Finance and Economics Discussion Series

Federal Reserve Board, Washington, D.C.
ISSN 1936-2854 (Print)
ISSN 2767-3898 (Online)

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2020-086

Please cite this paper as:
Darst, R. Matthew, Ehraz Refayet, and Alexandros Vardoulakis (2025). "Macroprudential Regulation and Lending Standards," Finance and Economics Discussion Series 2020-086r1. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2020.086r1.

Macroprudential Regulation and Lending Standards*

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May, 2025

Abstract

We examine how macroprudential capital requirements interact with competition between banks and non-banks to shape lending standards. Banks have private information and benefit from deposit insurance, while non-banks lack such advantages but are less regulated. We show that higher capital requirements raise banks' incentives to screen, tightening lending standards despite a decline in lender protections at the contract level. Non-bank competition does not erode but rather strengthens aggregate standards by crowding out riskier bank lending. Optimal capital regulation is lower in the presence of non-banks. Our analysis helps rationalize dynamics in leveraged loan and private credit markets.

JEL Classification: G01,G21,G28

Keywords: Lending standards, credit cycles, asymmetric information, non-banks, macroprudential regulation

*We would like to thank Mitchell Berlin, Giovanni Dell'Ariccia, Robert Marquez, Raoul Minetti, Christine Parlour and seminar participants at the Federal Reserve Board, the IMF, the OCC, and the day ahead conference of the Federal Reserve System, the North American Econometric Society meetings, the Royal Economic Society, and IFABS. All errors are our own. The views expressed in this paper are those of the authors and do not necessarily represent those of the Federal Reserve Board of Governors or anyone in the Federal Reserve System. Refayet: The views expressed in this paper are my own and are based on independent research and do not necessarily reflect the views of the Office of the Comptroller of the Currency, the Department of the Treasury, or the United States government. This paper is the result of my independent research and has not been reviewed by the OCC.

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1 Introduction

In the aftermath of the Global Financial Crisis (GFC), policy makers introduced stricter bank regulation to mitigate system-wide risks and complement the bank-specific risk assessments of microprudential regulators (Hanson, Kashyap, and Stein, 2011; Aikman, Bridges, Kashyap, and Siegert, 2019). At the same time, the stricter bank regulation has pushed activity to non-bank financial institutions, which operate outside the macroprudential regulatory perimeter (Buchak, Matvos, Piskorski, and Seru, 2018; Irani, Iyer, Meisenzahl, and Peydro, 2021). This migration of activity has raised concerns about higher systemic risk because non-banks have less oversight and may extend riskier loans. The left panel in Figure 1 shows that the rapid growth in nonfinancial business credit from non-banks coincides with the macroprudential capital regime that raised banks' capital ratios.

An often raised concern about credit migration to unregulated non-banks is that non-bank loans have fewer lender protections that could amplify losses during a crisis and depress economic activity. However, since the GFC and rise of non-bank lending, default rates have tended to remain low, often below even historic norms. The right panel in Figure 1 shows the relationship between the fraction of covenant-lite leveraged loans (blue bars), a proxy for lender protections, along with realized (red line) and expected (black line) default rates. Overall, the picture is clear: lender protections at the contract level are alarmingly low but realized default rates remain low and below expectations, suggesting that lending standards may not have deteriorated on aggregate.

We present a model capturing the following dynamics: (i) the need for a macroprudential regulation, (ii) credit migration to non-banks, (iii) lower lender protection at the contract level, and (iv) lack of deterioration in aggregate credit quality and lending standards.[1] The key to understanding how higher capital requirements can lower lender protection at the contract level without an associated deterioration in aggregate lending standards is through their differential impact on the intensive and extensive lending margins.

First, consider an environment with only banks that benefit from subsidized deposit insurance. Tighter capital requirements are passed through to borrowers via higher interest rates and competition pushes each individual bank to lower collateral requirements and,

[1] More recently, these dynamics have also been observed in the rapidly expanding private credit market. See Cai and Haque (2024).

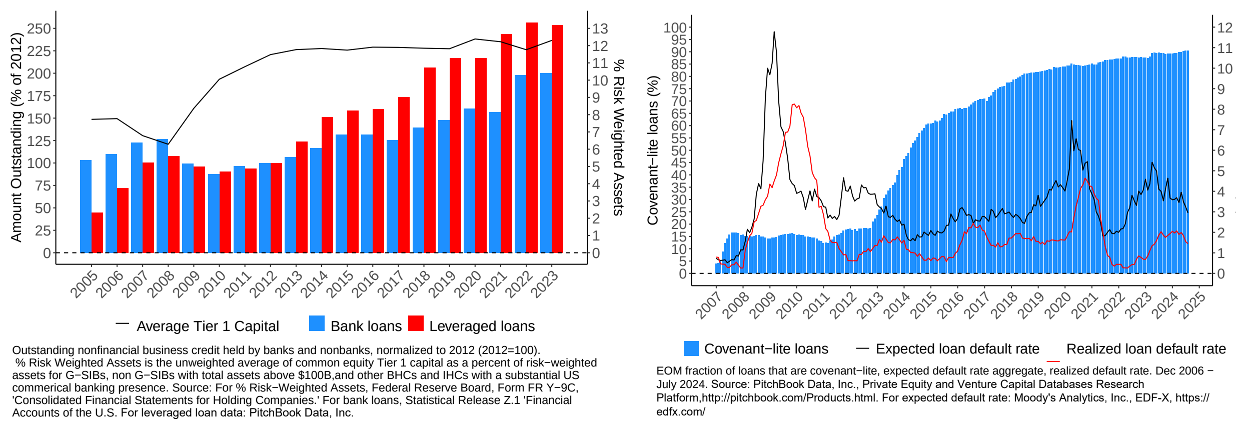

Figure 1: Panel (a) - Tier 1 Capital Requirements and Leveraged Loans Commitments from Banks and Non-banks. Panel (b) - Fraction of Covenant-lite Loans and Loan Default Rates

hence, lender protection at the contract level to avoid losing borrowers to other banks (the intensive lending effect). At the same time, higher capital requirements increase banks' skin in the game, incentivizing them to screen out bad loans more frequently to avoid large losses in default (the external lending margin). Hence, the overall pool of loans consists of higher-quality borrowers despite each loan having less collateral pledged.

Now, suppose that there is an alternative type of intermediary that, unlike banks, does not benefit from the deposit insurance subsidy akin to Donaldson, Piacentino and Thakor (2021). This puts them at a funding cost disadvantage relative to banks. Macroprudential regulation curtails the benefit accruing from the deposit insurance subsidy to banks and therefore allows for competition between banks and non-banks.

Does macroprudential regulation allow non-banks to step in and offer loans to lower quality borrowers that banks screen out? The answer is no. This is because the deposit insurance subsidy is more valuable when making loans to bad borrowers. Hence, non-banks cannot offer a more competitive contract to screened-out bad borrowers. Instead, non-banks compete with banks to attract good borrowers: for a given lending rate, non-banks can profitably set a slightly lower collateral requirement than banks. Thus, macroprudential regulation results in a migration of good borrowers to non-banks with lower collateral requirements, but does not erode the average quality of loans extended in equilibrium.

We build on Dell'Ariccia and Marquez (2006) along several dimensions to capture the aforementioned dynamics in an environment with banks and non-banks, and optimally set capital regulation. There are two types of borrowers, good and bad. Good borrowers have projects with positive net present value (NPV), while bad borrowers have projects with negative NPV but with higher upside conditional on success. On average, a portfolio of both good and bad projects has positive NPV. Banks have private information about borrowers with whom they have existing relationships, but there is another set of borrowers whose projects' quality is unknown. While the mass of known borrowers is fixed, the mass of unknown borrowers can vary and it represents the level of (new) demand for credit.

Collateral requirements in loan contracts can be used to screen out bad borrowers but are costly because of inefficient liquidation of collateral in default. Alternatively, loan contracts without collateral requirements feature only a competitive interest rate and pool all borrowers together. Thus, banks face an adverse selection problem because funding all projects mixes all unknown borrowers (good and bad) with competing banks' known bad borrowers. There are two alternative lending regimes that determine the aggregate lending standards: (i) lending standards are tighter when collateral is required and bad borrowers are screened out, and (ii) lending standards are looser when all borrowers receive funding without collateral requirements.

The level of credit demand determines the equilibrium lending regime—the external lending margin. But within the tighter regime, collateral requirements at the contract level may be higher or lower—the intensive lending margin. With respect to the external margin, higher credit demand by unknown borrowers mitigates adverse selection because their projects have, on average, a positive NPV . In particular, there exists a threshold for aggregate credit demand above which banks switch from a regime with tighter standards to one with looser standards. Capital regulation impacts this decision by affecting the relative cost of lending across the two regimes and intensifying competition from non-banks.

We derive the following three results. First, a social planner sets a positive macroprudential capital requirement that trades off the cost of inefficient liquidation of collateral in the tighter-lending-standards regime versus the cost of funding some negative NPV projects in the looser-lending-standards regime. The level of the optimal macroprudential capital requirement determines the threshold for switching from tighter to looser lending standards. Absent non-banks, a higher macroprudential requirement—driven by the desire to decrease the cost of funding some negative NPV projects—improves the aggregate quality of funded projects and reduces aggregate default rates. This is because higher capital requirements effectively erode the deposit insurance subsidy that is more valuable when making loans to riskier borrowers. Hence, banks are less likely to extend such loans and instead use collateral for screening. At the same time, to remain competitive, banks lower the amount of collateral required at the loan level to screen out bad borrowers. In sum, aggregate default rates go down but lender protections at the contract level weaken in response to stricter macroprudential regulation.

Second, stricter macroprudential regulation increases competition from non-banks but, strikingly, aggregate lending standards tighten further. In other words, an economy with non-banks supports a tighter lending regime—whereby collateral is used to screen out bad borrowers—for higher levels of credit demand relative to an economy with only banks.

The intuition behind this result is as follows. Non-banks can compete more easily with banks in the regime where collateral is used to screen out bad borrowers. The reason is twofold: first, as stated above, the deposit insurance subsidy to banks is more valuable when borrowers are not screened; second, collateral is an equally efficient screening mechanism for both banks and non-banks. This implies that non-banks determine lending costs in the tighter lending-standards-regime, while banks do so in the looser-lending-standards regime. Because, tighter macroprudential regulation does not impact non-banks, the lending cost in the tighter standards regime is unaffected. However, tighter regulation increases the lending cost in the looser standards regime, where credit continues to be intermediated by banks. In sum, compared to an economy with only banks, the cost of lending increases only in the looser standards regime, while it does not affect the cost of screening out bad borrowers in the tighter standards regime. Therefore, a higher level of credit demand is required to make lending profitable with looser standards. In equilibrium, expected default rates are lower. In conjunction with the first result above, this result rationalizes the four aforementioned dynamics observed in the data.

Third, the optimal macroprudential capital requirement is lower in the presence of non-bank competition. Recall that the social planner trades off the inefficient collateral liquidation with the funding of some negative NPV projects when choosing macroprudential capital requirements. From the second result above, we know that aggregate lending standards are tighter under non-bank competition for the same level of capital requirement. Thus, the planner could soften capital requirements to economize on liquidation cost of collateral in the tighter regime, while preserving the same aggregate lending standards in the presence of non-bank competition.

Related Literature. Our paper contributes to the literature by linking macroprudential regulation and the rise of non-bank lending to aggregate lending standards and financial stability. To that extent, we relate to three broad strands of the literature.

The first strand has studied how lending standards evolve along business and credit cycles. Dell'Ariccia and Marquez (2006) and Ruckes (2004) show how lending standards weaken during credit expansions, while Gormley (2014) studies how lender entry influences aggregate credit extension and output when new lenders can poach good borrowers from other banks. Moreover, several recent papers study the dynamics of lending standards. Fishman, Parker and Straub (2024) study how screening intensity dynamically affects the quality of the borrower pool, while Farboodi and Kondor (2023) study how sentiment affects credit outcomes and how the quality of the borrower pool endogenously fluctuates with standards, generating credit cycles. Gorton and Ordonez (2019) and Asriyan, Laeven and Martin (2022) study how the use of collateral in lending contracts affects information acquisition and the emergence of boom-bust cycles. We contribute to this literature by explicitly studying the effect of regulation on lending standards in a modern financial system that features both banks and non-banks.

The second strand of the literature has focused more on the rise of non-bank financial intermediation and how they compete with banks. Buchak, Matvos, Piskorski and Seru (2018) and Irani, Iyer, Meisenzahl and Peydro (2021) study the rise of non-bank financial intermediation in mortgage and non-financial business lending markets and establish the role of bank regulation. Donaldson, Piacentino and Thakor (2021) develop a model where banks and non-banks co-exist in equilibrium and show that funding cost differences result in different lending strategies, but do not focus on lending standards. Parlour, Rajan and Zhu (2022) study the impact of FinTech competition in payment services on bank profitability and loan quality when information externalities accrue to banks. Vives and Ye (2025*b*) focus on the effect of informational technology (IT) on lenders' competition and monitoring intensity. Vives and Ye (2025*a*) show how non-banks can exploit IT to price discriminate and poach borrowers from banks, with the relative funding costs between banks and non-banks driving the quality of non-bank loans. We contribute to this literature by explicitly examining how capital regulation and non-bank competition affects lending standards. Moreover, these papers generally abstract from adverse selection in lending and, thus, cannot explain the worsening of lending protections at the contract level without a simultaneous increase in aggregate default rates, which our model delivers.

The third strand of the literature examines more closely the effect of regulation on migration of lending activity from banks to non-banks. Begenau and Landvoigt (2021) show that tighter bank capital regulation leads to a shift of activity toward non-banks, though the overall financial system becomes safer due to reduced risk-taking incentives. Dempsey (2025) similarly shows that raising bank capital requirements reduces bank risk-taking and bank failures but prompts firms to shift toward non-bank lenders; yet banks adjust in the long-run and the overall quantity of aggregate investment remains largely unchanged. Bengui and Bianchi (2022) and Davila and Walther (2022) show that the imperfect implementation and enforcement of regulation causes some activity to leak to unregulated institutions; optimal policy is still useful to reduce financial system's vulnerability but it should account for these leakages. We contribute to this literature by deriving the optimal macroprudential regulation under adverse selection and non-bank competition.

The rest of the paper is organized as follows. Section 2 presents the model with banks as the only financial intermediaries, establishes how capital requirements affect bank competition and lending standards, and set optimal macroprudential capital requirements. Section 3 introduces non-bank competition and the associated implications for macroprudential capital requirements and lending standards. Section 4 derives the optimal capital regulation with non-bank intermediation. Section 5 concludes. All proofs that are not immediately obvious from the text are included in the Appendix.

2 Model with Banks

This section presents the model and derives the equilibrium when banks are the only financial intermediaries in the economy.

2.1 Time, Uncertainty, and Agents

Consider an economy with two time periods, $t = 0, 1$. Time 0—the most important time period—is broken into a three-stage game that is described below. Consider two types of agents: entrepreneurs/firms and banks, both of which have a discount factor of one.

Suppose there is a continuum of firms with mass $1 + \lambda$, each of which has an end of period wealth W that is sufficient to meet any collateral requirement. Each firm is endowed with a risky project that transforms \$1 of input at $t = 0$ into a random output at $t = 1$. Firms differ in the quality of their projects: a firm has either a good or a bad project that produce $y_G = G$ or $y_B = B$, respectively, when they succeed; for simplicity, both projects produce 0 when they fail. In addition, the probability that good (bad) firms produce $G\,(B)$ is given by $p_G\,(p_B)$ where $p_G > p_B$. Let the average probability of success be defined by $p_\mu = \alpha p_G + (1-\alpha)p_B$. Moreover, we assume that the bad project has a higher payoff than the good project when successful, i.e., $B > G$, but bad projects have a negative net present value, i.e., $p_G G > 1 > p_B B$. Let the fraction of good and bad firms in the economy be given by α and $(1 - \alpha)$, respectively. The mass of borrowers given by $\lambda \in [0, \infty)$ are unknown, i.e., none of the banks know the quality of their project, while the mass of borrowers equal to 1 are known, i.e., at least one bank knows the quality of their projects.

There are $N > 1$ banks that compete for borrowers. Banks are symmetric and each bank knows the quality of a non-overlapping mass of $1/N$ different firms, i.e., each firm's quality is known by only one bank. Private information exposes each bank to adverse selection from bad borrowers known only to other banks. Thus, each bank at $t = 0$ can either attempt to engage in screening and separate bad borrowers from the rest, or pool all borrowers together exposing itself to adverse selection. As described below, banks can use non-price terms, i.e., collateral, to separate good from bad borrowers.

There are three stages in the game at time 0. In stage 1 banks offer a menu of contracts to unknown borrowers. The contracts are defined by the tuple (R_k, C_k), $k = \{S, P\}$ where R_k is the face value of the debt in either separating ($k = S$) or pooling ($k = P$) contracts. C_k^j is the corresponding required collateral, which banks can seize if projects fail. We use the typical assumption that banks only recover a fraction of the value of the posted collateral upon project failure given by κC_k with $\kappa < 1$. Hence, collateral foreclosure is inefficient and we will assume that the cost $1 - \kappa$ is sufficiently high that banks default if the bad state realizes.[2] In stage 2, banks observe the outcome of stage 1 and can offer competitive contracts to their known borrowers. Borrowers choose their preferred contract among those offered by all banks. In stage 3, banks may reject loan applicants.[3] Debts are repaid or collateral is seized, and agents consume at $t = 1$.

All firms are risk-neutral and maximize expected profits. Firms will consider the loan contract (R_k, C_k) if expected profits are positive, i.e.,

$$p_j(y_j - R_k) - (1 - p_j)C_k \geq 0. \tag{1}$$

Our notion of collateral is quite general and can encompass the most common forms of collateral used in loan contracts as long as two conditions hold: 1) collateral is costly for the firm to pledge because it represents a wealth transfer to the lender, and 2) enforcing claims on the collateral in bankruptcy is costly to the lender. Bankruptcy costs can arise from the legal resources and time needed to settle the priority claims in bankruptcy resolution, from inefficient liquidation, or from the second-best use of assets. The collateral in the model can be physical collateral such as real estate, financial collateral, such as marketable securities, or going concern collateral, such as accounts receivable or blanket liens. Empirically, Caglio, Darst and Kalemli-Ozcan (2021), using loan-level supervisory data accompanied with private-firm balance sheets, show that private firms almost always post collateral in the form of one of the aforementioned types.

2.2 Banks, Risk-shifting, and Microprudential Capital Requirements

Banks fund the loans to firms by raising equity capital and deposits in perfectly elastic markets. As in Allen, Carletti and Marquez (2015), we assume that there is a segmented investor base, such that the owners of banks are willing to inject equity funding, while outside investors are only willing to hold debt instruments. For simplicity, the outside option of the latter is a riskless technology with zero net yield, while the former demand a gross expected

[2] As we will show in detail, banks will default in the bad state for most parameters values even if $\kappa \to 1$ for all admissible capitalization levels. For some other parameters, this requires that κ is below some threshold. This is a reasonable assumption both to simplify the exposition of the different cases, and based on empirical observations. Kermani and Ma (2023) find that the U.S. industry average recovery rate for PPE is only 35%.

[3] If more than one bank offers the same contract to a group of borrowers, a sharing rule is invoked to guarantee the existence of equilibrium. In particular, all the borrowers that would choose a contract offered by more than one bank are randomly allocated to one of these banks.

return $E > 1$ to supply equity. Equity is long-term and receives payment only at $t = 1$ after deposits have been paid in full. On the contrary, deposits specify an uncontingent gross payment $X \geq 1$ at withdrawal. Because deposits are fully insured, in equilibrium, $X = 1$, equal to the riskless gross return required by outside investors.

Banks pay a premium for insurance, denoted by ι, implying a total cost of deposit funding equal to $D = X + \iota$. The insurance premium cannot be conditioned on the loan type, which is private information to the banks. As such, banks have an incentive to risk shift and lend only to bad projects due to limited liability. The same regulator that insures deposits can eliminate the risk-taking behavior by setting a high enough equity capital requirement, denoted by γ, such that banks have enough skin in the game. We call these requirements "microprudential" capital requirements, as opposed to "macroprudential" capital requirements that target systemic-wide externalities and we study later on. We follow the literature that considers subsidized deposit insurance premium, which does not reflect the bank's portfolio risk in equilibrium. As such, we take ι as given, i.e. independent of capital requirements, and for simplicity take $\iota \to 0$ in our proofs.[4]

We make the following two assumptions to ensure banks raise deposits and have an incentive to risk shift:

Assumption 1 $E > p_G G$.

Assumption 2 *Good and bad firms' project payoffs satisfy* $G < (1 + (p_G - p_B)D)/p_G$ *and* $B > (p_G/p_B)(G - D) + D$.

See Appendix for details how assumption 2 introduces risk-shifting incentives.

2.2.1 Microprudential capital requirements

The bank regulator can set the capital requirement to prevent risk-shifting. The regulator knows that B is the maximum gross loan rate bad firms are willing to accept. Thus, it is sufficient to set γ high enough such that the profits from lending to bad firms are lower than the required return of equity, i.e., $\gamma E > p_B[B - (1 - \gamma)D]$. Note that banks repay

[4] See also Van den Heuvel (2008), Donaldson, Piacentino and Thakor (2021), and Jermann and Xiang (forthcoming) for the link between deposit insurance and bank risk-taking.

deposits only when the projects succeed because of limited liability. The microprudential capital requirement, $\overline{\gamma}$, that prevents risk-shifting in equilibrium is given by

$$1 > \gamma > \overline{\gamma} \equiv \frac{p_B(B-D)}{E - p_B D}. \tag{2}$$

Under microprudential capital requirements, banks are willing to lend to known good borrowers if the expected profits are higher than the required return on equity. Hence, the minimum gross loan rate that makes banks break-even under microprudential capital requirements is given by

$$p_G[R(\overline{\gamma}) - (1-\overline{\gamma})D] = \overline{\gamma}E \quad \Rightarrow \quad R(\overline{\gamma}) = \overline{\gamma}\frac{E - p_G D}{p_G} + D. \tag{3}$$

The following assumption guarantees that it is rational for good types to borrow under microprudential capital requirements, i.e., $G > R(\overline{\gamma})$.

Assumption 3 $\frac{p_G(G-D)}{E-p_G D} > \frac{p_B(B-D)}{E-p_B D}$.

The following proposition summarizes the results of this subsection that relate optimal lending rates under microprudential capital requirements with risk-shifting incentives.

Proposition 1 *Let project returns satisfy assumptions 1, 2, and 3. The microprudential capital requirement that prevents risk-shifting is given by* (2)*.*

2.3 Equilibrium with Banks

We solve the game at $t = 0$ by backward induction and focus on pure-strategy symmetric equilibria. Stage 3 is not interesting, but necessary to obtain a stable equilibrium. Recall that banks can reject borrowers in stage 3, so borrowers cannot coordinate on contracts that provide negative returns to banks. At stage 2, banks will offer their known good borrowers the contract $\left(R^G, 0\right)$ which makes them indifferent to their outside option; the contract that is offered to borrowers at stage 1. Note that the contract offered to known good borrowers does not entail collateral because it is costly for borrowers and banks already know their type. Known bad borrowers will not receive credit from their relationship banks in stage 2 because they have negative NPV projects for which banks make losses, in expectations, under the microprudential capital requirements in (2). Therefore, known bad borrowers will only receive credit in stage 1 if in equilibrium all unknown borrowers are pooled into a common contract. We now proceed to solve the game at stage 1 and determine whether a separating or pooling equilibrium ensues.

2.3.1 Separating equilibrium with banks

The first equilibrium concept we construct is the separating/screening equilibrium. In particular, banks use collateral in loan contracts to distinguish between good and bad borrowers. Define this contract by (R_s, C_s). Banks want to attract only good borrowers while deterring bad borrowers. Good borrowers are willing to borrow if

$$p_G (G - R_s) - (1 - p_G) C_s \geq 0, \tag{4}$$

while bad borrowers will not try to mimic the good borrowers if

$$p_B (B - R_s) - (1 - p_B) C_s \leq 0. \tag{5}$$

In addition, perfect competition among banks drives expected profits to zero on the contract they offer to good borrowers, i.e.,

$$p_G (R_s - (1 - \overline{\gamma}) D) + (1 - p_G) \max \{(\kappa C_s - (1 - \overline{\gamma}) D), 0\} = \overline{\gamma} E, \tag{6}$$

The first term in the left-hand side of (6) are the expected profits when borrowers do not default, while the second term are the residual expected profits at default after repaying deposits, bounded below by zero due to limited liability. The right-hand side is the required return on equity capital.

Then, the separating loan contract, offered to both G and B borrowers, is determined by the binding incentive compatibility constraint of bad borrowers (5) and the individual rationality constraint of banks (6). The IC constraint of good borrowers will be non-binding.

We show in the proof of Proposition 2 that the second term in the left-hand side of (6) is zero in equilibrium, i.e., $\kappa C_s < (1-\overline{\gamma})D$, under sufficiently low κ, which can be as high as one for most parameterizations. Thus, banks' expected profits are not affected by using costly collateral to screen out bad borrowers and the gross loan rate in the separating allocation is given by $R_s = R(\overline{\gamma})$ in (3). The following proposition summarizes the optimal contract in the separating allocation offered by banks in stage 1 of the game at $t = 0$.

Proposition 2 *For $\overline{\gamma}$ given by (2), the loan contract that banks offer is characterized by*

$$R_s = \frac{1}{p_G}\overline{\gamma}E + (1-\overline{\gamma})D, \tag{7}$$

$$C_s = \frac{p_B}{1-p_B}\left(B - R_s\right). \tag{8}$$

We now proceed to derive the condition for a separating equilibrium. A separating allocation is an equilibrium when no bank would choose to offer a profitable pooling contract (Rothschild and Stiglitz, 1976). Define the pooling contract as $(R_p, 0)$, which does not use collateral because collateral is costly. A bank offering a pooling contract must, at minimum, break even, which puts a lower bound on R_p. Given that a pooling contract attracts all unknown and known bad borrowers other banks reject, the break even condition requires:

$$\overbrace{\lambda p_\mu[R_p - (1-\overline{\gamma})\,D]}^{\substack{\text{Expected profits}\\ \text{from unknown borrowers}}} + \overbrace{(1-\alpha)\,\frac{N-1}{N}p_B[R_p - (1-\overline{\gamma})\,D]}^{\substack{\text{Expected profits from bad borrowers}\\ \text{rejected by other banks}}} \geq \overbrace{\overline{\gamma}E\left[\lambda + (1-\alpha)\,\frac{N-1}{N}\right]}^{\substack{\text{Required payoff}\\ \text{to equity}}}$$

$$\Rightarrow R_p \geq \frac{(1-\alpha)\,\frac{N-1}{N}\left[\overline{\gamma}E + (1-\overline{\gamma})\,Dp_B\right] + \lambda\left[\overline{\gamma}E + (1-\overline{\gamma})\,Dp_\mu\right]}{\lambda p_\mu + (1-\alpha)\,\frac{N-1}{N}p_B}. \tag{9}$$

Given R_p, a good firm would not deviate from the separating allocation if its profits are higher compared to pooling, i.e., $p_G\,(y_G - R_p) \leq p_G\,(y_g - R_s) - (1-p_G)\,C_s$, which yields:

$$R_p \geq R_s + \frac{1-p_G}{p_G}C_s. \tag{10}$$

This condition compares the effective borrowing cost under pooling and separating contracts; the cost for the latter comprises both the loan rate and the loss of collateral.

Substituting the lower bound for R_p from (9) in (10), we can derive the necessary and sufficient condition for the separating allocation to constitute an equilibrium:

$$\frac{(1-\alpha)\frac{N-1}{N}\left[\overline{\gamma}E+(1-\overline{\gamma})Dp_B\right]+\lambda\left[\overline{\gamma}E+(1-\overline{\gamma})Dp_\mu\right]}{\lambda p_\mu+(1-\alpha)\frac{N-1}{N}p_B}\geq R_s+\frac{1-p_G}{p_G}C_s. \qquad (11)$$

Condition (11) does not hold for all λ. Start with the two limiting cases $\lambda \to 0$ and $\lambda \to \infty$. Equilibrium is always separating when all borrowers in the economy are known, i.e., $\lambda \to 0$.[5] The intuition is that when borrowers are known, the pooling contract only attracts competitor banks' known bad borrowers. For $\lambda \to \infty$, the information asymmetry between competing banks becomes irrelevant because at the limit all borrowers are unknown to all banks. For this case a deviation from the separating contract requires:

$$\frac{\overline{\gamma}E}{p_\mu}+(1-\overline{\gamma})D<R_s+\frac{1-p_G}{p_G}C_s. \qquad (12)$$

Condition (12) depends on the average borrower quality among types, α, through p_μ. As $\alpha \to 0$, $p_\mu \to p_B$ and a deviation from a separating equilibrium is not profitable, which we show in detail below in the proof of Proposition 3. Intuitively, banks always choose to separate borrowers when only bad types exist ($\alpha \to 0$) because they essentially extend credit exclusively to negative NPV projects under pooling. Alternatively, a deviation from a separating equilibrium is always profitable for $\alpha \to 1$, that is $p_\mu \to p_G$, irrespective of the value of λ. Intuitively, when only good types exist, separating borrowers is no longer the optimal strategy because collateral requirements are costly and unnecessary. We show there will be a threshold for α, denoted by $\overline{\alpha}$, such that (12) holds and a deviation from a separating equilibrium is profitable for $\lambda \to \infty$. By continuity and the fact that the left-hand side of (11) is strictly decreasing in λ, we can conclude that there is a threshold for λ, denoted by $\overline{\lambda}$, below which deviations from a separating equilibrium are not profitable.

Proposition 3 *There exists $\overline{\alpha} > 0$ such that condition (12) holds. The equilibrium pure-strategies satisfy the following:*

1. *if $\alpha < \overline{\alpha}$, banks offer unknown borrowers the unique separating contract (R_s, C_s);*

2. *for $\alpha > \overline{\alpha}$, there exists $0 < \overline{\lambda} < \infty$ such that banks offer unknown borrowers the unique separating contract (R_s, C_s) when $\lambda \leq \overline{\lambda}$;*

[5] The necessary and sufficient condition for (11) to hold as $\lambda \to 0$ is $p_G > p_B$.

3. there is no separating equilibrium if and only if $\alpha > \overline{\alpha}$ and $\lambda > \overline{\lambda}$.

The following Corollary is important for the subsequent analysis.

Corollary 1 *Known good borrowers receive the contract $\left(R^G, 0\right)$, with $R^G = R_s + (1 - p_G)/p_G C_s$.*

To show this Corollary observe that each bank can offer a contract to its known good borrowers that does not require any collateral. These borrowers will prefer this contract if the loan rate, R^G, is less than or equal to the effective repayment under a separating contract offered by a competitive banks, given by $R_s + (1 - p_G)/p_G C_s$. Hence, a bank can offer known good borrowers a contract that makes them indifferent and extract all surplus given by $R^G - R_s = (1 - p_G)/p_G C_s$.

2.3.2 Pooling Equilibrium with banks

Pooling allocations are possible when profitable deviations from the separating equilibrium exist. In particular, in the pooling equilibrium, banks offer all firms the contract defined by the break-even condition (9) set to equality:

$$R_p = \frac{(1-\alpha)\frac{N-1}{N}\left[\overline{\gamma}E + (1-\overline{\gamma})\,Dp_B\right] + \lambda\left[\overline{\gamma}E + (1-\overline{\gamma})\,Dp_\mu\right]}{\lambda p_\mu + (1-\alpha)\frac{N-1}{N}p_B}. \tag{13}$$

Proposition 4 *If $\alpha > \overline{\alpha}$ and $\lambda > \overline{\lambda}$, the unique equilibrium pure-strategy profile is the pooling allocation given by $(R_p, 0)$.*

Proposition 3 showed that there is no separating equilibrium for $\alpha > \overline{\alpha}$ and $\lambda > \overline{\lambda}$. It then suffices to establish that the pooling strategy is a stable equilibrium. To see this, assume (11) does not hold so a pooling equilibrium is possible. Then, assume that some bank offers a "cream-skimming" deviation, (R'', C'') that is preferred by good borrowers but not bad borrowers compared to the pooling contract $(R_p, 0)$, i.e., $R'' + [(1-p_G)/p_G]C'' < R_p$ and $R'' + [(1-p_B)/p_B]C'' > R_p$. Thus, all good borrowers will choose to borrow from that bank, while all the other banks offering the pooling contract will attract only bad borrowers. The fact that all the contracts offered at stage 1 of the game are observable by all banks at stage 2 suffices to prevent such "cream-skimming" from being a profitable deviation in equilibrium. The reasoning behind this result can be described in the following steps:

(i) If the “cream-skimming” contract is offered by one bank, then all other banks will observe it and decline to offer the pooling contract at the final stage, because it would attract only bad borrowers. As a result, not only good but also bad borrowers may decide to borrow from the “cream-skimming” contract.

(ii) To exclude bad borrowers, contract terms need to be such that $C'' \geq C_s + [p_B/(1 - p_B)](R_s - R'')$ using (5).

(iii) $R'' + [(1 - p_G)/p_G]C'' < R_p$, which is necessary for good borrowers to prefer the "cream-skimming" over the pooling contract, also implies that $R'' + [(1 - p_G)/p_G]C'' < R_s + [(1 - p_G)/p_G]C_s$ or $C'' < C_s + [p_G/(1 - p_G)](R_s - R'')$.

(iv) Satisfying the two restrictions on C'' requires $(R_s - R'')(p_G - p_B)/[(1 - p_G)(1 - p_B)] > 0$ or $R'' < R_S$. As a result, the bank would make losses under these "cream-skimming" contract terms, because R_s is the minimum lending rate under which the bank breaks even in a separating equilibrium (see Proposition 2).

(v) This means that a "cream-skimming" contract that can separate good from bad borrowers, while at the same time being more appealing to good types, cannot exist in equilibrium because banks would never offer it.

(vi) It follows that the only "cream-skimming" contracts that can be offered cannot separate good from bad borrowers and, hence, will attract all borrowers should banks stop offering the pooling contract.

(vii) Finally, an individual bank would never want to deviate by offering such a "cream-skimming" contract because it would earn an R'' less that the minimum rate required to break even when all good and bad borrowers choose to borrow, which is equal to R_p in (9).

Taking all these out-of-equilibrium paths into consideration, all banks will offer the pooling contract $(R_p, 0)$. Because of the sharing rule, one bank ends up lending to all unknown borrowers and all but its known bad borrower through a pooling contract, while it offers its good known borrowers the contract $(R_p^G, 0)$ with R_p^G just below R_p in order to retain them. Similarly, the other banks offer R_p^G to their known good borrowers, but do not lend through a pooling contract in the final stage. The pooling equilibrium is unique and stable, and the pooling loan rate is given by (13).

2.4 Capital Requirements and Lending Standards

How are lenders' protection at the contract level and aggregate lending standards affected by changes in capital requirements? The degree of lenders' protection is given by the level of collateral requirements, while aggregate lending standards are determined by whether the equilibrium lending regime features separating or pooling contracts. Hence, the effect of changing capital requirements, γ, on lenders' protection is given by $dC_s/d\gamma$ and on aggregate lending standards by $d\overline{\lambda}/d\gamma$. Recall that $\overline{\lambda}$ is the level of credit demand that corresponds to a switch from a separating to a pooling equilibrium. Also recall that collateral requirements are zero in the pooling regime so we will examine how they change with γ only in the separating one.

Changes in capital requirements impact equilibrium loan terms for both separating and pooling contracts, (R_s, C_s) and $(R_p, 0)$, respectively. Consider first how separating allocations are affected. Replacing $\overline{\gamma}$ with γ in Proposition 2, the separating contract terms as a function of a general γ can be written as $R_s = \gamma E/p_G + (1-\gamma)D$ and $C_s = [p_B/((1-p_B)p_G)][p_G B - (\gamma E + (1-\gamma)Dp_G)]$. Taking the derivatives with respect to γ results in the following Proposition.

Proposition 5 *Consider the separating loan contract (R_s, C_s). Then, $dR_s/d\gamma > 0$, $dC_s/d\gamma < 0$, and $d[R_s(\gamma) + [(1-p_G)/p_G]C_s(\gamma)]/d\gamma > 0$.*

Hence, borrowing costs in the separating region are increasing in capital requirements, but the collateral requirement is decreasing. The intuition is that higher capital requirements are passed on to borrowers through higher interest rates. Moreover, higher borrowing costs tighten bad borrowers' incentive compatibility constraint (5), making it easier for banks to separate good from bad borrowers. As a result, banks can reduce the collateral required to separate borrower types. The net effect is that the effective borrowing cost, $R_s + [(1-p_G)/p_G]C_s$, rises.

Similarly, by replacing $\overline{\gamma}$ with γ to get the pooling rate derived in Proposition 4 as a function of the general capital requirement, we can show that the borrowing cost in the pooling regime also increases with capital requirements, i.e., $dR_p/d\gamma > 0$. Using these results on the sensitivity of separating and pooling contract terms to γ, the following proposition establishes that lending standards tighten in equilibrium as γ increases.

Proposition 6 *Capital requirements tighten lending standards by increasing the domain over which the equilibrium strategy profile is the separating contract* (R_s, C_s) *relative to the pooling contract* $(R_p, 0)$*. Specifically,* $d\overline{\alpha}/d\gamma > 0$ *and* $d\overline{\lambda}/d\gamma > 0$*.*

Recall that $\overline{\alpha}$ is the threshold for the portion of good borrowers above which pooling is possible, while $\overline{\lambda}$ is the threshold for the credit demand from unknown borrowers above which banks offer a pooling contract conditional on $\alpha > \overline{\alpha}$. The proposition shows that the threshold, $\overline{\alpha}$, must be higher if banks are to fund all projects through weak lending standards. Intuitively, a higher capital requirement, γ, increases the amount of skin-in-the-game, therefore the average quality of the lending portfolio needs to be higher for banks to be willing to offer pooling contracts. Additionally, for every unit of increase in γ, it is more expensive to offer a pooling contract relative to a separating contract, because shareholders need to be compensated more for funding negative net present value projects. Thus, the threshold, $\overline{\lambda}$, increases as well.

2.5 Optimal Macroprudential Capital Requirements

The comparative statics in Proposition 6 considers $\gamma \geq \overline{\gamma}$ to be exogenous. In this section we establish when a regulator would like to set $\gamma > \overline{\gamma}$ endogenously, i.e., macroprudential capital requirements are optimal. These requirements balance the deadweight loss from requiring collateral in the separating regime against funding negative NPV projects in the pooling regime. This distinguishes them for the microprudential capital requirement that address the possibility of risk-shifting at the level of an individual bank.

We consider a planner that maximizes the overall surplus in the economy without consideration for how the surplus is distributed. The planner can implement any desired income redistribution through lump-sum transfers. Hence, the planner's problem maximizes the ex-ante net surplus from firm investment projects over the distribution of credit demand across the separating and pooling regimes.

Consider, first, the credit demand in the separating regime, $\lambda \leq \overline{\lambda}$. The net surplus from firm projects is the expected net return to all good projects, $\alpha (1 + \lambda) (p_G G - 1)$, minus the expected loss from inefficient collateral liquidation, $\alpha\lambda(1-p_G)(1-\kappa)C_s(\gamma)$. The total mass of good projects funded is $\alpha(1+\lambda)$, but only $\alpha\lambda$ are required to post collateral, because banks lend to their known good borrowers without requiring collateral.

The net surplus from firm projects in the pooling regime is the expected net return to funding all good projects, $\alpha(1+\lambda)(p_G G-1)$, plus the return to funding all but $1/N$ bad projects, $(1-\alpha)((N-1)/N+\lambda)(p_B B-1)$.[6]

The planner chooses γ to maximize expected surplus W:

$$W = \int_0^{\overline{\lambda}} \left[\alpha(1+\lambda)(p_G G-1) - \alpha\lambda(1-p_G)(1-\kappa)C_s\right] d\lambda + \int_{\overline{\lambda}}^{\infty} \left[\alpha(1+\lambda)(p_G G-1) + (1-\alpha)\left(\frac{N-1}{N}+\lambda\right)(p_B B-1)\right] d\lambda, \tag{14}$$

subject to $\overline{\gamma} \leq \gamma$ and $\gamma \leq \gamma_{max}$, where γ_{max} is the maximum level of the capital requirement that makes lending profitable. The first line integrates over the level of demand in the separating regime i.e., $\lambda < \overline{\lambda}$. The second line integrates over the level of demand in the pooling regime, i.e., $\lambda \geq \overline{\lambda}$.

Denoting by ψ_{min} and ψ_{max} the Lagrange multipliers for $\overline{\gamma} \leq \gamma$ and $\gamma \leq \gamma_{max}$, respectively, the optimality condition with respect to γ is

$$\overbrace{\frac{d\overline{\lambda}}{d\gamma}}^{\substack{\text{Expansion of}\\ \text{separating region}}} \left[\overbrace{-\alpha\overline{\lambda}(1-p_G)(1-\kappa)C_s}^{\substack{\text{Cost from inefficient liquidation}\\ \text{of collateral}}} + \overbrace{(1-\alpha)\left(\frac{N-1}{N}+\overline{\lambda}\right)(1-p_B B)}^{\substack{\text{Benefit from funding fewer}\\ \text{negative NPV projects}}} \right]$$

$$\underbrace{-\frac{dC_s}{d\gamma}\frac{\overline{\lambda}^2}{2}\alpha(1-p_G)(1-\kappa)}_{\substack{\text{Incremental decrease in}\\ \text{required collateral}}} + \psi_{min} - \psi_{max} = 0. \tag{15}$$

Equation (15) has the following intuitive interpretation. The terms in the first line capture the effect that operates through aggregate lending standards on the extensive margin.

[6]Recall that each bank has $1/N$ known borrowers. Thus, the pooling bank will not fund its known bad borrower, but will fund all competitor banks' bad borrowers.

Increasing the capital requirement expands the separating region, because $d\overline{\lambda}/d\gamma > 0$ from Proposition 6. More separation in equilibrium comes with costs and benefits. On the one hand, more separation requires more aggregate collateral across projects, which imposes an inefficient liquidation cost–the first term multiplying $d\overline{\lambda}/d\gamma$. On the other hand, more separation reduces the number of negative NPV projects undertaken by bad firms in the pooling region–the second term multiplying $d\overline{\lambda}/d\gamma$. The third force comes from the first term on the second line, which captures the intensive margin of higher γ. Higher γ decreases the amount of collateral that each firm needs to pledge as shown in Proposition 5, which reduces the inefficiency from liquidating collateral. In an interior solution, these three forces balance each other. The optimal capital requirement is above the microprudential level if the positive effects from the extensive and intensive margins dominate the negative effect of possibly greater (inefficient) collateral liquidation. The following proposition establishes conditions under which macroprudential capital requirements are optimal.

Proposition 7 *Define the elasticity of $\overline{\lambda}$ w.r.t γ by $\eta_{\overline{\lambda},\gamma}$ and similarly the elasticity of C_s w.r.t γ as $\eta_{C_S,\gamma}$. The following statements hold:*

1. *If $\eta_{\overline{\lambda},\gamma} \leq -0.5\eta_{C_s,\gamma}$, the optimal capital requirement, γ^*, is equal to the maximum macroprudential level, γ_{max}.*

2. *If $\eta_{\overline{\lambda},\gamma} > -0.5\eta_{C_s,\gamma}$, and depending on parameters, the optimal capital requirement, γ^*, is equal to either: (i) the microprudential requirement, $\overline{\gamma}$; (ii) the maximum macroprudential level, γ_{max}; or (iii) an interior macroprudential level between these two extremes.*

Proposition 7 says that if the lending standards' threshold, $\overline{\lambda}$, is not sufficiently responsive to γ such that $\eta_{\overline{\lambda},\gamma} \leq -0.5\eta_{C_s,\gamma}$, then the optimal capital requirement is set at the maximum level γ_{max}. The intuition is as follows. Increasing γ increases $\overline{\lambda}$ and, then, the region of λ's where collateral is inefficiently liquidated, but it also reduces the level of required collateral, C_s. The latter force mitigates the adverse effect from tightening standards and always dominates the former force if the responsiveness of $\overline{\lambda}$ to γ is sufficiently lower than the responsiveness of C_s to γ. Given that tighter standards reduce the loss from funding NPV projects, the optimal requirement is always γ_{max}. On the other hand, if $\overline{\lambda}$ is sufficiently responsive to γ such that $\eta_{\overline{\lambda},\gamma} > -0.5\eta_{C_s,\gamma}$, the cost of the more frequent liquidation of collateral dominates the benefit from the lower collateral requirements required. The net negative effect of the two needs, then, to be weighed with the positive effect of screening out negative NPV projects to determine the optimal capital requirement given the parameterization of the economy.

To sum up, lending standards are increasing in capital requirements, and macroprudential capital requirements will be optimal in many cases. We now ask if the higher funding costs that macroprudential capital requirements impose on banks give space for other forms of intermediation, and if so, what is the equilibrium impact on lending standards?

3 Non-bank Competition, macroprudential Capital Requirements, and Lending Standards

Given the concomitant rise of non-bank intermediation and macroprudential regulation post-GFC, it is natural to ask whether our lending standards and optimal regulation results continue to hold in the presence of non-bank competition.

3.1 Modeling Non-Banks

Assume there are a large number of competitive non-banks that raise debt from the same outside investors as banks, demand a similar expected return, E, to supply equity, and have access to the same borrowers. However, non-banks do not have private information about any borrowers and treat the whole population of firms $(1+\lambda)$ as unknown. This assumption captures the fact that banks are the incumbent institutions with existing relationships with some borrowers, while non-banks are the entrants without prior information.[7]

[7] Given our assumptions, banks and non-banks have no strict incentive to collaborate. There are two reasons for this. First, both banks and non-banks have access to the same underlying lending technology and can screen efficiently using collateral. Second, both banks and non-banks have access to an elastic supply of funds. Therefore, even though banks may enjoy cheaper funding due to deposit insurance, they would not lend to non-banks at a rate lower than the effective loan rate to firms, since they can extend as many loans as they want. Similarly, non-banks do not need to resort to bank funding as they have direct access to elastic funding markets. Regulation may change the relative incentives of bank to extend loans to non-banks if they get a preferential regulatory treatment compared to loans to firms. In the absence of this regulatory arbitrage, cooperation between banks and non-banks would not occur in our model.

Non-bank debt holders are not insured, which imposes some market discipline on non-banks. However, the moral hazard problem from risk-shifting remains because the type of borrowers to whom non-banks lend is non-contractible. Therefore, non-banks need enough skin in the game to exclude risk-shifting. However, non-banks are unregulated and a market mechanism should ensure sufficient capital to resolve the moral hazard problem.

We assume for simplicity that non-bank equity is contractible. Therefore, long-term debt with covenants dictating the level of equity can resolve the moral hazard problem (Holmström and Tirole, 1997).[8] The contractibility of equity matters because non-banks can distribute dividends or repurchase shares after they have received the funds from debt-holders, so they may not have enough skin in the game to be discouraged from risk-shifting. If non-banks choose to operate with a level of equity less than what is required to discourage risk-shifting, the covenant would be violated and the debt-holder could seize the firm in the extreme, which would act as a deterrent. The minimum level of equity that long-term debt-holders would require non-banks to maintain is, then, given by

$$\gamma^{NB} = \frac{p_B(B - D^{NB})}{E - p_B D^{NB}}, \tag{16}$$

where $D^{NB} > 1$ captures the interest rate on non-bank debt, which will depend on the investment strategy of non-banks in equilibrium and will incorporate a default premium.

In our model, $D^{NB} > D$, because non-bank debt incorporates a default premium while bank deposits are insured, which also implies that $\gamma^{NB} < \overline{\gamma}$.[9] The funding cost difference between banks and non-banks has implications for the ability of non-banks to compete with banks. In fact, we show in Sections 3.2 and 3.3 that the combination of lower funding costs due to subsidized deposit insurance and information advantage that banks possess implies that non-banks cannot compete with banks in either the separating or pooling regions if banks are only subject to microprudential capital requirements.[10] We, then, turn to the

[8]We show in Appendix B that an alternative assumption with non-contractible equity yields the same outcome presented here. In that case, non-banks have a fragile funding structure with demandable debt as in (Diamond and Rajan, 2000). The capital requirement set by the market is identical in this alternative set up if the liquidation value of bank assets is sufficiently high.

[9]Note that we could derive a fair insurance premium, ι^f, such that $D^{NB} = D$. As long as the actual insurance premium ι is lower than ι^f, $D^{NB} > D$ and $\gamma^{NB} < \overline{\gamma}$. Without loss of generality and for simplicity, we set $\iota \to 0$. Our results generalize for $\iota \in (0, \iota^f)$, but the algebra is more cumbersome.

[10]Note that under fairly priced deposit insurance, banks and non-banks have the same overall cost of

effect of macroprudential capital requirements on non-bank entry and its implications for lending standards in Section 3.4.

3.2 Separating Contracts with non-banks

We first ask whether non-banks can offer separating contracts to borrowers at least as attractive as the contract offered by banks. Recall that the terms of the separating contract banks offer, (R_s, C_s), are given in Proposition 2. For this contract, the interest rate that outside investors charge non-banks and break even is

$$\overbrace{p_G(1-\gamma^{NB})D_s^{NB}}^{\substack{\text{Total Payoff}\\ \text{in good state}}} + \overbrace{(1-p_G)\kappa C_s}^{\substack{\text{Total payoff}\\ \text{in bad state}}} = \overbrace{1-\gamma^{NB}}^{\substack{\text{Outside option}\\ \text{on funds supplied}}}$$

$$\Rightarrow D_s^{NB} = \frac{1}{p_G} - \frac{1-p_G}{p_G}\frac{\kappa C_s}{1-\gamma^{NB}}, \tag{17}$$

since investors receive the contractual rate D_s^{NB} on the $1-\gamma^{NB}$ funds they supplied in the good state where the non-bank does not default, while they receive the salvage value of collateral, κC_s, in the bad state where both the borrower and the non-bank default. Then, the market-based non-bank capital requirement for a separating loan portfolio, γ_s^{NB}, is determined by substituting (17) in (16).

It is profitable for non-banks to participate and compete with banks and offer the separating contract to screen borrowers if $p_G\left(R_s - \left(1-\gamma_s^{NB}\right)D_s^{NB}\right) > \gamma_s^{NB}E$. Substituting R_s from Proposition 2, we obtain the necessary condition for non-banks to compete with banks in separating allocations:

$$E(\overline{\gamma} - \gamma_s^{NB}) > p_G\left[\left(1-\gamma_s^{NB}\right)D_s^{NB} - (1-\overline{\gamma})\,D\right]. \tag{18}$$

The left hand side of (18) is the advantage that non-banks have from lower equity cost. The right hand side is the nonbank disadvantage from higher debt financing costs. Using (16) and (2), it can be shown that the inequality implies a contradiction as long as $p_G > p_B$,

funding for separating contracts, but banks can offer a more competitive pooling rate due to their information advantage. As such, lending standards will continue to be determined as in Propositions 2 and 4 even without underpriced deposit insurance. Hence, our assumption that deposit insurance is subsidized is without loss of generality.

which always holds by assumption. Intuitively, the benefit of the deposit insurance subsidy accrues to banks with probability p_G but the benefit of lower equity costs for non-banks through risk-shifting occurs with probability p_B. Therefore, non-banks cannot compete with banks under microprudential capital requirement via separating contracts.

3.3 Pooling Contracts with non-banks

What are the terms of pooling contracts offered by non-banks? Recall that the pooling contract offered by banks is given by R_p in Proposition 4. Compared to banks, non-banks do not have inside information about any borrowers. Therefore, they will attract the entire pool of bad borrowers, $(1-\alpha)$, when they offer pooling contracts rather than the fraction $\frac{N-1}{N}(1-\alpha)$ that banks attract. The difference between the two pools of borrowers that banks and non-banks attract reflects banks' information advantage from knowing their existing clientele. Outside investors, anticipating a more risky pool of borrowers, set the required repayment on nonbank debt, D_p^{NB}, to break even with their outside option, i.e.,

$$\overbrace{p_B(1-\alpha)D_p^{NB}}^{\substack{\text{Total Payoff from bad}\\ \text{borrowers in good state}}} + \overbrace{p_\mu \lambda D_p^{NB}}^{\substack{\text{Total Payoff from unknown}\\ \text{borrowers in good state}}} = \overbrace{1-\alpha+\lambda}^{\substack{\text{Outside option}\\ \text{on funds supplied}}}$$

$$\Rightarrow D_p^{NB} = \frac{1-\alpha+\lambda}{(1-\alpha)p_B + \lambda p_\mu}. \tag{19}$$

Under the pooling contract, the non-bank would fund all bad borrowers $1-\alpha$ and all unknown borrowers λ, i.e., investors supply $1-\alpha+\lambda$ in total (recall that banks can and will keep their known good borrowers by offering a more competitive contract in stage 2 of the game). Since no collateral is posted, investors get zero in the bad state, while they receive the contractual rate D_p^{NB} when borrowers do not default in the good state; with probability p_B the bad borrowers repay in total $(1-\alpha)D_p^{NB}$ and with probability p_μ the unknown borrowers repay in total λD_p^{NB}.

The market-based non-bank capital for a pooling loan portfolio, γ_p^{NB}, is given by substituting (19) in (16). Hence, the best pooling contract that non-banks can offer while breaking even is

$$R_p^{NB} = \frac{(1-\alpha)\left[\gamma_p^{NB} E + (1-\gamma_p^{NB}) D_p^{NB} p_B\right] + \lambda \left[\gamma_p^{NB} E + (1-\gamma_p^{NB}) D_p^{NB} p_\mu\right]}{\lambda p_\mu + (1-\alpha) p_B}. \tag{20}$$

Non-banks can compete with banks in the pooling region if they can offer borrowers a lower repayment amount, $R_p^{NB} \leq R_p$. Comparing (20) with (13) determines whether non-bank competition is feasible. It is straightforward to show that $\lim_{\lambda \to 0} \left(R_p - R_p^{NB}\right) < 0$ and $\lim_{\lambda \to \infty} \left(R_p - R_p^{NB}\right) < 0$. There are two reasons for these results. First, non-banks have an information disadvantage and charge a higher borrowing cost than banks because they attract bad borrowers, who are known and rejected by banks; non-banks must fund $1-\alpha$ unknown bad borrowers compared to $\frac{N-1}{N}(1-\alpha)$ bad borrowers for banks. Second, similar to the separating contracts, the underpriced deposit insurance gives banks an overall cost advantage even though $\gamma_p^{NB} < \bar{\gamma}$. These two forces will be also important in the case of macroprudential regulation, to which we later return. Finally, it is straightforward to show that both $dR_p^{NB}/d\lambda, dR_p/d\lambda < 0$, which means, in conjunction with the two limits above, that the repayment amount non-banks require for pooling all borrowers is always higher than the repayment amount banks require.

In sum, non-banks cannot compete with banks and affect lending standards with either separating or pooling contracts under microprudential regulation and underpriced deposit insurance. This result is summarized in the following proposition.

Proposition 8 *Under the microprudential capital requirements for banks in Proposition 1 and the market-based capital requirement for non-banks in* (16)*, non-banks cannot compete with banks in any equilibrium allocation and lending standards are unaffected.*

3.4 Equilibrium Lending Standards with Non-banks

As established above, non-bank competition does not impact equilibrium lending standards when capital requirements are set at $\overline{\gamma}$. By continuity, there exists macroprudential capital requirements, $\gamma > \overline{\gamma}$, such that non-banks continue to be unable to compete with banks and lending standards are determined as in Proposition 6. However, capital requirements cannot increase without bound and keep non-banks at bay. At some point, increasing bank funding costs erodes banks' advantage over non-banks.

We show that the crucial point that determines how non-banks impact lending standards is whether non-banks start competing with banks first in separating or pooling contracts as γ increases. We focus on two thresholds for macroprudential capital requirements. The first threshold, denoted by $\hat{\gamma}$, indicates the level of bank capital at which non-banks can compete by offering separating contracts. The second threshold, denoted by $\hat{\hat{\gamma}}$, indicates the level of bank capital at which non-banks can compete by offering pooling contracts.

We first derive $\hat{\gamma}$, the level of bank capital that allows non-banks to compete through separating contracts. Non-banks will participate in the loan market if and only if the return to lending, $p_G R_s$, is weakly greater than their funding costs. Using Proposition 2 to determine R_s and (16), non-banks will compete with banks through separating contracts for $\gamma > \hat{\gamma}$ where $\hat{\gamma}$ is the solution to $E\left(\hat{\gamma} - \gamma_s^{NB}\right) = p_G\left[\left(1-\gamma_s^{NB}\right)D_s^{NB} - \left(1-\hat{\gamma}\right)D\right]$, or

$$\hat{\gamma} = \frac{\gamma_s^{NB}(E - p_G D_s^{NB}) + p_G(D_s^{NB} - D)}{E - p_G D}, \tag{21}$$

Any capital requirement set above this level allows non-banks to enter the loan market and compete with banks through separating contracts.

Now consider the possibility that non-banks can compete with banks through pooling contracts that do not require collateral. This occurs for macroprudential requirements $\gamma \geq \hat{\hat{\gamma}}$. Using Proposition 4, the pooling contract that banks offer borrowers given $\hat{\hat{\gamma}}$ must satisfy the following break-even condition:

$$\hat{\hat{R}}_p = \frac{(1-\alpha)\frac{N-1}{N}\left[\hat{\hat{\gamma}}E + \left(1-\hat{\hat{\gamma}}\right)Dp_B\right] + \lambda\left[\hat{\hat{\gamma}}E + \left(1-\hat{\hat{\gamma}}\right)Dp_\mu\right]}{(1-\alpha)\frac{N-1}{N}p_B + \lambda p_\mu}. \tag{22}$$

Note once again that λ enters into the break-even pooling contract because the returns to pooling are a function of the mass of unknown borrowers, all of whom receive funding. Banks have both a funding advantage due to subsidized deposit insurance and an information advantage due to known borrowers over non banks. Both of those advantages are eroded as $\lambda \to \infty$. The reasons are, first, that banks do not have an information advantage when the mass of unknown borrows to both banks and non-banks dominates the mass of borrowers known to banks, and second, through equation (19), D_p^{NB} is decreasing in λ and is at its minimum for $D_p^{NB}|_{\lambda\to\infty} = D/p_\mu$. Hence, non-banks most easily compete with banks in pooling contracts under macroprudential capital requirements for $\lambda \to \infty$. Thus, $\hat{\hat{\gamma}}$ is determined by equating $\widehat{\widehat{R}}_p$ and R_p^{NB} for $\lambda \to \infty$:

$$\hat{\hat{\gamma}} = \frac{\overline{\gamma}_p^{NB}(E - p_\mu D/p_\mu) + p_\mu(D/p_\mu - D)}{E - p_\mu D}, \tag{23}$$

where γ_p^{NB} is given by (16) for $D^{NB} = D/p_\mu$. The following proposition shows that $\hat{\gamma} < \hat{\hat{\gamma}}$ and non-banks first compete with banks in separating contracts.

Proposition 9 *Non-banks compete first in separating allocations and then pooling allocations as macroprudential capital requirements increase, i.e., $\hat{\gamma} < \hat{\hat{\gamma}}$.*

The intuition is as follows. First, banks possess both a funding and information advantage over non-banks in pooling equilibria but only a funding advantage in separating equilibria; the information advantage in separating equilibria is negated due the collateral requirement screening out all bad borrowers. Second, the deposit insurance subsidy that banks enjoy is more valuable in pooling equilibria because bad borrowers, which are more likely to default, also receive funding. Hence, the necessary increase in regulatory capital requirement that allows non-banks to compete with banks is smaller in separating than pooling equilibria.

Note that the information advantage banks possess does not play a role in Proposition 9 as it erodes for $\lambda \to \infty$. By contrast, banks have an information advantage over non-banks $\forall \lambda \in (0, \infty)$ that makes it more difficult for non-banks to compete in pooling equilibria. Therefore, non-banks compete first in separating equilibria for any value of λ. However, macroprudential requirements in excess of $\hat{\hat{\gamma}}$ raise bank funding costs to a level that begin to negate banks' information advantage and allow non-banks to compete in pooling for values of λ bounded away from infinity.

In fact, our next proposition shows how macroprudential regulation impacts the competition between banks and non-banks in separating and pooling contracts and that there is a threshold value $\tilde{\gamma} > \hat{\hat{\gamma}}$ above which banks are completely disintermediated.

Proposition 10 *There exist three thresholds for macroprudential capital requirements: $\hat{\gamma} < \hat{\hat{\gamma}} < \tilde{\gamma}$ such that:*

1. *For $\gamma < \hat{\gamma}$, non-banks cannot compete and banks fund all borrowers;*

2. *For $\hat{\gamma} \leq \gamma < \hat{\hat{\gamma}}$, non-banks disintermediate banks in separating contracts;*

3. *For $\hat{\hat{\gamma}} \leq \gamma < \tilde{\gamma}$, non-banks disintermediate banks both in separating contracts and in pooling contracts for high enough λ but banks continue to lend in pooling equilibria with lower λ;*

4. *For $\gamma \geq \tilde{\gamma}$, banks are completely disintermediated and non-banks fund all demand for credit.*

Having established that different macroprudential capital requirements allow non-banks to compete with different types of contracts, separating vs. pooling, we now turn to their impact on both the level of lender protections at the contract level and aggregate lending standards. With respect to the former, collateral requirements in separating equilibria decrease as γ increases from its microprudential level $\overline{\gamma}$ up to $\hat{\gamma}$ when non-banks start offering more competitive separating contracts. This follows from Proposition 5. Thereafter, the lending rate and collateral requirement are given by the zero-profit condition for a non-bank that funds only good borrowers, and the individual rationality constraint of bad borrowers that are dissuaded from borrowing. Given that the latter implies the same inverse relationship between the rate and collateral requirement as in the economy with only banks, it follows that the collateral requirement that non-banks will offer, when they can effectively compete, will be associated with the interest rate a bank would charge for $\gamma = \hat{\gamma}$. In other words, collateral requirements—capturing lenders' protection at the contract level—do not improve once non-banks can compete with banks in separating contracts and are lower than before non-banks were able to be compete.

Turning to the aggregate lending standards, recall that they are captured by the threshold $\overline{\lambda}$ where the economy switches from a separating equilibrium with collateralized lending to a pooling equilibrium with non-collateralized lending. Each threshold for the macroprudential capital requirement in Proposition 10 is associated with a different value of the λ threshold. For $\gamma \in [\overline{\gamma}, \hat{\gamma})$ the threshold $\overline{\lambda}$ is the level of credit demand that equalizes the effective rate that banks offer on separating and pooling contracts (see Proposition 6). For $\gamma \in [\hat{\gamma}, \tilde{\gamma})$, the threshold $\hat{\lambda}$ equalizes the effective rate that non-banks offer on separating contracts with the rate that banks offer on pooling contracts. For $\gamma \geq \tilde{\gamma}$, the threshold $\tilde{\lambda}$ equalizes the effective rates that non-banks offer on separating and pooling.

The following proposition ranks these thresholds and summarizes how macroprudential regulation affects lending standards in the presence of competition by non-banks.

Proposition 11 *In the presence of non-bank competition,* $d\hat{\lambda}/d\gamma > d\overline{\lambda}/d\gamma > 0$*,* $\overline{\lambda}(\hat{\gamma}) = \hat{\lambda}(\hat{\gamma})$*, and* $\hat{\lambda}(\tilde{\gamma}) = \tilde{\lambda}(\tilde{\gamma})$*.*

Recall from Proposition 6 that macroprudential capital requirements tighten aggregate lending standards by increasing the threshold value of aggregate credit demand for which banks screen borrowers. Proposition 11 establishes that non-bank competition amplifies this (positive) relationship. Higher capital requirements increase the cost to banks of offering pooling contracts but do not impact the cost of non-bank separating contracts. This means that the threshold value of λ that determines separating vs. pooling regions increases more for a given increase in γ when non-banks are present than when they are not. In other words, there is more screening and separating in equilibrium and less pooling. Finally, for sufficiently high macroprudential capital requirements, banks are completely disintermediated and lending standards are kept at their higher level, $\tilde{\lambda}(\tilde{\gamma})$.

In sum, Propositions 6 and 11 establish that neither non-bank competition or macroprudential regulation, even if coupled together, erode aggregate lending standards despite lenders' protections being lower at the contract level. On the contrary, lending standards monotonically tighten with higher macroprudential requirements and the effect is *stronger* in the presence of non-bank competition.

We should, however, note that it is possible for lending standards to deteriorate with higher macroprudential capital requirements if non-banks were first able to compete in pooling contracts. The reasoning is analogous to why they increase when non-banks first compete with separating. In particular, if non-banks initially compete using pooling contracts with weak standards while banks retain their advantage in screening, then higher macroprudential capital requirements that increase bank funding costs raise the relative costs of bank screening contracts compared to non-bank pooling contracts. This is not the case in the model we present and additional assumptions about how banks and non-banks differ would be needed to obtain such a result.

4 Optimal macroprudential regulation with non-banks

We now address how the planner optimally sets capital requirements with non-banks competing with banks. Recall from Proposition 7 in Section 2.5 that the planner optimally sets γ^* depending on the elasticity of $\overline{\lambda}$ with respect to γ and other parameters. The planner's problem in the presence of non-bank competition is similar, but the planner needs to take into consideration the various threshold values of γ where the economy switches from the separating to pooling regime derived in Proposition 10.

Define by Γ_k, $k \in K$, the different intervals for values of γ. For each interval the planner chooses the γ that maximizes the social welfare function $W^{NB}_{\Gamma_k}(\gamma)$ (see below for detailed expressions). Denote this optimal γ for each interval by $\gamma^{**}_k \equiv argmax_\gamma W^{NB}_{\Gamma_k}(\gamma)$. Then, the optimal γ^{**} overall is the γ^{**}_k that delivers the higher social welfare $W^{NB}_{\Gamma_k}(\gamma^{**}_k)$, i.e., $\gamma^{**} = argmax_{\gamma^{**}_k} W^{NB}_{\Gamma_k}(\gamma^{**}_k)$.

Before presenting $W^{NB}_{\Gamma_k}(\gamma)$ for each interval, let us reiterate the different thresholds of γ that define these intervals: $\overline{\gamma}$ is microprudential capital requirement; $\hat{\gamma}$ is the threshold for macroprudential capital requirement where non-banks start competing in separating contracts; $\hat{\hat{\gamma}}$ is the threshold where non-banks start competing in pooling contracts for very high credit demand; $\tilde{\gamma}$ is the threshold where banks are disintermediated in both separating and pooling contracts but can still lend to their known good borrowers; $\tilde{\tilde{\gamma}}$: threshold where banks cannot lend to their known good borrowers; and γ_{max} is the threshold where banks cannot lend using separating contracts even in the absence of non-banks.

For $\Gamma_1 = \{\gamma \in [\overline{\gamma}, \hat{\gamma})\}$ the social welfare function is the same as in (14) given that non-banks cannot compete for these levels of γ, i.e.,

$$W^{NB}_{\Gamma_1}(\gamma) = \int_0^{\overline{\lambda}} \left[\alpha\left(1+\lambda\right)\left(p_G G - 1\right) - \alpha\lambda\left(1-p_G\right)\left(1-\kappa\right)C_s\right] d\lambda$$

$$+ \int_{\overline{\lambda}}^{\infty} \left[\alpha(1+\lambda)\left(p_G G - 1\right) + (1-\alpha)\left(\frac{N-1}{N} + \lambda\right)\left(p_B B - 1\right)\right] d\lambda. \qquad (24)$$

Recall that the switch from the separating to the pooling regime happens for $\lambda \geq \overline{\lambda}$.

For $\Gamma_2 = \{\gamma \in [\hat{\gamma}, \hat{\hat{\gamma}})\}$ non-banks lend through the separating regime and banks in the pooling regime. The social welfare function is given by

$$W_{\Gamma_2}^{NB}(\gamma) = \int_0^{\hat{\lambda}} \left[\alpha\left(1+\lambda\right)\left(p_G G - 1\right) - \alpha\lambda\left(1-p_G\right)\left(1-\kappa\right)C_s^{NB}\right] d\lambda$$
$$+ \int_{\hat{\lambda}}^{\infty} \left[\alpha(1+\lambda)\left(p_G G - 1\right) + (1-\alpha)\left(\frac{N-1}{N} + \lambda\right)\left(p_B B - 1\right)\right] d\lambda. \quad (25)$$

The differences between (24) and (25) are that the collateral is given by $C_s(\gamma^{NB})$ for all $\gamma \geq \hat{\gamma}$ rather than $C_s(\gamma)$, and that the switch from separating to pooling regime happens for credit demand higher than $\hat{\lambda}$ rather than $\overline{\lambda}$.

For $\Gamma_3 = \{\gamma \in [\hat{\hat{\gamma}}, \tilde{\gamma})\}$ non-banks can compete in the pooling region for credit demand $\lambda \geq \hat{\hat{\lambda}}$, where the threshold $\hat{\hat{\lambda}}$ is given by the point where the pooling contract banks offer becomes as expensive as the one offered by non-banks, i.e., $R_p(\gamma, \hat{\hat{\lambda}}) = R_p^{NB}(\hat{\hat{\lambda}})$. The social welfare function is given by

$$W_{\Gamma_3}^{NB}(\gamma) = \int_0^{\hat{\lambda}} \left[\alpha\left(1+\lambda\right)\left(p_G G - 1\right) - \alpha\lambda\left(1-p_G\right)\left(1-\kappa\right)C_s^{NB}\right] d\lambda$$
$$+ \int_{\hat{\lambda}}^{\hat{\hat{\lambda}}} \left[\alpha(1+\lambda)\left(p_G G - 1\right) + (1-\alpha)\left(\frac{N-1}{N} + \lambda\right)\left(p_B B - 1\right)\right] d\lambda$$
$$+ \int_{\hat{\hat{\lambda}}}^{\infty} \left[\alpha(1+\lambda)\left(p_G G - 1\right) + (1-\alpha)\left(1+\lambda\right)\left(p_B B - 1\right)\right] d\lambda. \quad (26)$$

Note that the separating region still obtains for $\lambda < \hat{\lambda}$ given that banks continue to offer the pooling contract for credit demand $\lambda \in [\hat{\lambda}, \hat{\hat{\lambda}}]$. Thus, the difference between (25) and (26) is that non-banks fund all bad projects conditional on high demand for loans, $\lambda > \hat{\hat{\lambda}}$.

For $\Gamma_4 = \{\gamma \in [\tilde{\gamma}, \tilde{\tilde{\gamma}})\}$ banks are disintermediated both in the separating and pooling regimes, but can still lend to their known good borrowers, hence the only collateral liquidation cost in the separating regime comes from non-bank lending. The social welfare function is given by

$$W_{\Gamma_4}^{NB}(\gamma) = \int_0^{\tilde{\lambda}} \left[\alpha\left(1+\lambda\right)\left(p_G G - 1\right) - \alpha\lambda\left(1-p_G\right)\left(1-\kappa\right)C_s^{NB}\right] d\lambda$$

$$+ \int_{\tilde{\lambda}}^{\infty} \left[\alpha(1+\lambda)\left(p_G G - 1\right) + \left(1-\alpha\right)\left(1+\lambda\right)\left(p_B B - 1\right)\right] d\lambda. \tag{27}$$

Finally, for $\Gamma_5 = \{\gamma \in [\tilde{\tilde{\gamma}}, \gamma_{max}]\}$ banks cannot even lend to their known good borrowers. The social welfare function is given by

$$W_{\Gamma_5}^{NB}(\gamma) = \int_0^{\tilde{\lambda}} \left[\alpha\left(1+\lambda\right)\left(p_G G - 1\right) - \left(1+\alpha\lambda\right)\left(1-p_G\right)\left(1-\kappa\right)C_s^{NB}\right] d\lambda$$

$$+ \int_{\tilde{\lambda}}^{\infty} \left[\alpha(1+\lambda)\left(p_G G - 1\right) + \left(1-\alpha\right)\left(1+\lambda\right)\left(p_B B - 1\right)\right] d\lambda. \tag{28}$$

The difference between (27) and (28) is that collateral is required for all good borrowers in the latter, since non-banks do not have an informational advantage.

Evaluating social welfare across intervals, the planner will never set $\gamma \geq \tilde{\tilde{\gamma}}$. The reason is that she can do better setting $\gamma \in [\tilde{\gamma}, \tilde{\tilde{\gamma}})$ given that lending standards are unaffected because non-banks intermediate the whole market. Similarly, there is no scope to set $\gamma > \tilde{\gamma}$, because the planner can achieve the same level of welfare by setting $\gamma \to \tilde{\gamma}$, since $\hat{\lambda}(\tilde{\gamma}), \hat{\hat{\lambda}}(\tilde{\gamma}) \to \tilde{\lambda}$ and $W_{\Gamma_3}^{NB}(\tilde{\gamma}) \to W_{\Gamma_4}^{NB}(\tilde{\gamma})$. Thus, the optimal solution when non-banks are present is between $\overline{\gamma}$ and $\tilde{\gamma}$. This result establishes that the optimal capital requirement is lower in the presence of non-banks for economies parameterized such that $\gamma^* = \gamma_{\max}$ with only banks (see Proposition 7). The following Proposition generalizes this result for all parameterizations.

Proposition 12 *The optimal capital requirement with non-banks never exceeds the optimal requirement without non-banks, and is strictly lower if non-banks are active in the loan market.*

The intuition behind Proposition 12 is as follows. Recall that the planner trades off the cost from the inefficient collateral liquidation in the separating regime with the cost of funding negative NPV projects in the pooling regime. The collateral liquidation cost is relatively higher after a level of γ when non-banks disintermediate banks in separating allocations. The reason is that the collateral requirement non-banks set, C_s^{NB}, does not vary with capital regulation contrary to the one set by banks that is decreasing in γ (recall that $dC_s/d\gamma < 0$ from Proposition 5). In addition, for high enough γ non-banks also start disintermediating banks in pooling allocations for $\lambda > \hat{\hat{\lambda}}$. Hence, the social cost of funding negative NPV projects increases since non-banks fund all bad borrowers due to their informational disadvantage. Both forces work in the same direction and urge the planner to set a lower optimal macroprudential requirement in the presence of non-bank competition.

5 Conclusion

This paper provides a theoretical framework for understanding how macroprudential capital regulation affects lending standards in an economy where banks and nonbanks compete. We show that while higher capital requirements reduce lender protections at the individual contract level—by lowering collateral requirements—they tighten aggregate lending standards and do not adversely affect aggregate default rates by incentivizing banks to screen out riskier borrowers. The entry of non-banks into the credit market, triggered by tighter bank capital regulation, does not lead to a deterioration in aggregate lending standards. Instead, non-banks compete with banks by offering loans to good borrowers under lower collateral requirements, without attracting the riskier borrowers that banks reject. Such dynamics have been observed in the leveraged loan markets after the Global Financial Crisis and in private credit markets more recently; dynamics that our model can rationalize.

We show that the presence of non-banks amplifies the positive impact of capital regulation on aggregate lending standards by raising the threshold value of credit demand where lending standards start to deteriorate, thereby potentially increasing the resilience of credit quality to financial expansions. At the same time, the optimal macroprudential capital requirement is lower in the presence of non-banks, mitigating regulators' ability to further tighten standards.

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A Appendix - Proofs

Derivation of assumption 2. We restrict attention to good and bad project's payoffs, G and B, that generate the possibility of risk-shifting when there are no capital requirements, i.e., $\gamma = 0$. Consider that banks engage in risk-shifting offering a gross loan rate, R, that satisfies the following three conditions. First, it should be individually rational for bad firms to borrow, i.e., $B \geq R$. Second, it should not be individually rational for good types to borrow, i.e., $R > G$; otherwise a pooling equilibrium would obtain, which does not constitute risk-shifting given that the average borrower has positive NPV. Third, risk-shifting should be individually rational for banks, i.e., profits should be higher than the maximum possible profit from lending to good borrowers or, $R > (p_G/p_B)(G-D)+D$. In addition, bad projects have negative NPV, i.e., $p_B R \leq p_B B < 1$, which in combination with the previous condition yields $p_G G - (p_G - p_B)\, D < 1$. Combining these conditions, we derive assumption 2 as a sufficient condition to obtain risk-shifting as the only equilibrium when capital requirements, γ, are zero. ■

The proofs of Propositions 1, 4, and 5, are immediate from the text.

Proof of Proposition **2.** The equilibrium separating contract terms R_s and C_s are derived by solving jointly (5) and (6) given that the bank defaults in the bad state, i.e., $\kappa C_s - (1-\overline{\gamma})D < 0$. We proceed to verify that this is true for sufficiently low κ. We, first, examine the case that this condition is true for all $\kappa \in [0, 1)$. Take $\kappa \to 1$ and assume that $C_s = p_B/(1-p_B)(B-R_s) \geq 1-\overline{\gamma}$, which implies that $R_s \leq B-(1-p_B)/p_B(1-\overline{\gamma})$. Using the equilibrium value of R_s and $D = 1$, this can only be true for $\overline{\gamma} \leq p_G(p_B B-1)/(p_B E-p_G) < 0$ if $E > p_G/p_B$, or $\overline{\gamma} \geq p_G(1-p_B B)/(p_G - p_B E) > 1$ if $E < p_G/p_B$ and $E > p_G B$. In other words, for these set of parameters the bank defaults in the bad state not only for $\overline{\gamma}$, but for any level of admissible capital requirement γ. For $E < p_G/p_B$ and $E < p_G B$, there may exist γ such that $C_s > (1-\gamma)D$. In such cases, we will impose that $\kappa < \overline{\kappa}_\gamma \equiv (1-\gamma)D/C_s$, such that the bank defaults if the bad state realizes. ■

Proof of Proposition **3.** We first establish the existence of the threshold $\overline{\alpha}$ above which condition (12) is satisfied. The left-hand side of (12) is decreasing in α, while the right-hand side is independent of α. Using the participation constraint for good types in a separating equilibrium, $p_G(G - R_s) - (1 - p_G) C_s \Rightarrow G > R_s + \frac{1-p_G}{p_G} C_s$. Re-writing (12) and taking $\alpha \to 0$ as

$$\frac{\overline{\gamma}E}{p_B} + (1 - \overline{\gamma}) D > G \Rightarrow \overline{\gamma} = \frac{p_B(B - D)}{E - p_B D} > \frac{p_B(G - D)}{E - p_B D}$$

which always holds because $B > G$. Hence, there is no pooling equilibrium even for sufficiently high λ for $\alpha \to 0$. Letting $\alpha \to 1$, condition (12) becomes $p_G(R_s - (1 - \overline{\gamma}) D) + (1 - p_G) C_s > \overline{\gamma}E$, which always holds because $\overline{\gamma}E = p_G(R_s - (1 - \overline{\gamma}) D)$. Hence, $\exists \overline{\alpha} \in (0, 1)$ such that condition (12) holds, and the separating allocation cannot be an equilibrium for sufficiently high λ and α. Putting this together with the fact that there is no pooling equilibrium for $\lambda \to 0$, part (i) follows immediately. To establish the threshold $\overline{\lambda}$ in part (ii), note that the left-hand side of (11) is continuous and decreasing in λ and approaches $\overline{\gamma}E/p_B + (1 - \overline{\gamma}) D$. Thus, if (12) holds, then there must be a $\overline{\lambda} > 0$ such that equilibrium is separating if $\lambda \leq \overline{\lambda}$. Moreover, the zero-profit condition from which the contract (R_s, C_s) is derived ensures that no bank can profitably offer a different contract. From Rothschild-Stiglitz argument, no separating strategy exists when condition (11) is violate. Therefore, part (iii) shows the conditions for violating condition (11) while preserving condition (12) and eliminating all separating equilibria.

There is no pooling equilibrium under the conditions established in parts (i)-(iii) because a necessary condition for pooling to be an equilibrium is that condition (9) holds. But, for $\lambda < \overline{\lambda}$, condition (11) implies that a bank could offer a deviating contract $(R_s + \epsilon, C_s)$ for $\epsilon > 0$ sufficiently small that attracts only good borrower and make a profit. Thus, there is no pooling equilibrium for $\lambda < \overline{\lambda}$. Lastly, for $\alpha < \overline{\alpha}$, a bank could offer a deviating contract $(R_s + \epsilon, C_s)$ for $\epsilon > 0$ sufficiently small that attracts only good borrowers and make a profit while still preserving the relationship $\frac{\overline{\gamma}E}{p_\mu} + (1 - \overline{\gamma}) D > R_s + \epsilon + \frac{1-p_G}{p_G} C_s$. ■

Proof of Proposition 6. The equilibrium value of $\overline{\lambda}$ is implicitly defined by indifference condition of the pooling and separating contracts: $\bar{R}_s = R_p$, where $\bar{R}_s = R_s + (1 - p_G)/p_G C_s$. Totally differentiating, $\frac{d\bar{R}_s}{d\gamma} = \frac{\partial R_p}{\partial \gamma} + \frac{\partial R_p}{\partial \overline{\lambda}} \frac{\partial \overline{\lambda}}{\partial \gamma} \Rightarrow \frac{\partial R_p}{\partial \overline{\lambda}} \frac{\partial \overline{\lambda}}{\partial \gamma} = \frac{d\bar{R}_s}{d\gamma} - \frac{\partial R_p}{\partial \gamma}$. Re-writing the equilibrium price of the pooling contract,

$$R_p = \frac{\gamma E \left(\overline{\lambda} + (1 - \alpha) \frac{N-1}{N}\right) + (1 - \gamma) D \left(\overline{\lambda} p_\mu + (1 - \alpha) \frac{N-1}{N} p_B\right)}{\overline{\lambda} p_\mu + (1 - \alpha) \frac{N-1}{N} p_B} \tag{A.1}$$

It is straightforward to see that $\frac{\partial R_p}{\partial \overline{\lambda}} = \frac{(1-\alpha)\frac{N-1}{N}(\gamma E(p_B - p_\mu))}{(\cdot)^2} < 0 \Rightarrow p_B < p_\mu$. Therefore, $\text{sign}\left(\frac{\partial \overline{\lambda}}{\partial \gamma}\right) = -\text{sign}\left(\frac{d\bar{R}_s}{d\gamma} - \frac{\partial R_p}{\partial \gamma}\right)$. Plugging in the separating contract terms $R_s = \overline{\gamma}\frac{E - p_G D}{p_G} + D$ and $C_s = \frac{p_B(B - R(\gamma))}{1-p_B}$ from Proposition 2 we obtain

$$\bar{R}_s = \left[\gamma\left(\frac{E}{p_G} - D\right) + D\right]\frac{p_G - p_B}{p_G\,(1-p_B)} + \frac{(1-p_G)}{p_G}\frac{p_B}{(1-p_B)}B. \tag{A.2}$$

Noting that $\gamma\frac{d\bar{R}_s}{d\gamma} = \gamma\left(\frac{E}{p_G} - D\right)\frac{p_G - p_B}{p_G(1-p_B)}$, one can express $\gamma\frac{d\bar{R}_s}{d\gamma} = \bar{R}_s - \frac{p_G - p_B}{p_G(1-p_B)}D - \frac{(1-p_G)p_B}{p_G(1-p_B)}B$. Lastly, we need to find $\frac{\partial R_p}{\partial \gamma}$. Note that $R_p = \gamma\frac{E\left(\overline{\lambda} + (1-\alpha)\frac{N-1}{N}\right)}{\overline{\lambda}p_\mu + (1-\alpha)\frac{N-1}{N}p_B} - \gamma D + D \Rightarrow R_p = \gamma\frac{\partial R_p}{\partial \gamma} + D$. Hence, one can write $\gamma\frac{\partial R_p}{\partial \gamma} = R_p - D$. Thus, $\gamma\left(\frac{d\bar{R}_s}{d\gamma} - \frac{\partial R_p}{\partial \gamma}\right)\frac{1}{\gamma} = \bar{R}_s - \frac{p_G - p_B}{p_G(1-p_B)}D - \frac{(1-p_G)p_B}{p_G(1-p_B)}B - R_p + D$. Using the equilibrium relationship that $\bar{R}_s = R_p$,

$$\left(\frac{d\bar{R}_s}{d\gamma} - \frac{\partial R_p}{\partial \gamma}\right) = -\frac{(1-p_G)\,p_B}{p_G\,(1-p_B)}B + \frac{(1-p_G)\,p_B}{p_G\,(1-p_B)}D < 0, \tag{A.3}$$

because $B > D$. To conclude, $\frac{\partial \overline{\lambda}}{\partial \gamma} > 0$. ■

Proof of Proposition 7. First, consider the case that $\kappa = 1$. Then, $\psi_{min} = 0$ and $\psi_{max} > 0$, because $d\overline{\lambda}/d\gamma > 0$ from Proposition 6. In other words, the planner imposes the maximum capital requirement because there is no cost from liquidating collateral. Now consider $\kappa < 1$, and rewrite (15) as:

$$-\frac{dC_s}{d\gamma}\overline{\lambda}^2\alpha(1-p_G)(1-\kappa)\left[\frac{\eta_{\overline{\lambda},\gamma}}{\eta_{C_s,\gamma}} + \frac{1}{2}\right] + \frac{d\overline{\lambda}}{d\gamma}(1-\alpha)\left(\frac{N-1}{N} + \overline{\lambda}\right)(1 - p_B B) + \psi_{min} - \psi_{max} = 0,$$

where

$$\frac{\eta_{\overline{\lambda},\gamma}}{\eta_{C_s,\gamma}} = \frac{d\overline{\lambda}/d\gamma}{dC_s/d\gamma}\frac{C_s(\gamma)}{\overline{\lambda}(\gamma)} < 0,$$

i.e. the ratio of the elasticities of $\overline{\lambda}(\gamma)$ and $C_s(\gamma)$ with respect to γ is negative from Propositions 5 and 6. Dividing through by $\frac{d\overline{\lambda}}{d\gamma}$, we have

$$F + \frac{d\overline{\lambda}}{d\gamma}^{-1}\left[\psi_{min} - \psi_{max}\right] = 0,$$

where $F \equiv -\overline{\lambda} \cdot C_s \cdot \alpha(1-p_G)(1-\kappa)\left[1+\frac{1}{2}\frac{\eta_{C_s,\gamma}}{\eta_{\lambda,\gamma}}\right]+(1-\alpha)\left(\frac{N-1}{N}+\overline{\lambda}\right)(1-p_B B)$.

We already know that $F>0$ for $\kappa=1$. Therefore, if $dF/d\kappa<0 \Rightarrow \psi_{max}>0, \forall\kappa\in[0,1]$. It is straightforward to see that $\frac{\eta_{C_s,\gamma}}{\eta_{\lambda,\gamma}} \leq -2 \Rightarrow dF/d\kappa<0$. Hence $\frac{\eta_{C_s,\gamma}}{\eta_{\lambda,\gamma}} \leq -2$ or $\eta_{\lambda,\gamma} \leq -0.5\eta_{C_s,\gamma}$ is sufficient for $\gamma^* = \gamma_{\max}\,\forall\kappa$.

Now consider $0 > \frac{\eta_{C_s,\gamma}}{\eta_{\lambda,\gamma}} > -2$ or $\eta_{\lambda,\gamma} > -0.5\eta_{C_s,\gamma}$, implying $dF/d\kappa>0$. Taking the limit of F as $\kappa \to 0$

$$\lim_{\kappa\to 0} F = -\overline{\lambda} C_s \alpha(1-p_G)\left[1+\frac{1}{2}\frac{\eta_{C_s,\gamma}}{\eta_{\lambda,\gamma}}\right]+(1-\alpha)\left(\frac{N-1}{N}+\overline{\lambda}\right)(1-p_B B).$$

If $\lim_{\kappa\to 0} F>0$, then again $\gamma^*=\gamma_{\max}\,\forall\kappa$. If $\lim_{\kappa\to 0} F<0$, $\gamma^* \in [\overline{\gamma}, \gamma_{max})$. ■

Proof of Proposition 8. Equation (18) shows that for $p_G > p_B$, the benefit of lower equity cost for non-banks never outweighs their higher financing costs under microprudential capital requirements. Thus non-banks cannot compete with banks in separating contracts.

Now consider pooling contracts. For $\lambda \to 0$, substituting the equilibrium values of $\overline{\gamma}$, γ^{NB}, and D_p^{NB} into equations (13) and (20) yields $R_p = R_p^{NB}$. Thus, $\lim_{\lambda\to 0}\left(R_p - R_p^{NB}\right) = 0$. Note that for $\lambda \to 0$, the separating contract always dominates the pooling contract for banks: all good borrowers are known to at least one bank and thus receive funding, while all remaining (unfunded) borrowers offer negative NPV projects and thus banks cannot do better by offering a pooling contract when $\lambda \to 0$. Additionally, we have shown that non-banks cannot compete with banks through separating contracts under microprudential capital requirements. Thus for $\lambda \to 0$, non-banks cannot compete with banks.

For $\lambda \to \infty$, substituting the equilibrium values of $\overline{\gamma}$, γ^{NB}, and D_p^{NB} into equations (13) and (20) yields $R_p < R_p^{NB}$ for $p_\mu < 1$, which holds by definition. Thus, $\lim_{\lambda\to\infty}\left(R_p - R_p^{NB}\right) < 0$ and non-banks cannot compete with banks through pooling contracts.

For intermediate values of λ, using equations (13) and (20) we obtain

$$\frac{\partial R_p}{\partial \lambda} = \frac{(1-\alpha)\left(\frac{N}{N-1}\right)\bar{\gamma}E(p_B - p_\mu)}{\left[\lambda p_\mu + (1-\alpha)\left(\frac{N}{N-1}\right)p_B\right]^2} < 0, \tag{A.4}$$

and

$$\frac{\partial R_p^{NB}}{\partial \lambda} = \frac{(1-\alpha)\gamma^{NB}E(p_B - p_\mu)}{\left[\lambda p_\mu + (1-\alpha)p_B\right]^2} < 0, \tag{A.5}$$

since $p_B < p_\mu$. In combination with $\lim_{\lambda\to 0}\left(R_p - R_p^{NB}\right) = 0$ and $\lim_{\lambda\to\infty}\left(R_p - R_p^{NB}\right) < 0$, (A.4) and (A.5) imply that non-banks cannot compete through pooling contracts for any value of λ under microprudential capital requirements. Therefore, under microprudential capital requirements, non-banks are unable to compete with non-banks either through separating or pooling contracts. ■

Proof of Proposition 9. $\hat{\gamma}$ is the capital requirement that equates bank and non-bank participation constraints when offering a separating contract given by equation (21). $\hat{\hat{\gamma}}|_{\lambda\to\infty}$ is the capital requirement that equates bank and non-bank participation constraints when offering a pooling contract given by equation (23). Note that $D_s^{NB} = \frac{D - \frac{(1-p_G)\kappa}{1-\gamma_s^{NB}}}{p_G} < \frac{D}{p_G} \Rightarrow D_s^{NB} p_G < D$. Using this inequality, we can re-write equation (21) as

$$\hat{\gamma} < \frac{\gamma_s^{NB} E - p_G D}{E - p_G D} + \frac{D(1-\gamma_s^{NB})}{E - p_G D} = \frac{\gamma_s^{NB}(E-D)}{E - p_G D} + \frac{D(1-p_G)}{E - p_G D}.$$

Using $\lim_{\lambda\to\infty} D_p^{NB} = \frac{D}{p_\mu}$, $\hat{\hat{\gamma}}$ can be expressed as

$$\hat{\hat{\gamma}} = \frac{\gamma_p^{NB}(E-D) + D(1-p_\mu)}{E - p_\mu D}$$

We derive a sufficient condition such that $\hat{\hat{\gamma}} > \hat{\gamma}$ and show that is always holds when pooling is possible in equilibrium. Using the above relationships we need

$$\frac{\gamma_p^{NB}(E-D) + D(1-p_\mu)}{E - p_\mu D} > \frac{\gamma_s^{NB}(E-D) + D(1-p_G)}{E - p_G D}$$

$$\Rightarrow \gamma_p^{NB}(E - p_G D) - \gamma_s^{NB}(E - p_\mu D) + D(p_G - p_\mu) > 0.$$

Using (16) for the respective separating and pooling non-bank equity requirements, the required condition becomes

$$\frac{p_B(B - D_p^{NB})}{E - p_B D_p^{NB}}(E - p_G D) - \frac{p_B(B - D_s^{NB})}{E - p_B D_s^{NB}}(E - p_\mu D) + D(p_G - p_\mu) > 0.$$

Since $D_p^{NB} > D_s^{NB}$, substituting D_s^{NB} into the denominator of the first term on the left decreases the l.h.s of inequality. Then the following becomes sufficient: $p_B(B - D_p^{NB})(E -$

$p_G D) - p_B(B - D_s^{NB})(E - p_\mu D) + D(p_G - p_\mu)(E - p_B D_s^{NB}) > 0$. Re-grouping and re-arranging we have $D(p_G - p_\mu)(E - p_B B) - p_B(D_P^{NB} - D_S^{NB})(E - p_G D) > 0$. Note that we can re-group the above condition irrespective of whether $p_G D \gtrless p_B B$ and maintain sufficiency. Hence, substitute $p_G D$ for $p_B B$ and re-group to obtain $(E - p_G D)\left[D(p_G - p_\mu) - p_B(D_P^{NB} - D_S^{NB})\right] > 0$. Using

$$\lim_{\lambda \to \infty} D_p^{NB} = \frac{D}{p_\mu}$$

and

$$D_s^{NB} = \frac{D - \frac{(1-p_G)\kappa}{1-\gamma_s^{NB}}}{p_G} < \frac{D}{p_G},$$

the sufficient condition can be written as $(E - p_G D)\left[D(p_G - p_\mu) - \frac{p_B}{p_G p_\mu}(p_G - p_\mu)D\right] > 0$. Hence, if this holds, the original inequality holds. Once again re-grouping and cancelling terms, the sufficient condition simplifies to $p_\mu p_G - p_B > 0$. Plugging in $p_\mu = \alpha p_G + (1-\alpha)p_B$, we obtain $p_G(\alpha p_G + (1-\alpha)p_B) > p_B \Rightarrow 1 > \alpha > \frac{p_B(1-p_G)}{p_G(p_G - p_B)}$. For this to be met, it is necessary that $\frac{p_B(1-p_G)}{p_G(p_G-p_B)} < 1 \Rightarrow p_G^2 > p_B$.

This condition is sufficient condition for non-banks to first compete in separating allocations as macroprudential regulation gets tighter. The interpretation is that good types must be sufficiently more likely to produce good outcomes than bad, formally given by $p_G^2 > p_B$, which is stronger than requiring $p_G > p_B$. This stronger condition is implied by requiring that $\alpha \geq \overline{\alpha}$ derived in Proposition 2, which gives the minimum level of α such that there can exist a pooling equilibrium for high enough λ. The intuition is simple. Note that if $\alpha < \overline{\alpha}$ only the separating equilibrium is possible and, thus, non-banks necessarily can only compete in separating contracts. ■

Proof of Proposition 10. The relationship between thresholds $\hat{\gamma}$ and $\hat{\hat{\gamma}}$ accrue from Proposition 9. Here in we show that $\tilde{\gamma}$, i.e., the macroprudential requirement that allows non-banks to compete in pooling contracts for any λ, satisfies the additional relationships stated in Proposition 10.

$\tilde{\gamma}$ is the solution to $R_p(\tilde{\gamma}, \lambda) = R_p^{NB}(\lambda)$. From (13) and (20), this can be written as

$$\frac{(1-\alpha)\,\frac{N-1}{N}\left[\tilde{\gamma}E + (1-\tilde{\gamma})\,Dp_B\right] + \tilde{\lambda}\left[\tilde{\gamma}E + (1-\tilde{\gamma})\,Dp_\mu\right]}{(1-\alpha)\,\frac{N-1}{N}p_B + \tilde{\lambda}p_\mu}$$

$$= \frac{(1-\alpha)\left[\gamma_p^{NB}(\tilde{\lambda})E + (1-\gamma_p^{NB}(\tilde{\lambda}))D_p^{NB}(\tilde{\lambda})p_B\right] + \tilde{\lambda}\left[\gamma_p^{NB}(\tilde{\lambda})E + (1-\gamma_p^{NB}(\tilde{\lambda}))D_p^{NB}(\tilde{\lambda})p_\mu\right]}{(1-\alpha)p_B + \tilde{\lambda}p_\mu}, \tag{A.6}$$

where $\gamma_p^{NB}(\tilde{\lambda})$ and $D_p^{NB}(\tilde{\lambda})$ are given by (16) and (19). $\lambda = \tilde{\lambda}$ is the value of λ for the exogenous credit demand for which separating and pooling equilibria are equivalent for non-banks and banks are completely disintermediated. Because of Proposition 9, non-banks compete first in separating allocations as macroprudential requirements increase, thus $\tilde{\lambda}$ is the credit demand that makes non-banks switch from offering separating to pooling contracts (absent competition from banks), i.e.,

$$R_s^{NB} + \frac{1-p_G}{p_G}C_s^{NB} = R_p^{NB}(\tilde{\lambda}), \tag{A.7}$$

where $R_s^{NB} = \gamma_s^{NB}E/p_G + (1-\gamma_s^{NB})D_s^{NB}$ and $C_s^{NB} = [p_B/[(1-p_B)p_G]][p_G B - (\gamma_s^{NB}E + (1-\gamma_s^{NB})D_s^{NB}p_G)]$—the separating contract terms for non-banks are derived using the same steps as for the separating contract terms for banks in Proposition 2.

From (A.6) and (A.7) we also get that $R_s^{NB} + (1-p_G)/p_G C_s^{NB} = R_p(\tilde{\gamma}, \tilde{\lambda})$, i.e., the effective rate on the non-banks' separating contracts is equal to the pooling rate banks offer. Now, consider a $\gamma' < \tilde{\gamma}$. Then, $R_s^{NB} + (1-p_G)/p_G C_s^{NB} > R_p(\gamma', \tilde{\lambda})$, and hence the threshold λ' that equate the two is strictly less than $\tilde{\lambda}$. From (A.7), this implies that $R_p^{NB}(\lambda') > R_p(\gamma', \lambda')$, i.e., non-banks can compete in pooling contract for $\lambda \in [\lambda', \tilde{\lambda}]$. This confirms that $\tilde{\gamma}$ is the minimum threshold for the macroprudential requirement such that non-banks can compete in pooling contracts for all λ, i.e., $\tilde{\lambda} > \hat{\hat{\lambda}}$, and that for $\lambda > \tilde{\lambda}$ banks do not fund any unknown borrowers. ■

Proof of Proposition 11. From Proposition 6, we know that

$$d\overline{\lambda}/d\gamma = (\partial R_p/\partial\gamma)(dR_s/d\gamma - dR_p/d\gamma) > 0.$$

Following the following steps for the determination of $\hat{\lambda}$ from $R_s^{NB} = R_p(\hat{\lambda}(\hat{\gamma}))$ we get that $d\hat{\lambda}(\gamma)/d\gamma = -(\partial R_p/\partial\gamma)(dR_p/d\gamma) > 0$, because $(\partial R_p/\partial\gamma) < 0$. Note that this also implies that $d\hat{\lambda}/d\gamma > d\overline{\lambda}/d\gamma$. Finally, because $R_s(\hat{\gamma}) = R_s^{NB}$ and by continuity, we have that $R_p(\overline{\lambda}(\hat{\gamma})) = R_p(\hat{\lambda}(\hat{\gamma}))$, and thus $\overline{\lambda}(\hat{\gamma}) = \hat{\lambda}(\hat{\gamma})$. Similarly, $\hat{\lambda}(\tilde{\gamma}) = \tilde{\lambda}(\tilde{\gamma})$ as a direct consequence of (A.6). ■

Proof of Proposition 12. Recall that the optimal capital requirements in the absence and in the presence of non-banks are denoted by γ^* and γ^{**}, respectively. For the parameterization in Proposition 7 such that $\gamma^* \in [\tilde{\gamma}, \gamma_{max}]$, we already established in the body of the paper that $\gamma^{**} < \tilde{\gamma}$ and, hence, the optimal capital requirement is strictly lower in the presence of non-banks.

We now turn to the other possible cases starting with $\gamma^* \in \Gamma_2$, i.e., $\gamma \in [\hat{\gamma}, \hat{\hat{\gamma}})$. Using (15) we get that

$$\begin{aligned}&-\alpha\overline{\lambda}(\gamma^*)\,(1-p_G)\,(1-\kappa)\,C_s(\gamma^*) + (1-\alpha)\left(\frac{N-1}{N} + \overline{\lambda}(\gamma^*)\right)(1-p_B B)\\ &= \left(\frac{d\overline{\lambda}}{d\gamma}\right)^{-1}\left[\frac{dC_s(\gamma^*)}{d\gamma}\frac{(\overline{\lambda}(\gamma^*))^2}{2}\alpha(1-p_G)(1-\kappa) - \psi_{min}\right] < 0,\end{aligned} \tag{A.8}$$

which also implies that

$$\begin{aligned}&-\alpha(1-p_G)(1-\kappa)C_s(\gamma^*) + (1-\alpha)(1-p_B B) < 0\\ \& \quad &-\alpha(1-p_G)(1-\kappa)C_s^{NB} + (1-\alpha)(1-p_B B) < 0,\end{aligned} \tag{A.9}$$

because $C_s^{NB} = C_s(\hat{\gamma}) > C_s(\gamma^*)$.

Evaluating the first-order optimality condition for (25) at $\gamma = \gamma^*$ yields

$$\frac{d\hat{\lambda}(\gamma^*)}{d\gamma}\left[-\alpha\hat{\lambda}(\gamma^*)\,(1-p_G)\,(1-\kappa)\,C_s^{NB} + (1-\alpha)\left(\frac{N-1}{N} + \hat{\lambda}(\gamma^*)\right)(1-p_B B)\right]$$
$$<\frac{d\hat{\lambda}(\gamma^*)}{d\gamma}\left[-\alpha\overline{\lambda}(\gamma^*)\,(1-p_G)\,(1-\kappa)\,C_s(\gamma^*) + (1-\alpha)\left(\frac{N-1}{N} + \overline{\lambda}(\gamma^*)\right)(1-p_B B)\right], \tag{A.10}$$

because $C_s^{NB} = C_s(\hat{\gamma}) > C_s(\gamma^*)$ and $\hat{\lambda}(\gamma^*) > \overline{\lambda}(\gamma^*)$ from Proposition 11. Moreover, the last term in (A.10) is negative due to (A.8). Hence, γ^* cannot be a optimal solution to (25). Given that $\gamma^* \in (\hat{\gamma}, \hat{\hat{\gamma}})$, the expression in (A.8) is positive evaluated at $\gamma = \hat{\gamma}$ because the Lagrange multiplier drops out and capital requirements do not affect the non-bank collateral requirement, so the derivative is equal to zero. This implies that the l.h.s of (A.10) evaluated at $\hat{\gamma}$ can be either positive or negative because the r.h.s is positive. If the l.h.s is positive, then there exists $\gamma^{**} \in (\hat{\gamma}, \gamma^*)$ because $\hat{\lambda}\,(\gamma^*)$ is increasing in γ, which implies that the capital requirement could be raised to the level equating it to the r.h.s. If the l.h.s is negative, we get a corner solution and $\gamma^{**} = \hat{\gamma}$. To conclude the proof for this case, we need to show that social welfare is not higher in interval $\Gamma_3 = \{\gamma \in [\hat{\hat{\gamma}}, \tilde{\gamma})\}$ (if welfare is higher for $\gamma \in \Gamma_1$, then trivially $\gamma^{**} < \gamma^*$). The optimality condition for (26) is given by

$$\frac{d\hat{\lambda}(\gamma)}{d\gamma}\left[-\alpha\hat{\lambda}(\gamma)\,(1-p_G)\,(1-\kappa)\,C_s^{NB} + (1-\alpha)\left(\frac{N-1}{N} + \hat{\lambda}(\gamma)\right)(1-p_B B)\right]$$
$$+\frac{d\hat{\hat{\lambda}}(\gamma)}{d\gamma}\frac{1-p_B B}{N}, \tag{A.11}$$

which is negative from (A.10) because $\frac{d\hat{\lambda}(\gamma)}{d\gamma} > 0$, $\hat{\lambda}(\gamma) > \hat{\lambda}(\gamma^*)$, and $\frac{d\hat{\hat{\lambda}}(\gamma)}{d\gamma} < 0$. The latter accrues from the fact that non-banks start competing with banks in pooling contracts first for high λ and then for lower ones, as γ increases further. Combining all the results above, we can conclude that $\gamma^{**} < \gamma^*$ if $\gamma^* \in \Gamma_2$.

Using similar logic we can also show that $\gamma^{**} < \gamma^*$ is true for $\gamma^* \in \Gamma_3$. Hence, the optimal capital requirement is strictly lower in the presence of non-banks for parameterizations where non-banks are active in loan markets (either in separating or both separating and pooling contracts). Finally, for $\gamma^* \in \Gamma_1$, i.e., under parameterization where non-banks are not active in loan markets, we can similarly show that the optimality conditions for (25) and (26) are negative. Since $W_{\Gamma_1}^{NB} = W$, this implies that $\gamma^{**} = \gamma^*$ concluding the proof. ■

B Appendix - Nonbank Contracting

If the equity choice is not contractible, then long-term debt is not a viable solution. In this case a fragile funding structure consisting of runnable debt can restore incentives and non-banks would voluntarily maintain a level of equity that suffices to signal that they have enough skin in the game to deter them from risk-shifting. For simplicity, assume that debt-holders are promised a gross interest rate greater or equal to one if they withdraw early, and an interest rate greater than one if they withdraw late, thus compensating them for credit risk. This is essentially a Diamond and Dybvig (1983) contract accounting for the possibility of non-bank default. Given that equity capital is observable, a drop below the required level would immediately induce debt-holders to withdraw early and a run would ensue. Because equity is worthless in a run, non-banks would voluntarily maintain the required level of capital.

The type of run described above is driven by bad fundamentals due to risk-shifting (see, for example, Jacklin and Bhattacharya, 1988, and Allen and Gale, 1998). As expected, there can be other type of runs driven by the type of coordination failure described in Diamond-Dybvig. In order to simplify the analysis, we make a technical assumption that eliminates the possibility of such panic-based runs.[11] In particular, we assume that the liquidation value ξ is high enough to cover early withdrawals by all debt-holders. Because their debt would be riskfree in the short run and because debt-holders are risk-neutral, the gross interest rate for early withdrawals can be set equal to their outside option, i.e., equal to one. Then, the level of equity, $\gamma^{NB'}$, that non-banks need to hold would need to satisfy the following two

[11] Otherwise, multiple equilibria would exist as is typically the case in coordination failure games. The multiplicity could be resolved by assuming that the withdrawal decision is driven by sunspots (Cooper and Ross, 1998) or, preferably, by modeling an incomplete information game (Goldstein and Pauzner, 2005; Kashyap, Tsomocos, and Vardoulakis, 2024).

conditions:

$$\gamma^{NB'} E \geq p_B[B - (1 - \gamma^{NB'})D^{NB'}] \tag{B.12}$$

$$\xi \geq 1 - \gamma^{NB'}, \tag{B.13}$$

where $D^{NB'}$ is the gross interest rate for late withdrawals. Condition (B.12) guarantees that there will be no risk-shifting in equilibrium, while condition (B.13) guarantees that there will be no panic-based runs. Combining the two and realizing that $\gamma^{NB'}$ takes its lowest value for $D^{NB'} = D'/p_B$, leads to the following assumption for the liquidation value.

Assumption 4 *The liquidation value ξ is higher than $\bar{\xi} = \frac{E - p_B B}{E - 1} < 1$.*

Hence, the theory of the non-bank capital structure we describe in this paper could combine elements of existing theories with frictions that characterize all financial institutions, namely risk-shifting due to the unobservability/noncontractability of the lending choice and instability due to run risk. If equity is contractible, similar to Holmström and Tirole (1997), then long-term debt is the solution. Otherwise, a fragile funding structure can induce the discipline needed to deter moral hazard and run risk in equilibrium (given assumption 4) similar to Calomiris and Kahn (1991) and Diamond and Rajan (2000). Hence, our theory can be applied to the various diverse non-bank financial institutions that have either stable or runnable liabilities. Moreover, the market-based non-bank equity capital will be the same for both types of institutions given the absence of panic-based runs for the latter, i.e., $\gamma^{NB} = \gamma^{NB'}$ and $D^{NB} = D^{NB'}$.