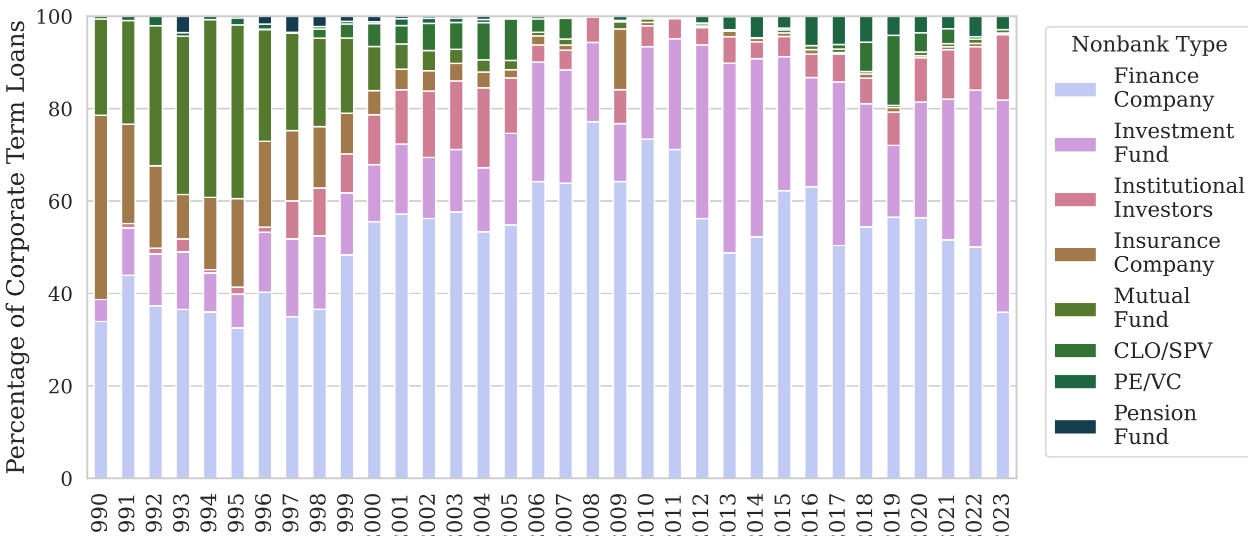
B.1 Additional Empirical Findings

Figure B.1.1: Net Bank Funding to Nonbanks



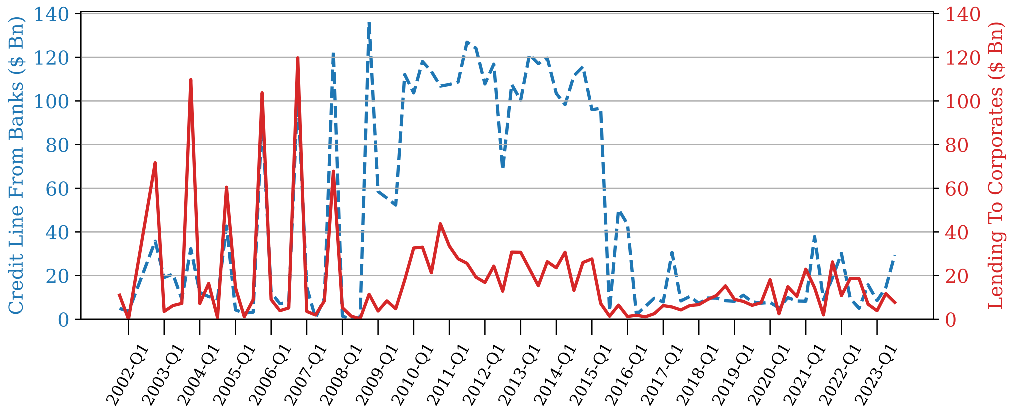
Notes. This figure plots the 1-year moving average of quarterly bank funding (amount in billions USD) to NBLs that lend to corporates, combining Legacy Dealscan and LSEG LoanConnector facility-level data. Green squared line is bank funding to nonbanks. Blue dot line is nonbank funding to banks. Black is the net bank funding to nonbanks. This figure shows: nonbanks rely heavily on banks for funding, but not vice versa, consistent with the finding in Acharya et al. (2024a).

Figure B.1.2: Term Loan Origination by Nonbank Type



Notes. This figure plots the time variation in origination of term loans by nonbank type. Finance companies contribute about 45.6% of total term loans generated by all NBLs, followed by investment fund (43.8%).

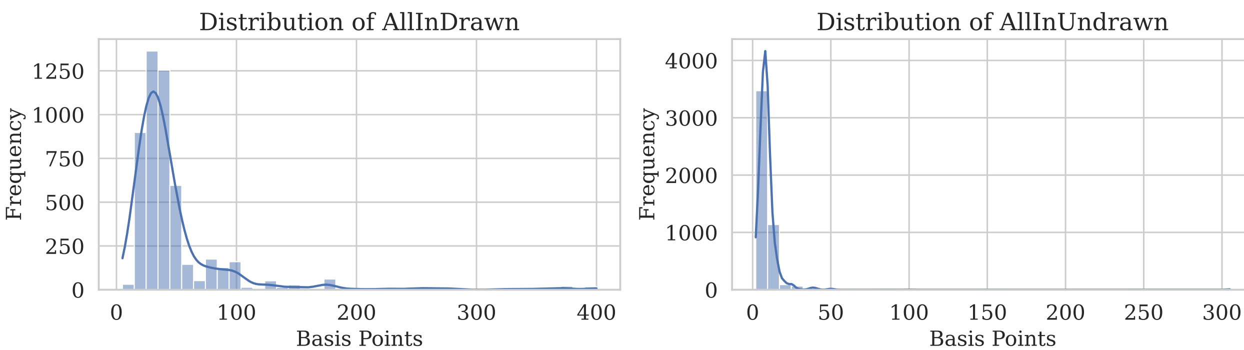
Figure B.1.3: NBL Credit Line Funding Vs. Lending



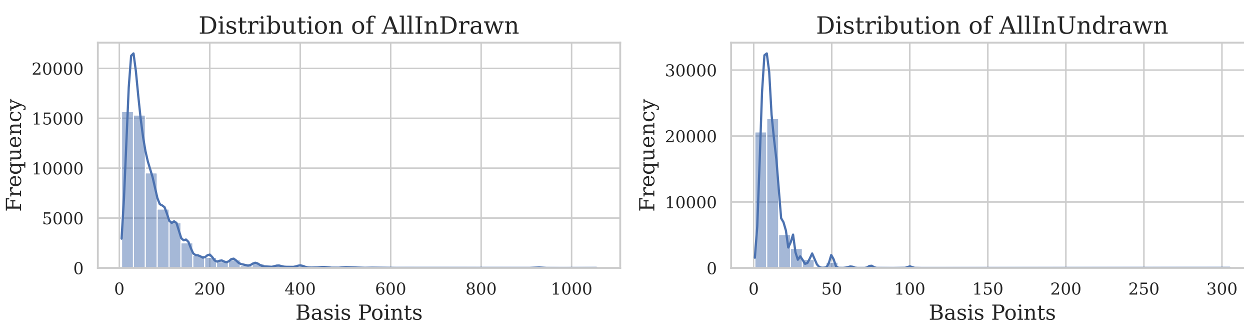
Notes. Solid red shows total quarterly lending for the 25% of Dealscan NBLs matched in Capital IQ. Blue dotted shows total quarterly undrawn credit lines for the same subset.

Figure B.1.4: Pricing for 364-Day Credit Facilities

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

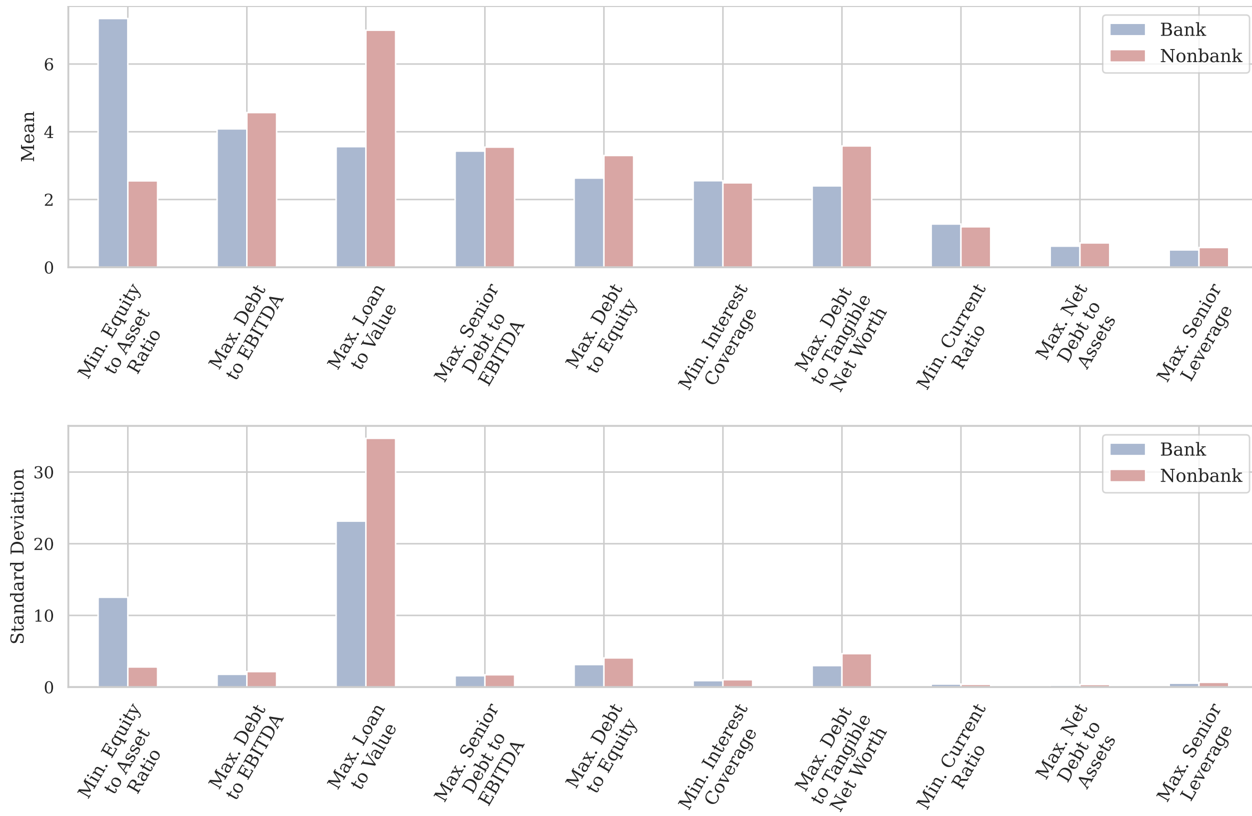


(b) 364-Day Credit Facilities Extended by Banks to Non-Financial Corporates



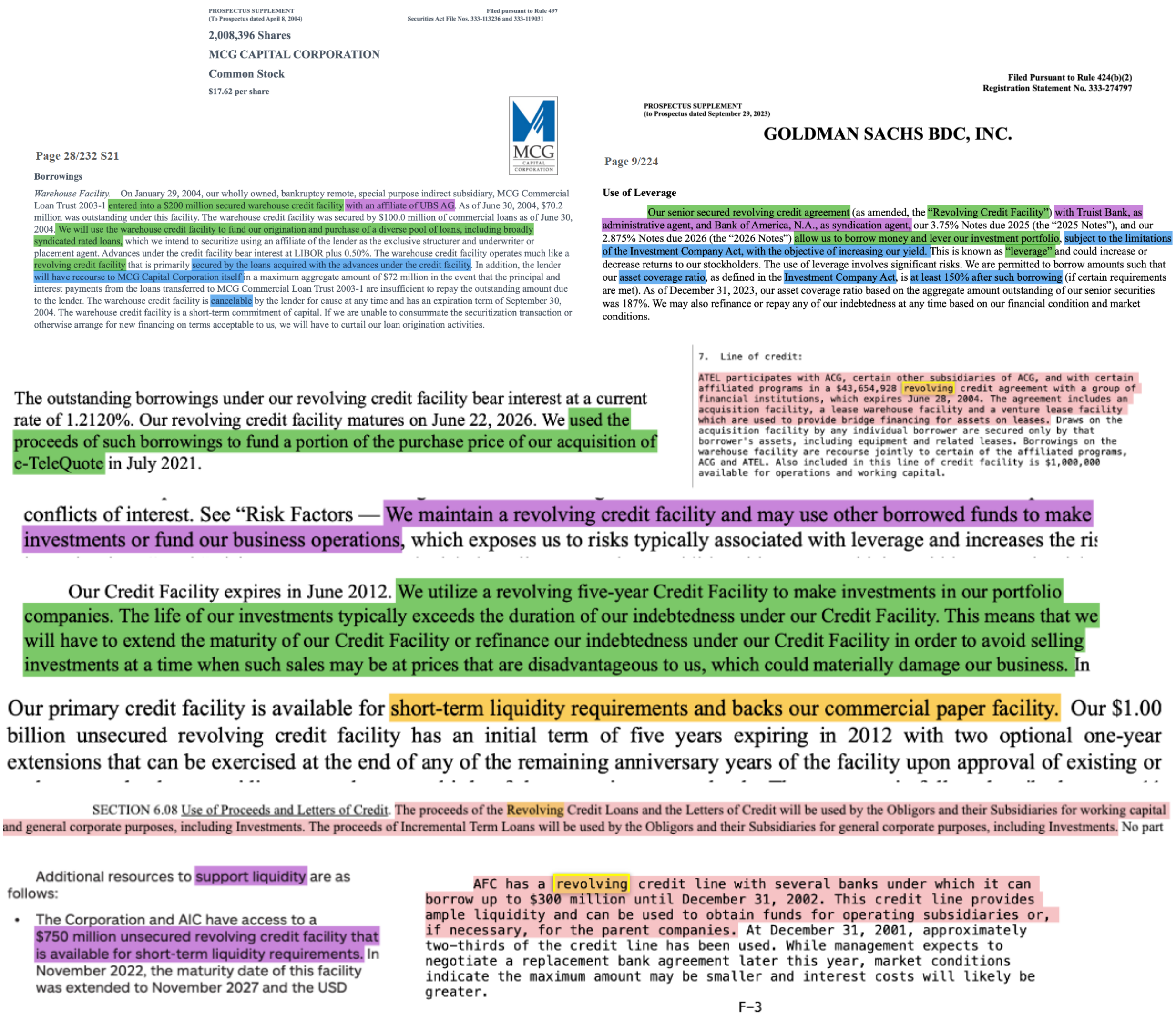
Notes. This figure isolates credit risk from maturity risk by focusing on bank credit lines that are exactly 364 days in maturity. Panel (a) (bank credit lines to NBLs): all-in-drawn spreads (n = 5085; mean = 47.98 bps; SD = 48.94) and all-in-undrawn spreads (n = 4810; mean = 9.13 bps; SD = 10.91). Panel (b) (bank credit lines to corporates): drawn spreads (n = 58764; mean = 76.86 bps; SD = 74.27) and undrawn spreads (n = 54041; mean = 12.96 bps; SD = 11.47).Both drawn and undrawn spreads are lower for NBLs.

Figure B.1.5: Covenant Differences between Bank-Originated and Nonbank-Originated Loans



Notes. This figure presents the mean and standard deviations of covenant metrics, distinguishing between loans extended by banks and those extended by nonbanks. While covenants within a syndication package are largely uniform across lenders, differences arise in cases where banks or nonbanks are the sole lenders or when nonbanks are originating more sub-A term loans. These distinctions reveal variations in the average values and variability of loan covenant restrictions. In particular, nonbank loans tend to exhibit slightly greater variability in covenant metrics, permitting higher thresholds for debt-to-EBITDA, debt-to-equity, and debt-to-net-worth ratios.

B.2 Textual Evidence



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.

The outstanding borrowings under our revolving credit facility bear interest at a current rate of 1.2120%. Our revolving credit facility matures on June 22, 2026. We used the proceeds of such borrowings to fund a portion of the purchase price of our acquisition of e-TeleQuote in July 2021.

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7.  Line of credit:

ATEL participates with ACG, certain other subsidiaries of ACG, and with certain
affiliated programs in a $43,654,928 revolving credit agreement with a group of
financial institutions, which expires June 28, 2004. The agreement includes an
acquisition facility, a lease warehouse facility and a venture lease facility
which are used to provide bridge financing for assets on leases. Draws on the
acquisition facility by any individual borrower are secured only by that
borrower's assets, including equipment and related leases. Borrowings on the
warehouse facility are recourse jointly to certain of the affiliated programs,
ACG and ATEL. Also included in this line of credit facility is $1,000,000
available for operations and working capital.
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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

Additional resources to support liquidity are as follows:

- The Corporation and AIC have access to a $750 million unsecured revolving credit facility that is available for short-term liquidity requirements. In November 2022, the maturity date of this facility was extended to November 2027 and the USD

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AFC has a revolving credit line with several banks under which it can
borrow up to $300 million until December 31, 2002. This credit line provides
ample liquidity and can be used to obtain funds for operating subsidiaries or,
if necessary, for the parent companies. At December 31, 2001, approximately
two-thirds of the credit line has been used. While management expects to
negotiate a replacement bank agreement later this year, market conditions
indicate the maximum amount may be smaller and interest costs will likely be
greater.
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Figure B.2.1: The screenshots of Prospectuses with highlighted sentences indicate evidence of investment uncertainty or liquidity support.

Figure B.2.2: The two word clouds are sentences that indicate investment uncertainty (left) and liquidity support (right).

C Calibration Appendix

C.1 Credit Line Spread

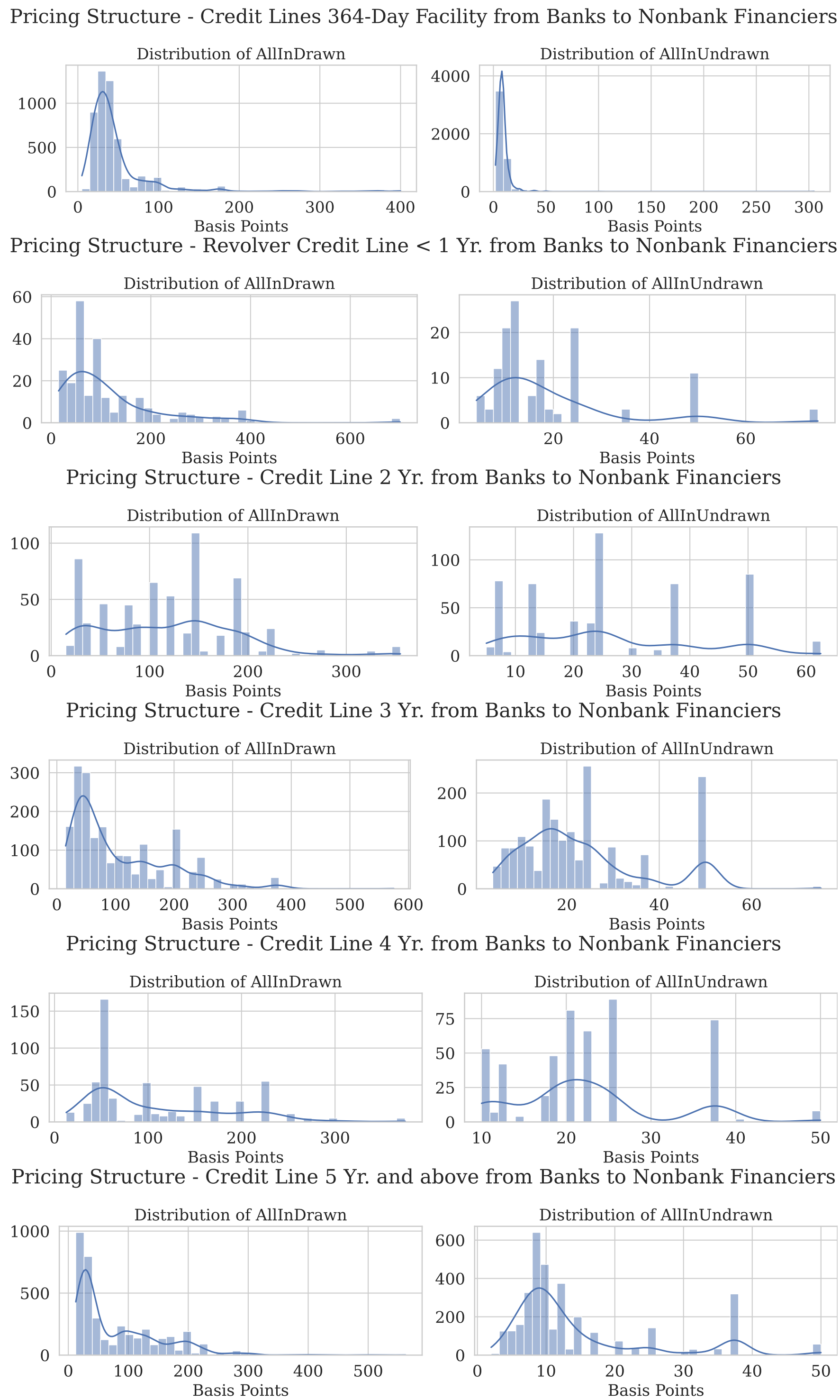

Figure C.1: This figure plots the all-in-drawn and all-in-undrawn spread in Dealscan and LSEG LoanConnector for credit lines from banks to nonbank lenders, categorized in maturities of exactly 364 days, less than 1 year, exactly 2 years, 3 years, 4 years, and 5 years and above.

C.2 Holding Share of Corporate Loans on Banks' and Nonbank Lenders' 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 LoanConnector.

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, and 3% of credit lines after origination, increasing to 49%, 73%, 54%, and 4% 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% [21], we adjust the

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

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 categorys 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 as term loans, after accounting for the portion sold, is given by:

$$\sum_{\text{Category}} \text{adj. share} \times \text{Pct. (Ent. Dur.)} = 43.48\%$$

C.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 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:

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.

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% [22] and WAM T of 10 years 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 periods 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:

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

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

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

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

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

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

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.

D Counterfactual Cash Contract

D.1 NBLs

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

$$N_t^N = \mathscr{P}_t^A[A_t^N + \mathcal{I}^{seized}(L_t^{cash})] + \max\{L_t^{cash} - \mathcal{I}^{seized}(L_t^{cash}), 0\} - B_t^N \, .$$

The recursive problem of a nonbank is:

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

subject to nonbank budget constraint

$$q_t A_{t+1}^N + q_t^{cash} L_{t+1}^{cash} \leq (1-\phi_0^N) N_t^N + e_t^N - \Psi^N\left(e_t^N\right) + q_t^r B_{t+1}^N, \tag{E.2}$$

and nonbank loan no-shorting constraint

$$0 \leq A_{t+1}^N, \tag{E.3}$$

and nonbank cash no-shorting limit

$$0 \leq L_{t+1}^{cash}, \tag{E.4}$$

where

$$\Psi^N\left(e_t^N\right) = \frac{\phi_1^N}{2}\left(e_t^N\right)^2 \, .$$

D.1.1 First-order Conditions

Attach Lagrange multiplier μ_t^N to the nonbank no-shorting constraint on loans to firms (E.3), and $\mu_{t,L}^N$ for the nonbank cash no-shorting constraint (E.4) and ν_t^N to the budget constraint (E.2).

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

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

Nonbank Loans. The FOC for loans A_{t+1}^N is

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

Nonbank Debt. The FOC for loans B_{t+1}^N is

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

Nonbank Cash. The FOC for nonbank cash L_{t+1}^{cash} is

$$\begin{aligned}
&\left(q_t^{cash} - \frac{\partial q_t^r}{\partial L_{t+1}^{cash}} B_{t+1}^N\right) \nu_t^N = \mu_{t,L}^N \\
&+ \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \tilde{V}_{N,t+1}^N \left(1 - F_{\epsilon,t+1}^N\right) \left(\mathscr{P}_{t+1}^A \frac{\partial \mathcal{I}_{t+1}^{seized}}{\partial L_{t+1}^{cash}} + \mathbb{1}_{\{L_{t+1}^{cash} - \mathcal{I}^{seized}(L_t^{cash})>0\}} \left(1 - \frac{\partial \mathcal{I}_{t+1}^{seized}}{\partial L_{t+1}^{cash}}\right)\right)\right] .
\end{aligned}$$

where

$$\begin{aligned}
\frac{\partial \mathcal{I}^{seized}(L_t^{cash})}{\partial L_t^{cash}} =& \frac{\partial}{\partial L_t^{cash}} \left(\int_0^{L_t^{cash}} \iota_t dF(\iota_t) + \int_{L_t^{cash}}^{\infty} L_t^{cash} dF(\iota_t)\right) \\
=& f(L_t^{cash}) L_t^{cash} - L_t^{cash} f(L_t^{cash}) + \int_{L_t^{cash}}^{\infty} dF(\iota_t) \\
=& 1 - F(L_t^{cash}) . \qquad \text{(E.5)}
\end{aligned}$$

D.1.2 Euler Equations

First take the envelope condition:

$$\tilde{V}_{N,t}^N = \phi_0^N + \left(1 - \phi_0^N\right) \nu_t^N .$$

Combining this with the FOC for equity issuance above to eliminate ν_t^N 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 the intermediary as

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

I can organize the FOCs as:

$$q_t - \frac{\partial q_t^r}{\partial A_{t+1}^N} B_{t+1}^N = \tilde{\mu}_t^N + \mathrm{E}\left[\mathcal{M}_{t,t+1}^N \mathscr{P}_{t+1}^A\right] , \qquad \text{(E.6)}$$

$$q_t^r + \frac{\partial q_t^r}{\partial B_{t+1}^N} B_{t+1}^N = \mathrm{E}\left[\mathcal{M}_{t,t+1}^N\right] , \qquad \text{(E.7)}$$

$$q_t^{cash} - \frac{\partial q_t^r}{\partial L_{t+1}^{cash}} B_{t+1}^N = \tilde{\mu}_{t,L}^N + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^N \left(\mathscr{P}_{t+1}^A (1 - F(L_t^{cash})) + \mathbb{1}_{\{L_{t+1}^{cash} - \mathcal{I}^{seized}(L_t^{cash})>0\}} F(L_t^{cash})\right)\right] . \qquad \text{(E.8)}$$

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

D.1.3 Partial Derivatives

Derivative of q_t^r with respect to L_{t+1}^{cash}.

$$q_t^r = \frac{(1-\theta)\,\varsigma C_t^H}{(1-\varsigma)B_{t+1}^H} + \mathrm{E}_t\Bigg\{\mathcal{M}_{t,t+1}\Bigg[1 - F_{\epsilon,t+1}^N$$
$$+ F_{\epsilon,t+1}^N \underbrace{\left((1-\zeta^N)\frac{\mathscr{P}_t^A\left[A_t^N + \mathcal{I}^{seized}\left(L_t^{cash}\right)\right] + \max\left\{L_t^{cash} - \mathcal{I}^{seized}(L_t^{cash}), 0\right\}}{B_{t+1}^N}\right)}_{:=\mathcal{A}_{t+1}^{H,cash}} + \underbrace{\frac{\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}}{B_{t+1}^N}}_{:=\mathcal{B}_{t+1}^{H,cash}}\Bigg]\Bigg\}. \tag{E.9}$$

Let's first define a few terms,

$$\mathcal{A}_{t+1}^{H,cash} \equiv (1-\zeta^N)\frac{\mathscr{P}_t^A\left[A_t^N + \mathcal{I}^{seized}\left(L_t^{cash}\right)\right] + \max\left\{L_t^{cash} - \mathcal{I}^{seized}(L_t^{cash}), 0\right\}}{B_{t+1}^N},$$

and

$$\mathcal{B}_{t+1}^{H,cash} \equiv \frac{\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}}{B_{t+1}^N}$$

Household choose their commercial paper to nonbanks, taking into account the risks associated with nonbank debt. Let's group some terms in the Euler Equation of the price of the commercial paper:

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

We would like to evaluate:

$$\frac{\partial q_t^r}{\partial L_{t+1}^{cash}} = \mathrm{E}_t\left\{\mathcal{M}_{t,t+1}\left[\left(\mathcal{A}_{t+1}^{H,cash} - 1\right)\frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}} + \frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial L_{t+1}}F_{\epsilon,t+1}^N + \frac{\partial \mathcal{B}_{t+1}^{H,cash}}{\partial L_{t+1}}\right]\right\} \tag{E.10}$$

First, we take the derivative of $\mathcal{A}_{t+1}^{H,cash}$ with respect to L_{t+1} :

$$\frac{\partial \mathcal{A}_{t+1}^{H,cash}}{\partial L_{t+1}^{cash}} = \left(1-\zeta^N\right)\left[\frac{\left(\mathscr{P}_{t+1}^A\frac{\partial \mathcal{I}_{t+1}^{seized}}{\partial L_{t+1}} + \mathbb{1}_{\{L_{t+1}^{cash} - \mathcal{I}^{seized}(L_t^{cash})>0\}}(1 - \frac{\partial \mathcal{I}_{t+1}^{seized}}{\partial L_{t+1}})\right)}{B_{t+1}^N}\right]$$

Then, we take derivative of $F_{\epsilon,t+1}^N$ with respect to L_{t+1}^{cash}. To do so, we first take the derivative of the default threshold $-\tilde{V}_{t+1}^N$ with respect to L_{t+1}^{cash}. Then we use Leibniz rule,

$$\frac{\partial F^N_{\epsilon,t+1}}{\partial L^{cash}_{t+1}} = -f^N_{\epsilon,t+1}\left(-\tilde{V}^N_{t+1}\right)\frac{\partial \tilde{V}^N_{t+1}}{\partial N^N_{t+1}}\frac{\partial N^N_{t+1}}{\partial L_{t+1}}$$
$$= -\, f^N_{\epsilon,t+1}\left(-\tilde{V}^N_{t+1}\right)\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\left(\mathscr{P}^A_{t+1}\frac{\partial \mathcal{I}^{seized}_{t+1}}{\partial L^{cash}_{t+1}} + \mathbb{1}_{\{L^{cash}_{t+1}-\mathcal{I}^{seized}(L^{cash}_t)>0\}}(1-\frac{\partial \mathcal{I}^{seized}_{t+1}}{\partial L_{t+1}})\right)$$

At last, we take the derivative of $\mathcal{B}^H_{t+1}$ with respect to L^N_{t+1}.

$$\frac{\partial\left(\epsilon^{N,-}_{t+1}F_{\epsilon,t+1}\right)}{\partial L^{cash}_{t+1}} = \frac{\partial}{\partial L^{cash}_{t+1}}\int_{-\infty}^{-\tilde{V}^N_{t+1}}\epsilon_{t+1}f^N_{\epsilon,t+1}d\epsilon = \frac{\partial\left(-\tilde{V}^N_{t+1}\right)}{\partial L^{cash}_{t+1}}\left(-\tilde{V}^N_{t+1}\right)f^N_{\epsilon,t+1}\left(-\tilde{V}^N_{t+1}\right) = -\tilde{V}^N_{t+1}\frac{\partial F^N_{\epsilon,t+1}}{\partial L^{cash}_{t+1}}$$

Plugging these aforementioned expressions into (E.10) yields an explicit form of the derivative.

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

$$\frac{\partial q^{cash}_t}{\partial L^{cash}_{t+1}} = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}\mathscr{P}^A_{t+1}\left(-f(L^{cash}_{t+1})\right) + f(L^{cash}_{t+1})\delta\left(L^{cash}_{t+1}-\mathcal{I}^{seized}(L^{cash}_t)\right)\right],$$

where

$$\delta\left(L^{\text{cash}}_{t+1}-\mathcal{I}^{seized}(L^{cash}_t)\right) = \frac{d}{dL^{\text{cash}}_{t+1}}\mathbb{1}_{\{L^{\text{cash}}_{t+1}-\mathcal{I}^{seized}(L^{cash}_t)>0\}}$$

is the Dirac delta concentrated at $L^{cash}_{t+1} = \mathcal{I}^{seized}(L^{cash}_t)$.

D.2 Banks

Bank net worth is given by

$$N^B_t = \mathscr{P}^A_t A^B_t - D_t - L^{cash}_t, \tag{E.11}$$

Bank's problem is characterized recursively as

$$V^B_t(\mathcal{S}_t) = \max_{\substack{A^B_{t+1},D_{t+1},\\ L^{cash}_{t+1},e^B_t}} \phi^B_0 N^B_t - e^B_t + \epsilon^B_t + \mathrm{E}_t\left[\mathcal{M}_{t,t+1}V^B_{t+1}(\mathcal{S}_{t+1})\right], \tag{E.12}$$

subject to bank budget constraint

$$q_t A^B_{t+1} - \left(q^f_t - \kappa\right)D_{t+1} \leq (1-\phi^B_0)N^B_t + q^{cash}_t L^{cash}_{t+1} + e^B_t - \Psi^B\left(e^B_t\right), \tag{E.13}$$

bank capital requirement,

$$D_{t+1} + L^{cash}_{t+1} \leq \xi A^B_{t+1}, \tag{E.14}$$

and no-shorting constraint on bank loan origination to firms,

$$0 \leq A^B_{t+1} \tag{E.15}$$

D.2.1 First-Order Conditions

Attach Lagrange multipliers λ^B_t to the capital requirement (E.14), μ^B_t to the no-shorting constraint on bank loans (E.15) and ν^B_t to the budget constraint (E.13). Denote $V^B_{N,t+1} = \frac{\partial V^B_{t+1}}{\partial N^B_{t+1}}$.

Equity Issuance. We can differentiate 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 loans A^B_{t+1}

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

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

$$\left(q^f_t - \kappa\right) \nu^B_t = \lambda^B_t + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} V^B_{N,t+1}\right]\ ,$$

Cash. The FOC for cash L^{cash}_{t+1} is

$$q^{cash}_t \nu^B_t + \frac{\partial q^{cash}_t}{\partial L^{cash}_{t+1}} \nu^B_t L^{cash}_{t+1} = \lambda^B_t + \mathrm{E}_t\left[\mathcal{M}_{t,t+1} V^B_{N,t+1}\right]\ .$$

D.2.2 Euler Equations

First take the envelope condition:

$$V^B_{N,t} = \phi^B_0 + \left(1 - \phi^B_0\right) \nu^B_t\ .$$

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

$$V^B_{N,t} = \phi^B_0 + \frac{1 - \phi^B_0}{1 - \phi^B_1 e^B_t}\ .$$

Define the stochastic discount factor of the intermediary as

$$\mathcal{M}^B_{t,t+1} = \mathcal{M}_{t,t+1}\left(1 - \phi^B_1 e^B_t\right)\left(\phi^B_0 + \frac{1 - \phi^B_0}{1 - \phi^B_1 e^B_{t+1}}\right)\left(1 - F^B_{\epsilon,t+1}\right)$$

I can organize the FOCs as:

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

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

$$q_t^{cash} + \frac{\partial q_t^{cash}}{\partial L_{t+1}^{cash}} L_{t+1}^{cash} - \tilde{\lambda}_t^B = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^B\right] \ , \tag{E.18}$$

where we define $\tilde{\mu}_t^B \equiv \mu_t^B / \nu_t^B$ and $\tilde{\lambda}_t^B \equiv \lambda_t^N / \nu_t^B$.

E Counterfactual Debt Contract

Suppose in the counterfactual economy banks offer a debt contract to nonbank lenders (NBLs) characterized by the loan price q_t^{debt} and the debt quantity L_t^{debt}. NBLs are able to use term loans to fund investment opportunities in the same fashion as before: this implies no change in the environment of the economy but only a modification of the asset markets structure.

E.1 Nonbank Lenders

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

$$N_t^N = \mathscr{P}_t^A A_t^N + \mathscr{P}_t^A \mathcal{I}_t^{debt} - L_t^{debt} - B_t^N$$

where

$$\mathcal{I}_t^{debt} = \int_0^\infty \min\{\iota, L_t^{debt}\} dF(\iota)$$

E.1.1 Optimization Problem

The recursive problem of a nonbank is:

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

subject to nonbank budget constraint

$$q_t A_{t+1}^N - q_t^{debt} L_{t+1}^{debt} \leq (1 - \phi_0^N) N_t^N + e_t^N - \Psi^N\left(e_t^N\right) + q_t^r B_{t+1}^N, \tag{D.2}$$

and nonbank no-shorting constraint

$$0 \leq A_{t+1}^N, \tag{D.3}$$

where

$$\Psi^N\left(e_t^N\right) = \frac{\phi_1^N}{2}\left(e_t^N\right)^2 \ .$$

E.1.2 First-order Conditions

Attach Lagrange multiplier and ν_t^N to the budget constraint (D.2) and μ_t^N to the nonbank no-shorting constraint on loans to firms (D.3).

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

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

Nonbank Loans. The FOC for loans A_{t+1}^N is

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

Nonbank Debt. The FOC for loans B_{t+1}^N is

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

Alternative Financing - Debt Contract The FOC for alternative financing debt contract L_{t+1}^{debt} is

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

E.1.3 Euler Equations

First take the envelope condition:

$$\tilde{V}_{N,t}^N = \phi_0^N + \left(1-\phi_0^N\right)\nu_t^N \ .$$

Combining this with the FOC for equity issuance above to eliminate ν_t^N 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 the intermediary as

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

I can organize the FOCs as:

$$q_t - \frac{\partial q_t^r}{\partial A_{t+1}^N} B_{t+1}^N = \tilde{\mu}_t^N + \mathrm{E}\left[\mathcal{M}_{t,t+1}^N \mathscr{P}_{t+1}^A\right] \ , \tag{D.4}$$

$$q_t^r + \frac{\partial q_t^r}{\partial B_{t+1}^N} B_{t+1}^N = \mathrm{E}\left[\mathcal{M}_{t,t+1}^N \left(1 - \theta \Lambda\left(c(L_{t+1})\right)\right)\right] \ , \tag{D.5}$$

$$q_t^{debt} + \frac{\partial q_t^r}{\partial L_{t+1}^{debt}} B_{t+1}^N + \frac{\partial q_t^{debt}}{\partial L_{t+1}^{debt}} L_{t+1}^{debt} = \mathrm{E}_t\left[\mathcal{M}_{t,t+1}^N \left(1 - \mathscr{P}_{t+1}^A (1 - F(L_{t+1}^{debt}))\right)\right] \ . \tag{D.6}$$

where I plug in equation (A.5) and define $\tilde{\mu}_t^N \equiv \mu_t^N / \nu_t^N$.

E.2 Banks

Bank net worth is given by

$$N_t^B = \mathscr{P}_t^A A_t^B - D_t + \mathscr{P}_t^{debt} L_t^{debt} \ , \tag{D.7}$$

where

$$\mathscr{P}_{t+1}^{debt}(L_{t+1}^{debt}) = \left(1 - F_{\epsilon,t+1}^N\right) + F_{\epsilon,t+1}^N RV_{t+1}^N + \frac{F_{\epsilon,t+1}^N \epsilon_{t+1}^{N,-}}{B_{t+1}^N + L_{t+1}^{debt}} \ , \tag{D.8}$$

where the recovery value of NBL default is

$$RV_{t+1}^N = (1 - \zeta^N) \cdot \frac{\mathscr{P}_{t+1}^A \left(A_{t+1}^N + \mathcal{I}_{t+1}^{debt}(L_{t+1}^{debt})\right)}{B_{t+1}^N + L_{t+1}^{debt}} \ . \tag{D.9}$$

Bank's problem is the same as before expect for the budget constraint

$$q_t A_{t+1}^B - q_t^f D_{t+1} \leq (1 - \phi_0^B) N_t^B - q_t^{debt} L_{t+1}^{debt} + e_t^B - \Psi^B\left(e_t^B\right) , \tag{D.10}$$

bank capital requirement,

$$D_{t+1} \leq \xi\left(A_{t+1}^B + L_{t+1}^{debt}\right) , \tag{D.11}$$

no-shorting constraint on bank alternative debt contract to NBLs,

$$0 \leq L_{t+1}^{debt} \ , \tag{D.12}$$

E.2.1 First-Order Conditions

Attach Lagrange multiplier μ_t^L to the no-shorting constraint on bank alternative debt contract to NBLs (D.12). The FOC for term loan L_{t+1}^{debt} is

$$q_t^{debt} \nu_t^B - \mu_t^{debt} - \lambda_t^B \xi = \mathrm{E}_t\left[\mathcal{M}_{t,t+1} \tilde{V}_{N,t+1}^B \left(1 - F_{\epsilon,t+1}^B\right) \left(\mathscr{P}_{t+1}^{debt} + L_{t+1} \frac{\partial \mathscr{P}_{t+1}^{debt}}{\partial L_{t+1}^{debt}}\right)\right] \ .$$

which can be rewritten as

$$q_t^{debt} - \tilde{\mu}_t^{debt} - \tilde{\lambda}_t^B \xi = \mathrm{E}_t \left[\mathcal{M}_{t,t+1}^B \left(\mathscr{P}_{t+1}^{debt} + L_{t+1} \frac{\partial \mathscr{P}_{t+1}^{debt}}{\partial L_{t+1}^{debt}} \right) \right], \tag{D.13}$$

where we define $\tilde{\mu}_t^L \equiv \mu_t^L / \nu_t^B$ and $\tilde{\lambda}_t^B \equiv \lambda_t^N / \nu_t^B$.

E.2.2 Partial Derivative of $\mathscr{P}_{t+1}^{debt}$

Derivative of $\mathscr{P}_{t+1}^{debt}$ with respect to L_{t+1}^{debt}.

$$\mathscr{P}_{t+1}^{\text{debt}} \left(L_{t+1}^{\text{debt}} \right) = \left(1 - F_{\epsilon,t+1}^N \right) + F_{\epsilon,t+1}^N RV_{t+1}^N + \frac{F_{\epsilon,t+1}^N \epsilon_{t+1}^{N,-}}{B_{t+1}^N + L_{t+1}^{\text{debt}}}$$

where the recovery value of NBL default is

$$RV_{t+1}^N = \left(1 - \zeta^N \right) \cdot \frac{\mathscr{P}_{t+1}^A \left(A_{t+1}^N + \mathcal{I}_{t+1}^{\text{debt}} \left(L_{t+1}^{\text{debt}} \right) \right)}{B_{t+1}^N + L_{t+1}^{\text{debt}}}$$

$$\frac{\partial \mathscr{P}_{t+1}^{debt}}{\partial L_{t+1}^{debt}} = \left(RV_{t+1}^N - 1 \right) \frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}^{debt}} + F_{\epsilon,t+1}^N \frac{\partial RV_{t+1}^N}{\partial L_{t+1}^{debt}} + \frac{\partial}{\partial L_{t+1}^{debt}} \left(\frac{F_{\epsilon,t+1}^N \epsilon_{t+1}^{N,-}}{B_{t+1}^N + L_{t+1}^{debt}} \right) \tag{D.14}$$

I first take the derivative of the recovery value with respect to L_{t+1}^{debt} is

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

Then we use Leibniz rule,

$$\begin{aligned} \frac{\partial F_{\epsilon,t+1}^N}{\partial L_{t+1}} &= -f_\epsilon^N \left(-\tilde{V}_{t+1}^N \right) \frac{\partial \tilde{V}_{t+1}^N}{\partial N_{t+1}^N} \frac{\partial N_{t+1}^N}{\partial L_{t+1}} \\ &= -f_\epsilon^N \left(-\tilde{V}_{t+1}^N \right) \left(\phi_0^N + \frac{1 - \phi_0^N}{1 - \phi_1^N e_{t+1}^N} \right) \left(\mathscr{P}_{t+1}^A (1 - F_\iota(L_{t+1}^{debt})) - 1 \right) \end{aligned}$$

Finally, we can calculate

$$
\begin{aligned}
\frac{\partial\left(\epsilon_{t+1}^{N,-}F_{\epsilon,t+1}\right)}{\partial L_{t+1}} &= \frac{\partial}{\partial L_{t+1}^{N}}\int_{-\infty}^{-\tilde{V}_{t+1}^{N}}\epsilon_{t+1}f_{\epsilon,t+1}^{N}d\epsilon \\
&= \frac{\partial\left(-\tilde{V}_{t+1}^{N}\right)}{\partial L_{t+1}}\left(-\tilde{V}_{t+1}^{N}\right)f_{\epsilon}^{N}\left(-\tilde{V}_{t+1}^{N}\right) \\
&= \frac{\partial\left(-\tilde{V}_{t+1}^{N}\right)}{\partial N_{t+1}^{N}}\frac{\partial N_{t+1}^{N}}{\partial L_{t+1}}\left(-\tilde{V}_{t+1}^{N}\right)f_{\epsilon}^{N}\left(-\tilde{V}_{t+1}^{N}\right) \\
&= f_{\epsilon}^{N}\left(-\tilde{V}_{t+1}^{N}\right)\left(\phi_0^N+\frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\tilde{V}_{t+1}^{N}\left(\mathscr{P}_{t+1}^{A}(1-F_{\iota}(L_{t+1}^{debt}))-1\right).
\end{aligned}
$$

Hence,

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

Plugging each item in (D.14), we have:

$$
\begin{aligned}
\frac{\partial\mathscr{P}_{t+1}^{\text{debt}}}{\partial L_{t+1}^{\text{debt}}} &= (RV_{t+1}^{N}-1)\left[-f_{\epsilon}^{N}(-\tilde{V}_{t+1}^{N})\left(\phi_0^N+\frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\left(\mathscr{P}_{t+1}^{A}[1-F_{\iota}(L_{t+1}^{\text{debt}})]-1\right)\right] \\
&+ F_{\epsilon,t+1}^{N}\left(1-\zeta^N\right)\mathscr{P}_{t+1}^{A}\,\frac{\left[1-F_{\iota}(L_{t+1}^{\text{debt}})\right]\left(B_{t+1}^{N}+L_{t+1}^{\text{debt}}\right)-\left[A_{t+1}^{N}+\mathcal{I}_{t+1}^{\text{debt}}(L_{t+1}^{\text{debt}})\right]}{\left(B_{t+1}^{N}+L_{t+1}^{\text{debt}}\right)^2} \\
&+ \frac{f_{\epsilon}^{N}(-\tilde{V}_{t+1}^{N})\left(\phi_0^N+\frac{1-\phi_0^N}{1-\phi_1^N e_{t+1}^N}\right)\tilde{V}_{t+1}^{N}\left(\mathscr{P}_{t+1}^{A}[1-F_{\iota}(L_{t+1}^{\text{debt}})]-1\right)\left(B_{t+1}^{N}+L_{t+1}^{\text{debt}}\right)\;-\;F_{\epsilon,t+1}^{N}\,\epsilon_{t+1}^{N,-}}{\left(B_{t+1}^{N}+L_{t+1}^{\text{debt}}\right)^2}\,.
\end{aligned}
$$

E.2.3 Partial Derivatives of q_t^{debt}.

The derivatives of q_t^{debt} are very similar to the one for q_t^r. 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. We will focus on the one with respect to L_t^{debt}. Recall

$$
q_t^{debt}=\mathrm{E}_t\left\{\mathcal{M}_{t,t+1}^{B}\mathscr{P}_{t+1}^{debt}\left(L_{t+1}^{TL}\right)\right\}+\text{other terms} \tag{D.15}
$$

$$
q_t^r=\mathrm{E}_t\{\mathcal{M}_{t,t+1}\mathscr{P}_{t+1}^{debt}(L_{t+1}^{debt})\}+\text{other terms}\,. \tag{D.16}
$$

Let us bracket terms in $\mathcal{R}^{debt}_{t+1}(L^{debt}_{t+1})$, similar to how we define $\mathcal{A}^H$ and $\mathcal{B}^H$ in (A.24):

$$\mathcal{R}^{debt}_{t+1}(L^{debt}_{t+1}) = 1 - F^N_{\epsilon,t+1} + F^N_{\epsilon,t+1}\underbrace{\left((1-\zeta^N)\frac{\mathscr{P}^A_{t+1}(A^N_{t+1}+\mathcal{I}^{debt}_{t+1}(L^{debt}_{t+1}))}{B^N_{t+1}+L^{debt}_{t+1}}\right)}_{:=\mathcal{A}^{H,debt}} + \underbrace{\frac{\epsilon^{N,-}_{t+1}F_{\epsilon,t+1}}{B^N_{t+1}+L^{debt}_{t+1}}}_{:=\mathcal{B}^{H,debt}}$$

Derivative of q^{debt}_t with respect to L^{debt}_{t+1}. We would like to evaluate:

$$\frac{\partial q^{debt}_t}{\partial L_{t+1}} = \mathrm{E}_t\left\{\mathcal{M}^B_{t,t+1}\left[\left(\mathcal{A}^{H,debt}_{t+1}-1\right)\frac{\partial F^N_{\epsilon,t+1}}{\partial L^{debt}_{t+1}} + \frac{\partial \mathcal{A}^{H,debt}_{t+1}}{\partial L^{debt}_{t+1}}F^N_{\epsilon,t+1} + \frac{\partial \mathcal{B}^{H,debt}_{t+1}}{\partial L^{debt}_{t+1}}\right]\right\} \tag{D.17}$$

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

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

Then, we need to take derivative of $F^N_{\epsilon,t+1}$ with respect to L^{debt}_{t+1}. To do so, we first take the derivative of the default threshold $-\tilde{V}^N_{t+1}$ with respect to L^{debt}_{t+1}. Then we use Leibniz rule,

$$\begin{aligned}\frac{\partial F^N_{\epsilon,t+1}}{\partial L^{debt}_{t+1}} &= -f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1})\frac{\partial \tilde{V}^N_{t+1}}{\partial N^N_{t+1}}\frac{\partial N^N_{t+1}}{\partial L^{debt}_{t+1}} \\ &= -f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1})\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\left(\mathscr{P}^A_{t+1}\frac{\partial \mathcal{I}^{debt}_{t+1}(L^{debt}_{t+1})}{\partial L^{debt}_{t+1}} - 1\right).\end{aligned}$$

At last, we take the derivative of $\mathcal{B}^H_{t+1}$ with respect to L^{debt}_{t+1}.

$$\mathcal{B}^H_{t+1} = \frac{\epsilon^{N,-}_{t+1}F_{\epsilon,t+1}}{B^N_{t+1}+L^{debt}_{t+1}}$$

We can calculate

$$\begin{aligned}\frac{\partial\left(\epsilon^{N,-}_{t+1}F_{\epsilon,t+1}\right)}{\partial L^{debt}_{t+1}} &= \frac{\partial}{\partial L^{debt}_{t+1}}\int_{-\infty}^{-\tilde{V}^N_{t+1}} \epsilon_{t+1} f^N_{\epsilon,t+1} d\epsilon \\ &= \frac{\partial(-\tilde{V}^N_{t+1})}{\partial L^{debt}_{t+1}}(-\tilde{V}^N_{t+1})f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1}) \\ &= \frac{\partial(-\tilde{V}^N_{t+1})}{\partial N^N_{t+1}}\frac{\partial N^N_{t+1}}{\partial L^{debt}_{t+1}}(-\tilde{V}^N_{t+1})f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1}) \\ &= f^N_{\epsilon,t+1}(-\tilde{V}^N_{t+1})\left(\phi^N_0 + \frac{1-\phi^N_0}{1-\phi^N_1 e^N_{t+1}}\right)\left(\mathscr{P}^A_{t+1}\frac{\partial \mathcal{I}^{debt}_{t+1}(L^{debt}_{t+1})}{\partial L^{debt}_{t+1}} - 1\right)\tilde{V}^N_{t+1}.\end{aligned}$$

Hence,

$$
\begin{aligned}
\frac{\partial \mathcal{B}^{H}_{t+1}}{\partial L^{debt}_{t+1}} &= \frac{1}{B^{N}_{t+1}+L^{debt}_{t+1}} \frac{\partial \left(\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}\right)}{\partial L^{debt}_{t+1}} - \frac{\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}}{\left(B^{N}_{t+1}+L^{debt}_{t+1}\right)^2} \\
&= \frac{1}{B^{N}_{t+1}+L^{debt}_{t+1}} \left[\left(\mathscr{P}^{A}_{t+1} \frac{\partial \mathcal{I}^{debt}_{t+1}(L^{debt}_{t+1})}{\partial L^{debt}_{t+1}} - 1 \right) \tilde{V}^{N}_{t+1} f^{N}_{\epsilon,t+1}(-\tilde{V}^{N}_{t+1}) \left(\phi^{N}_{0} + \frac{1-\phi^{N}_{0}}{1-\phi^{N}_{1} e^{N}_{t+1}} \right) - \frac{\epsilon^{N,-}_{t+1} F_{\epsilon,t+1}}{B^{N}_{t+1}+L^{debt}_{t+1}} \right].
\end{aligned}
$$

We can then plug in the expressions to get the explicit form of the derivatives.

```
You are a finance analyst and you are looking at the reports of finance companies or investment funds that get
 revolving credit facilities.
Given sentences, you need to predict which whether it indicates "investment uncertainty": YES or NO.

The definition of "investment uncertainty": finance companies or investment funds have uncertainties in their
lending.
They do not know how much money they need in order to fund corporates.
Because of this uncertainty, they get revolving credit facilities so that they can draw down from these
revolving credit facilities if they need money to fund corporates.
Generally, if you find verbs like "to fund", "to purchase", "to acquire", "to invest", "to provide financing",
 "to provide bridge financing", or any other words with similar meanings, either in the active voice or the
passive voice like "financing provided through revolving credit facility," the purpose is "investment
uncertainty".
Also, nouns such as "investments", "acquisitions", etc. are also indicators of "investment uncertainty."

Again, you should only predict whether it is "investment uncertainty" and output YES or NO. Nothing else.

## Sample
Content:
The outstanding borrowings under our revolving credit facility bear interest at a current rate of 1.2120%. Our
 revolving credit facility matures on June 22, 2026. We used the proceeds of such borrowings to fund a portion
 of the purchase price of our acquisition of e-TeleQuote in July 2021.
investment uncertainty? (only reply YES or NO): YES

Content:
Additional resources to support liquidity are as follows:
The Corporation and AIC have access to a $750 million unsecured revolving credit facility that is available
for short-term liquidity requirements. In November 2022, the maturity date of this facility was extended to
November 2027 and the USD
investment uncertainty? (only reply YES or NO): NO

Content:
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 replacement lenders providing more than two-
thirds of the commitments to lend.
investment uncertainty? (only reply YES or NO): NO

Content:
From time to time, we will borrow funds, including under our revolving credit facilities, or issue debt
securities or preferred securities to make additional investments or for other purposes. This is known as "
leverage" and could increase or decrease returns to our stockholders. The use of borrowed funds or the
proceeds of preferred stock offerings to make investments has specific benefits and risks, and all of the
costs of borrowing funds or issuing preferred stock are borne by our stockholders.
investment uncertainty? (only reply YES or NO): YES

Content:
[CONTENTS]
investment uncertainty? (only reply YES or NO):
```

Figure B.2.3: Prompt of investment uncertainty prediction, where [CONTENTS] should be replaced by the input sentences.

```
You are a finance analyst and you are looking at the reports of finance companies, investment funds,
institutional investors, etc. that get revolving credit facilities.
Given sentences, you need to predict which whether it indicates "liquidity support": YES or NO.

The definition of "liquidity support":  to help satisfy liquidity requirement or provide back-up liquidity or
complement other liquidity facilities,
like the commercial paper program.
When you see words like "available for short-term liquidity requirements," "to meet short-term liquidity needs
," "to meet cash requirements," "to provide back-up liquidity,"
"to back up the commercial paper program," "back-stop support for our commercial paper program," "to satisfy
the current liquidity requirement,"
these are indicators of liquidity support.

Again, you should only predict whether it is "liquidity support" and output YES or NO. Nothing else.

## Sample
Content:
The outstanding borrowings under our revolving credit facility bear interest at a current rate of 1.2120%. Our
 revolving credit facility matures on June 22, 2026. We used the proceeds of such borrowings to fund a portion
 of the purchase price of our acquisition of e-TeleQuote in July 2021.
liquidity support? (only reply YES or NO): NO

Content:
Additional resources to support liquidity are as follows:
 The Corporation and AIC have access to a $750 million unsecured revolving credit facility that is available
for short-term liquidity requirements. In November 2022, the maturity date of this facility was extended to
November 2027 and the USD
liquidity support? (only reply YES or NO): YES

Content:
From time to time, we will borrow funds, including under our revolving credit facilities, or issue debt
securities or preferred securities to make additional investments or for other purposes. This is known as
leverage and could increase or decrease returns to our stockholders. The use of borrowed funds or the proceeds
 of preferred stock offerings to make investments has specific benefits and risks, and all of the costs of
borrowing funds or issuing preferred stock are borne by our stockholders.
liquidity support? (only reply YES or NO): NO

Content:
The maximum potential borrowings under the seasonal line of credit totaled $4,500,000 at October 31, 2003 and
at July 31, 2004. It is used to meet cash requirements during Sea Pines off-season winter months. The seasonal
 line of credit had no outstanding balance at October 31, 2003 or at July 31, 2004, and it expires on November
 1, 2007.
liquidity support? (only reply YES or NO): YES

Content:
[CONTENTS]
liquidity support? (only reply YES or NO):
```

Figure B.2.4: Prompt of liquidity support prediction, where [CONTENTS] should be replaced by the input sentences.