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**Banks, Non Banks, and Lending Standards**

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# Banks, Non-Banks, and Lending Standards <sup>\*</sup>

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## Abstract

We study how competition between banks and non-banks affects lending standards. Banks have private information about some borrowers and are subject to capital requirements to mitigate risk-taking incentives from deposit insurance. Non-banks are uninformed and market forces determine their capital structure. We show that lending standards monotonically increase in bank capital requirements. Intuitively, higher capital requirements raise banks' skin in the game and screening out bad projects assures positive expected lending returns. Non-banks enter the market when capital requirements are sufficiently high, but do not cause a deterioration in lending standards. Optimal capital requirements trade-off inefficient lending to bad projects under loose standards with inefficient collateral liquidation under tight standards.

**JEL Classification:** G01,G21,G28

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

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# 1 Introduction

Recessions and down-turns in business cycles are often preceded by periods of rapid credit growth. A major discussion following the financial crisis of 2007-09 centered on the observation that “shadow banks”, or more plainly non-bank financial intermediaries, are an important conduit through which credit is intermediated to households and firms. More recently, there is a growing concern whether the rapid growth in risky business lending fueled by non-bank investors’ demand for high-yield bonds, leveraged loans, and collateralized loan obligations (CLO), accompanied by loose lending standards, portends the next bust cycle. As an example, private credit from non-bank financial institutions, and in particular private equity funds, to high risk, middle market firms had been the fastest growing portion of the loan market totaling near \$800 billion in lending as of 2018.<sup>1</sup> Market participants have pointed to higher costs from stricter “prudential regulation” as one of the reasons why banks no longer serve this market. In addition, several empirical papers conclude that regulation has been an important factor in the rise of shadow banks after the crisis—for shadow banking in mortgages see Buchak, Matvos, Piskorski and Seru (2018) and for corporate loans see Irani, Iyer, Meisenzahl and Peydro (2020).

The narrative that rising capital costs drive banks out of markets into which non-banks enter with lax lending standards lacks a causal mechanism. In particular, does non-bank competition *cause* an erosion of equilibrium lending standards, or do non-banks enter into loan markets when lending standards *are already loose* and demand for credit among risky borrowers is high? The goal of this paper is to understand how regulation interacts with competition between bank and non-bank financial intermediaries and how it impacts aggregate lending standards.

We present a model of capital regulation and lending standards that builds on Dell’Ariccia and Marquez (2006). The model has 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 have higher upside conditional on success. On average, a portfolio of both good and bad projects is positive NPV. Banks have private information about bor-

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<sup>1</sup>See a Washington Post article by Butler (2019).

rowers with whom they have existing relationships, but there is another set of borrowers whose projects' quality are 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 good borrowers from bad borrowers, but liquidating collateral in default is inefficient. Alternatively, loan contracts without collateral requirements pool all borrowers. Thus, banks face an adverse selection problem because funding all projects mixes all unknown borrowers (good and bad) with competing banks' known bad borrowers. Lending standards are defined by two alternative credit regimes: i. lending standards are tight when collateral is required and bad borrowers are screened out, and ii. lending standards are loose when all borrowers receive funding without collateral requirements. Banks decide whether to go with the first or the second credit regime given the level of the demand for credit. Intuitively, a higher demand for credit by unknown borrowers mitigates the adverse selection problem because an unknown borrower has a positive NPV project on average. In this framework, lending standards are captured by a threshold for loan demand where banks switch from regime i. (tight standards) to regime ii. (loose standards). All these are standard from Dell'Aricecia and Marquez (2006).

We augment this framework in two important ways to examine how capital regulation interacts with non-bank competition to determine lending standards. First, we make the standard assumption that banks raise insured deposits and issue equity. Deposit insurance gives banks the incentive to risk-shift and fund bad projects that are negative NPV, but have higher upside conditional on success. To prevent risk-shifting, a regulator imposes microprudential capital requirements (see, for example, Cooper and Ross, 1998, Van den Heuvel, 2008, Begenau, 2020). Second, we assume unregulated intermediaries, non-banks, also provide agents with funding for their projects. Non-banks differ from banks in the following ways: i) non-banks issue unsecured debt, and a market-based solution is needed to determine their capital structure (we later elaborate on this); and ii) non-banks have no information about any borrowers and treat the entire mass of borrowers as unknown. In this simple framework, we derive the following results. First, perhaps unsurprisingly,

non-banks cannot compete with banks when capital requirements are set to just curb the moral hazard problem, i.e., when regulation is *microprudential* in nature. The reason is that banks have both an informational advantage and funding cost advantage due to deposit insurance. Second, increasing capital requirements beyond their microprudential level, improves lending standards. The reason is that the higher requirements increase all banks' funding costs, which strengthens each banks information advantage relative to competitors trying to poach good borrowers through lax standards. We call these requirements—which are above their microprudential level— *macroprudential* capital requirements, because, as it will become clear, they allow a social planner to trade off inefficient collateral liquidation with inefficiently funding negative NPV projects. Third, stricter macroprudential capital requirements introduce competition from non-banks. The reason is that higher funding costs erode the subsidized deposit insurance provided to banks, which enables non-banks to compete.

The fourth and main result of the paper shows that lending standards *monotonically improve* as macroprudential regulation tightens and the tightening effect is amplified in presence of non-bank competition. In other words, the economy with non-banks supports a separating credit regime characterized by tight lending standards for a larger threshold value of credit demand. Recall that lending standards are characterized by the threshold for loan demand after which the economy switches from the separating to the pooling regime. The intuition behind this, perhaps counterintuitive, result is as follows. Non-banks can compete more easily in separating contracts because the deposit insurance subsidy and the private information gives a relatively bigger advantage to banks in pooling where negative NPV projects are also funded. This implies that, for intermediate levels of macroprudential requirements, the separating contract is set by non-banks while the pooling contract is set by banks.<sup>2</sup> Hence, the price of the pooling contract increases with stricter macroprudential regulation, while the separating contract is unaffected. It is therefore more difficult for bad borrowers to profitably obtain funds in the pooling regime as the cost of pooling increases relative to separating, and lending standards tighten. On the contrary, in the absence of

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<sup>2</sup>Naturally, for extreme levels of macroprudential requirement banks are disintermediated both in separating and pooling contracts at which point lending standards are the tightest.

non-banks, the separating contract offered by banks also becomes more expensive with stricter regulation and, thus, the pooling contract is competitive for lower levels of credit demand. As we establish in the second result described above, lending standards do again tighten with stricter regulation, but less intensely than in the presence of non-banks.

Note that this fourth result relies on the fact that non-banks can more easily compete in separating contracts, which is very intuitive once one realizes that banks have a relative advantage in pooling contracts given that non-banks can use collateral to separate good from bad borrowers as efficiently as banks can. If, instead, non-banks could more easily compete in pooling contracts, the result would be reversed and lending standards would deteriorate with stricter macroprudential regulation. Yet, this cannot happen in our framework.

Our fifth and final result concerns the optimal macroprudential capital requirement in economies without and with non-banks. We consider a social planner that chooses bank capital requirements trading off the costs and benefits of tight versus loose standards. In particular, tight standards, through screening, reduce the number of negative NPV projects that are funded in equilibrium. However, more overall collateral is needed to screen, which raises the cost of inefficient liquidation. We show that non-bank competition constrains the planner's ability to set macroprudential capital requirements in the sense that the optimal macroprudential capital requirement is never higher when non-banks are present than when they are absent. The reason is that the planner generally favors screening out negative NPV projects, which can be achieved by tightening capital requirements. At the same time, capital requirements do not impact the separating contracts non-banks offer once they can compete, which require more collateral and, thus, imply higher liquidation costs. Hence, the planner would like to induce more screening by raising capital requirements, but cannot do so as effectively when non-banks offer separating contracts.

We should note that our model for non-banks can be of independent interest to the literature on financial intermediation and can encompass a wide variety of non-bank financial institutions, such as finance companies, insurance companies, mutual funds, hedge funds, etc. Our theory rests on the fact that non-banks have the incentive to risk-shift, but the assets they can invest in are illiquid. Hence, there is a moral hazard problem on the

asset choice and potentially run risk on the liabilities. The moral hazard from risk-shifting can be addressed by holding equity capital, but critically the type of debt the market imposes on non-banks depends on whether equity is contractible. For example, when equity is contractible, a combination of long-term debt and equity eliminates both run risk and addresses the moral hazard problem similar to Holmström and Tirole (1997). Contracting on equity is important because non-banks could issue dividends or repurchase shares after raising debt, reducing their skin in the game, which would encourage risk-shifting. In such a situation, a covenant in long-term debt would be triggered, accelerating repayment and allowing creditors to possess the firm in the extreme. Alternatively, if equity is not contractible, then a fragile funding structure of runnable debt restores incentives to prevent risk-shifting as non-banks would maintain a sufficient level of equity as in Diamond and Rajan (2000). Note that the moral hazard and illiquidity problems are also present for banks, but are resolved by two regulatory interventions: deposit insurance and capital requirements.

Our results have important implications for the effect that macro-prudential policy regimes currently in place across many central banks, such as countercyclical capital buffers, have on lending standards and credit extension. Countercyclical capital buffers, designed to increase regulatory bank capital during an expansion, actually strengthen lending standards not only in financial systems where most lending is concentrated in the regulated banking sector, but also in financial systems where non-banks aggressively compete with banks. In the latter, while activity will emigrate to non-banks and can erode banking profits, the shift in activity is not necessarily the *cause* of weaker lending standards. Additionally, the model's cross-section prediction is that optimal macroprudential capital requirements should be lower in jurisdictions with strong non-bank competition in lending markets than in places where the banking system is the dominant source of intermediated credit.

*Related Literature.* Our paper contributes to the literature on bank lending standards starting with Dell'Ariccia and Marquez (2006). We introduce a moral hazard problem and non-bank competition into this framework. Ruckes (2004) studies how bank lending stand-

ards vary over the business cycle. In his model, average borrower quality generally improves during expansions, creating more bank competition and lower loan prices. This results in less bank screening intensity and lower standards as higher risk borrowers obtain loans. In our model, changes in lending standards come from the interaction of capital requirements and non-bank competition when average borrower quality is held fixed. Gormley (2014) studies how lender entry influences aggregate credit extension and output when new lenders can “cream skim.” Banks screen borrowers by investing in a costly technology. In our model, lenders design contracts to separate borrowers, hence new entrants cannot cream skim.<sup>3</sup> Relatedly, Dell’Ariccia and Marquez (2004) study the effect of acquiring private information on loan portfolio quality on borrower capture. Inside information essentially gives banks market power making it difficult for borrowers to obtain financing from outside lenders.

More recently, Martinez-Miera and Repullo (2018) use a different framework to study a similar question. In their model, financial institutions make an observable monitoring decision that can affect the probability of a project’s success. They show that capital structure impacts both monitoring incentives and the moral hazard problem through costly capital certification. Our paper differs because we focus on the choice of financial institutions to design contracts that screen and separate borrowers and we do not endogenously derive the emergence of non-banks. Instead our focus is on the how regulation affects the competition between banks and non-banks and how that impacts lending standards.

Several recent papers study lending standard dynamics, but none of them consider the effects of regulation and non-bank competition on credit market outcomes. In particular, Fishman, Parker and Straub (2019) use a similar monitoring technology to Martinez-Miera and Repullo (2018) to study how screening intensity dynamically affects the quality of the borrower pool. Farboodi and Kondor (2019) study how sentiment affects credit outcomes where sentiment is modeled as a lender choice to use tests to determine borrower quality. The quality of the borrower pool endogenously fluctuates with standards generating credit cycles. Gorton and Ordonez (2019) and Asriyan, Laeven and Martin (2018) study how the

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<sup>3</sup>In this sense, we adopt the contract design approach to lending standards where lenders use collateral and other non-price terms to screen borrowers (Bester (1985), Gale and Hellwig (1985), Besanko and Thakor (1987)).

use of collateral in lending contracts affects information acquisition and the emergence of boom-bust cycles.

Finally, our paper is related to the emerging literature on the role of non-bank financial institutions. Donaldson, Piacentino and Thakor (2019) 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 (2020) study the impact of FinTech competition in payment services on bank profitability and loan quality when information externalities accrue to banks. Banks are informed relative to FinTech entrants as in our model, but they do not consider capital structure differences and endogenous lending standards. Plantin (2014) studies optimal liquidity regulation under regulatory arbitrage by banks, while Harris, Opp and Opp (2017) study how different microprudential regulation costs affect non-bank competition in a general equilibrium setting. Luck and Schempp (2014) and Ari, Kok, Darracq-Paries and Zochowski (2019) study how the endogenous emergence of banks and non-banks affect financial stability. We contribute to this literature by explicitly examining how capital regulation and non-bank competition affects lending standards, and by proposing a new way to model non-bank financial institution as described above.

The rest of the paper is organized as follows. Section 2 presents the model with just banks and establishes how capital requirements affect bank competition and lending standards. Section 3 introduces non-banks and shows the conditions under which they are able to compete with banks by loosening their lending standards. Section 4 shows how lending standards can vary over the cycle in responses to counter-cyclical capital requirements. Section 5 discusses the welfare implications and derives the optimal regulation. 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 only banks are present. Non-banks are introduced in section 3. As mentioned, the model builds on the bank lending

standards model of Dell’Ariccia and Marquez (2006), but features additional frictions to obtain a meaningful distinction between banks and non-banks, and introduces a role for micro- and macro-prudential capital regulation.

## 2.1 Time, Uncertainty, and Agents

Consider an economy with two time periods,  $t = 0, 1$ . Time 0 is broken into a three-stage game that is described below where all of the action takes place. For now, there are two types of agents that populate the economy (later, a third type of agent is introduced called a non-bank). We call the first type of agents entrepreneurs or firms. We refer to the second type as banks. Both firms and banks have a discount factor of one.

Suppose there is a continuum of firms given by the mass  $1 + \lambda$ , each of which has an end of period wealth given by  $W$  that is sufficient to meet any collateral requirement. Each firm is endowed with a risky production technology that transforms \$1 of input at  $t = 0$  into a random output at  $t = 1$ . This technology can be terminated early at any point between  $t = 0$  and  $t = 1$  yielding  $\xi \in (0, 1)$ . Firms differ in their technology endowment. In particular, a successful good project produces  $y = G$  while bad projects produce  $y = B$ ; 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 projects when successful, i.e.,  $B > G$ , but they have 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  $\alpha$  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 entrepreneurs. 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  $(R_k^j, C_k^j)$ ,  $j = \{G, B\}$ ,  $k = \{S, P\}$  where  $R_k^j$  is the face value of the debt for firm  $j$  in either separating or pooling equilibrium  $k$ .  $C_k^j$  is the corresponding required collateral, which banks can foreclose if projects fail. We use the typical assumption that banks only obtain a fraction of posted collateral upon project failure given by  $\kappa C$  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.<sup>4</sup> In stage two, 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 three, banks may reject loan applicants.<sup>5</sup> Debts are repaid or collateral is foreclosed, and agents consume at  $t = 1$ .

All entrepreneurs are risk-neutral and maximize expected profits. Entrepreneurs will consider the loan contract  $(R^i, C^i)$  if expected profits are positive, i.e.,

$$p_i(y - R^i) - (1 - p_i)C^i \geq 0; \text{ for } i = G, B. \quad (1)$$

## 2.2 Banks, Risk-shifting and Microprudential Capital Requirements

Banks fund the loans to entrepreneurs 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

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<sup>4</sup>As we will show in detail, banks will default in the bad state for most parameters values even if  $\kappa \rightarrow 1$  for all admissible capitalization levels. For some other parameters, this requires that  $\kappa$  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 (2020) find that the U.S. industry average recovery rate for PPE is only 35%.

<sup>5</sup>As in Dell'Ariccia and Marquez (2006), 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.

option of the latter is a riskless technology with zero net yield, while the former demand a gross expected 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 are demandable claims which specify an uncontingent gross payment  $D' \geq 1$  at withdrawal.

### 2.2.1 Deposit insurance

As firm projects are illiquid, i.e,  $\xi < 1$ , a coordination failure may induce all depositors to withdraw their deposits early before projects mature at  $t = 1$ .<sup>6</sup> Similar to much of the literature following Diamond and Dybvig (1983), we resolve the coordination problem by introducing deposit insurance, such that banks can raise fully insured deposits at a cost  $D' = 1$ , i.e., equal to the riskless gross return required by outside investors. Moreover, the deposit insurance premium is imperfectly priced, in other words, it is not a function of each bank's loan portfolio. As a result, deposit funding is insensitive to risk and banks can raise deposits at a gross cost  $D = D' + ip$ , where  $ip$  is the insurance premium. Because  $D$  is not a function of the type of project banks fund, and due to limited liability, banks have an incentive to take excessive risk. The same regulator that insures deposits can eliminate the risk-taking behavior by setting a high enough equity capital requirement, denoted by  $\gamma$ , such that banks have enough skin in the game. We call these requirements "microprudential" capital requirements.

Below we derive the optimal microprudential capital requirement, denoted by  $\bar{\gamma}$ , set at time 0 to prevent banks from risk-shifting. Risk-shifting occurs when banks use fully insured deposits to make loans to bad, negative NPV, firms.

Note that deposit insurance is inconsequential when banks finance with 100% equity. We make the following assumption to preclude all equity-financed banks.

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<sup>6</sup>Similar to Kashyap, Tsomocos and Vardoulakis (2020), we assume that banks have the ability to recall loans to pay early withdrawals, in which case entrepreneurs surrender their projects and are free of any other contractual obligation. Then,  $\xi$  is the liquidation value of projects or equivalently  $1 - \xi$  is the cost of termination. Alternatively, we could assume that  $\xi$  is the resale price of loans to outside investors. Given that the face value of loans is one,  $1 - \xi$  can be considered as the discount of selling loans in secondary markets. The exact microfoundations for  $\xi$  are not important for our environment, because runs will never occur in equilibrium. But, their possibility justifies the introduction of deposit insurance for banks and high enough market-based capital ratios for non-banks (see section 3 for details).

**Assumption 1**  $E > p_G G$ .

Under assumption 1, banks will raise some  $\epsilon$  fraction of funds from deposits with full insurance and may have the incentive to only fund bad projects.

### 2.2.2 Risk-shifting

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.,  $\gamma = 0$ . Define by  $R^G$  the maximum face value, or equivalently, gross loan rate that banks can charge known good borrowers without losing them to competing banks. The gross loan rate offered to bad firms,  $R^B$ , needs to satisfy the following three conditions. First, it should be individually rational for bad firms to borrow, i.e.,  $B \geq R^B$ . Second, it should not be individually rational for good types to borrow, i.e.,  $R^B > G$ .<sup>7</sup> Third, risk-shifting should be individually rational for banks, i.e., profits should be higher or,  $R^B > (p_G/p_B)(R^G - D) + D$ . In addition, bad projects have negative NPV, i.e.,  $p_B R^B \leq p_B B < 1$ , which in combination with the previous condition yields  $p_G R^G - (p_G - p_B) D < 1$ . Combining the latter two conditions with  $R^B \leq B$  and  $R^G \leq G$ , we derive the following assumption needed to obtain risk-shifting as the only equilibrium when capital requirements,  $\gamma$ , are zero.

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

### 2.2.3 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  $\gamma$  high enough such that the profits 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 deposits only when the projects succeed because of limited liability. The microprudential capital

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<sup>7</sup>If both good and bad firms are willing to borrow at the offered rate, we obtain a pooling equilibrium which will be examined below.

requirement,  $\bar{\gamma}$ , that prevents risk-shifting in equilibrium is given by

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

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, i.e.,  $p_G[R^G - (1-\bar{\gamma})D] \geq \bar{\gamma}E$ . Hence, the minimum gross loan rate to known good borrowers that makes banks break-even under microprudential capital requirements is given by

$$R(\bar{\gamma}) \equiv \bar{\gamma} \frac{E-p_G D}{p_G} + D. \quad (3)$$

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

**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. In presence of deposit insurance, the microprudential capital requirement that prevents risk-shifting is given by (2).*

### 2.3 Equilibrium with Banks

Similar to Dell’Ariccia and Marquez (2006), 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; borrowers cannot coordinate on contracts that provide negative returns to banks because they will be rejected. At stage 2, banks will offer their known good borrowers the contract  $(R^G, 0)$  which makes them just 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 the equilibrium debt contract pools all unknown borrowers 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  $(R_s^j, C_s^j)$ . Banks use a menu of contracts to attract only good borrowers subject to incentive compatibility (IC) and individual rationality constraints (IR). The following IC constraints ensure that the contract designed for good (bad) firms does not give higher profits to bad (good) firms should they choose to mimic:

$$\begin{aligned} p_G (G - R^G) - (1 - p_G) C^G &\geq p_G (G - R^B) - (1 - p_G) C^B \\ p_B (B - R^B) - (1 - p_B) C^B &\geq p_B (B - R^G) - (1 - p_B) C^G \end{aligned}$$

The IC constraint for bad types above boils down to their IR constraint,  $0 \geq p_B (B - R^G) - (1 - p_B) C^G$ , because they are offered no other contract under microprudential capital requirements (see Proposition 1 above). In addition, perfect competition among banks drives expected profits to zero on the contract they offer to good borrowers. As a result, the separating loan contract, offered to both  $G$  and  $B$  borrowers, is determined by the binding IR constraints of bad borrowers and banks, i.e.,

$$p_B (B - R_s) - (1 - p_B) C_s = 0 \tag{4}$$

$$p_G (R_s - (1 - \bar{\gamma}) D) + (1 - p_G) \max \{(\kappa C_s - (1 - \bar{\gamma}) D), 0\} = \bar{\gamma} E, \tag{5}$$

while the IC constraint of good borrowers will be non-binding.

Due to limited liability, the second term in (5) cannot be negative; we show in the proof

of Proposition 2 that it will be zero in equilibrium, i.e.,  $\kappa C_s < (1 - \bar{\gamma})D$ , under sufficiently low  $\kappa$ , which can be as high as one for most parameterizations. Consequently, banks' expected profits are not affected by using costly collateral to screen out bad borrowers leaving the equilibrium contract offered to good borrowers the same at stages 1 and 2. The gross loan rate in the separating allocation is, thus, given by  $R_s = R(\bar{\gamma})$  in (3). Thus, good borrowers face higher repayment rates in separating allocations due to the capital requirements that curb risk-shifting incentives. The optimal repayment value and collateral requirement is the solution to the IR and Zero profit equation system above. 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** *Under the microprudential capital requirement  $\bar{\gamma}$  given by (2) and for sufficiently high foreclosure costs, the loan contract that banks offer is characterized by gross loan rate  $R_s = \bar{\gamma}E/p_G + (1 - \bar{\gamma})D$  and collateral  $C_s = [p_B/((1 - p_B)p_G)][p_GB - (\bar{\gamma}E + (1 - \bar{\gamma})Dp_G)]$ .*

We now proceed to derive the condition for a separating equilibrium. A separating allocation is an equilibrium when no bank can offer an alternative contract in which all borrowers are pooled and can make positive profits (Rothschild and Stiglitz, 1976). Define the alternative pooling contract as  $(R_p, 0)$ . The pooling contract does not use collateral to screen because collateral is costly and the contract must be accepted by all borrowers. The repayment amount must be set low enough to lure good borrowers away from the separating contract; otherwise, it will not be profitable, in expectations, to banks. In particular, the gross loan rate,  $R_p$ , must satisfy  $p_G(y - R_p) > p_G(y - R_s) - (1 - p_G)C_s$ , which yields:

$$R_p < R_s + \frac{1 - p_G}{p_G}C_s. \quad (6)$$

In addition, the bank offering the pooling contract has to break even. Given that in pooling allocations, it funds all unknown borrowers and the known bad borrowers other

banks reject, breaking even requires:

$$\begin{aligned} \lambda p_\mu [R_p - (1 - \bar{\gamma}) D] + (1 - \alpha) \frac{N-1}{N} p_B [R_p - (1 - \bar{\gamma}) D] &\geq \bar{\gamma} E \left[ \lambda + (1 - \alpha) \frac{N-1}{N} \right] \geq 0 \\ \Rightarrow R_p &\geq \frac{(1 - \alpha) \frac{N-1}{N} [\bar{\gamma} E + (1 - \bar{\gamma}) D p_B] + \lambda [\bar{\gamma} E + (1 - \bar{\gamma}) D p_\mu]}{\lambda p_\mu + (1 - \alpha) \frac{N-1}{N} p_B}. \end{aligned} \quad (7)$$

Conditions (6) and (7) provide the necessary and sufficient conditions for the separating allocation to constitute an equilibrium:

$$\frac{(1 - \alpha) \frac{N-1}{N} [\bar{\gamma} E + (1 - \bar{\gamma}) D p_B] + \lambda [\bar{\gamma} E + (1 - \bar{\gamma}) D p_\mu]}{\lambda p_\mu + (1 - \alpha) \frac{N-1}{N} p_B} \geq R_s + \frac{1 - p_G}{p_G} C_s. \quad (8)$$

Equation (8) intuitively states that a separating equilibrium is stable as long as the break-even pooling rate that a deviating bank can offer is higher than the break-even separating rate. Notice that equation (8) links the severity of the adverse selection problem—mass of unknown borrowers,  $\lambda$ —to the existence of the separating equilibrium. In particular, equilibrium is always separating when all borrowers in the economy are known,  $\lambda \rightarrow 0$ .<sup>8</sup> The intuition is that when there are no unknown borrowers, the pooling contract only attracts competitor banks' known bad borrowers with negative NPV projects.

Alternatively, as the pool of unknown borrowers grows large, i.e.,  $\lambda \rightarrow \infty$ , the information asymmetry between competing banks becomes essentially irrelevant because all borrowers are effectively unknown to all banks. It may be profitable to deviate from the separating allocation to pooling depending on the value of  $\lambda$ . More precisely, the equilibrium is a function of  $\lambda$  when the following condition is satisfied:

$$\frac{\bar{\gamma} E}{p_\mu} + (1 - \bar{\gamma}) D < R_s + \frac{1 - p_G}{p_G} C_s. \quad (9)$$

If (9) holds, a stable separating equilibrium exists for  $\lambda$  below some threshold  $\bar{\lambda}$ . Note that condition (9) depends on the average borrower quality among types,  $\alpha$ . In particular, the equilibrium strategy profile is to never deviate from a separating equilibrium as  $\alpha \rightarrow 0$ .

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<sup>8</sup>The necessary and sufficient condition for (8) to hold as  $\lambda \rightarrow 0$  is  $p_G > p_B$ .

Alternatively, deviations are always profitable for  $\alpha \rightarrow 1$  irrespective of the value of  $\lambda$ . Intuitively, banks always choose to separate borrowers when only bad types exist ( $\alpha \rightarrow 0$ ) because they essentially extend credit exclusively to negative NPV projects under pooling. By contrast, when only good types exist, separating borrowers is no longer the optimal strategy because collateral requirements are costly and unnecessary. Thus, there will be a threshold proportion of good borrowers in the economy,  $\bar{\alpha}$ , above which the mass of unknown borrowers affects the choice between separating and pooling. The following proposition derives the thresholds  $\bar{\alpha}$  and  $\bar{\lambda}$  and characterizes the stable separating equilibrium.

**Proposition 3** *There exists  $\bar{\alpha} > 0$  such that condition (9) holds. The equilibrium pure-strategies satisfy the following: i) if  $\alpha < \bar{\alpha}$  banks offer unknown borrowers the unique separating contract  $(R_s, C_s)$ ; ii) for  $\alpha > \bar{\alpha}$ , there exists  $0 < \bar{\lambda} < \infty$  such that banks offer unknown borrowers the unique separating contract  $(R_s, C_s)$  when  $\lambda \leq \bar{\lambda}$ ; iii) there is no separating equilibrium if and only if  $\alpha > \bar{\alpha}$  and  $\lambda > \bar{\lambda}$ .*

Note that neither known or unknown bad borrowers receive credit in the separating equilibrium. Moreover, known good borrowers receive the contract  $(R_s^G, 0)$  that makes them just indifferent between the contract with 0 collateral and the separating contract offered to unknown borrowers at stage 1 of the game. It is straightforward to show that the loan rate for known good borrowers is strictly greater than the loan in the separating contract. In fact, the difference in the repayment amount represents the economic rent that banks extract from their known good borrowers and is given by

$$R_s^G - R_s = \frac{1 - p_G}{p_G} C_s. \quad (10)$$

### 2.3.2 Pooling Equilibrium with banks

The pooling allocation is trivially determined by the same conditions that prevent the existence of the separating allocation. In particular, in the pooling equilibrium banks offer

all firms the same contract defined by the break-even condition (7) set to equality:

$$R_p = \frac{(1 - \alpha) \frac{N-1}{N} [\bar{\gamma}E + (1 - \bar{\gamma}) Dp_B] + \lambda [\bar{\gamma}E + (1 - \bar{\gamma}) Dp_\mu]}{\lambda p_\mu + (1 - \alpha) \frac{N-1}{N} p_B}. \quad (11)$$

**Proposition 4** *If condition (9) holds, then for  $\lambda > \bar{\lambda}$  the unique equilibrium pure-strategy profile is the pooling allocation given by  $(R_p, 0)$ .*

When condition (8) fails, there is a pooling contract that good types prefer to the zero-profit separating contract. Hence, any bank that chooses to deviate and offer the pooling contract will make positive expected profits. As a result, the separating allocation cannot exist. Moreover, the pooling strategy is a stable equilibrium itself. To see this, assume that a bank decides to deviate from the pooling contract and offer contract  $(R'', C'')$ , which is preferred by good borrowers. i.e.,  $R'' + [(1 - \pi_G)/\pi_G]C'' < R_p$ , but not by bad borrowers, i.e.,  $R'' + [(1 - \pi_B)/\pi_B]C'' > R_p$ . Then, 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. If the “cream-skimming” contract is offered by one bank, then all other banks will observe it and decline to lend at the final stage, which means that both good and bad borrowers will coordinate on the “cream-skimming” contract. In turn, this would make the deviation unprofitable because the “cream-skimming” contract requires an above average borrower quality to be viable, which is impossible as it cannot separate good from bad borrowers. i.e.,  $C'' < C_s$  given by (8).

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  $1/N$  bad known borrowers 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 attract 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 (11).<sup>9</sup>

### 2.3.3 Numerical Example

Before moving to the model with non-banks, we show the main results up to this point using a numerical example. We choose the following parameters values:  $p_G = 0.7$ ,  $p_B = 0.2$ ,  $G = 1.6$ ,  $B = 2.4$ ,  $E = 1.8$ ,  $D = 1$ ,  $\alpha = 0.95$ ,  $N = 10$ ,  $\kappa = 0.9$ , which satisfy assumptions 1-3. Then, the microprudential capital requirement in Proposition 1 is equal to  $\bar{\gamma} = 0.15$ , while the separating contract in Proposition 2 is  $(R_s, C_s) = (1.235, 0.241)$ , implying an effective rate of  $R_s + (1 - \pi_G)/\pi_G C_s = 1.339$ . The pooling rate for  $\lambda = 0$  and  $\lambda \rightarrow \infty$  are equal to 2.2 and 1.2, respectively. Hence, a pooling equilibrium exists for  $\lambda$  higher than the threshold in Proposition 3, which is equal to  $\bar{\lambda} = 0.129$ . In other words, an increase in loan demand or about 13% stemming from new borrowers of unknown quality suffices to induce banks to loosen their lending standards. Finally, note that our parameterization implies  $\bar{\alpha} = 0.704 < \alpha$ , otherwise, from Proposition 3, only a separating equilibrium would exist.

## 3 Model with Banks and non-banks

This section introduces non-bank financial intermediaries and shows how competition between banks and non-banks affects lending standards under microprudential capital regulation. We assume there are a large number of competitive non-banks, which can raise debt from the same outside investors that banks raise deposits at expected cost  $D' = 1$  and can also raise equity capital at the same cost,  $E$ , as banks. Yet, 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.

Banks and non-banks are quite similar at the core aside from the information advantage of the former. As already mentioned, the same moral-hazard and run-risk problems that

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<sup>9</sup>We refer the reader to Dell'Ariccia and Marquez (2006) for alternative arguments to show the stability of the pooling equilibrium as well as a discussion of the relevant literature.

were present for banks are also present for non-banks. The way they are resolved, however, is different. Resolving these issues for non-banks may seem as a daunting task involving a lot of institutional details. There is a large variety of non-banks financial institutions including finance companies, broker dealers, special purpose vehicles, open-ended mutual funds, closed-ended mutual funds, private equity funds, hedge funds, insurance companies among others. The capital structure of these institutions—central to our analysis—differs as some engage in more maturity transformation than others.

We present a theory of non-bank capital that can be applied to the diverse non-bank financial institutions mentioned above. The theory is based on the possibility of risk-shifting and loan illiquidity, and it predicts a market-determined capital structure and equity capital for non-banks. Equity capital is important such that non-banks have enough skin in the game to prevent them for engaging in risk-shifting. There is not new. But, depending on whether non-bank equity capital is contractible or not, it will interact with non-bank liabilities differently to jointly resolve the moral hazard and run risk problems. We consider the two cases separately and show how equity contractibility governs the runnability of non-banks' liabilities in the presence of moral hazard.

If the level of non-bank equity is contractible, then long-term debt can jointly eliminate the possibility of a run and address risk-shifting by mandating a level of equity capital as a covenant in the debt contract. Why does the contractibility of equity matter? The reason is that 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

$$\gamma^{NB} = \frac{p_B(B - D^{NB})}{E - p_B D^{NB}}, \quad (12)$$

where  $D^{NB} > 1$  is 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.

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.<sup>10</sup> In particular, we assume that the liquidation value  $\xi$  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 conditions:

$$\gamma^{NB'} E \geq p_B [B - (1 - \gamma^{NB'}) D^{NB'}] \quad (13)$$

$$\xi \geq 1 - \gamma^{NB'}, \quad (14)$$

where  $D^{NB'}$  is the gross interest rate for late withdrawals. Condition (13) guarantees that

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<sup>10</sup>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 et al., 2020).

there will be no risk-shifting in equilibrium, while condition (14) 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  $\xi$  is higher than  $\bar{\xi} = \frac{E-p_B B}{E-1} < 1$ .*

The theory of the non-bank capital structure described above combines 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 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  $D^{NB} = D^{NB'}$ . The following proposition summarizes these results.

**Proposition 5** *The capital structure of non-banks consists of equity and long-term debt if the equity choice is contractible, and of equity and demandable risky debt otherwise. Given assumption 4, the level of equity is the same in both cases for the same loan portfolio and is given by (12), where  $D^{NB}$  is the repayment amount on long-term debt or the amount due for late withdrawals on demandable debt.*

A direct corollary of Propositions 1 and 5 is that the market-based equity ratio for non-banks is lower than the microprudential capital requirement for banks as long as  $D^{NB} > D$ . The cost of debt for non-banks incorporates a default premium, while the effective cost of deposits incorporates an insurance premium set by the regulator. For unpriced deposit insurance, i.e., for insurance premium lower than the endogenously determined default premium,  $\gamma^{NB} < \bar{\gamma}$ . In other words, non-banks can take more leverage than banks, but need to pay a higher interest rate for their debt than what banks pay for deposits.

This result has implications for the weighted average cost of capital of non-banks and their ability to compete with banks. We now turn to the loan portfolio choice of non-banks and whether they can compete by offering a separating or pooling contract.

### 3.1 Separating Equilibrium with Non-Banks

Can non-banks offer a separating contract 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 will require to provide debt to non-bank, while breaking even (recall they require  $D' = 1$  in expectation), is

$$D_s^{NB} = \frac{D'(1 - \gamma^{NB}) - \kappa C_s(1 - p_G)}{p_G(1 - \gamma^{NB})}. \quad (15)$$

Then, the market-based non-bank capital for a separating loan portfolio,  $\gamma_s^{NB}$  is given by substituting (15) in (12).

Moreover, using (15) and  $D = 1 + IP$ , we can derive the fair insurance premium equating the expected cost of non-bank debt and bank deposits for separating contracts:

$$IP_s^f = \frac{(1 - p_G)}{p_G} \left( D - \frac{\kappa C}{1 - \bar{\gamma}} \right). \quad (16)$$

As long as the insurance premium is lower than  $IP_s^f$ ,  $D_s^{NB} > D$  and  $\gamma_s^{NB} < \bar{\gamma}$ . Without loss of generality and for simplicity, we will assume that  $IP = 0$ .

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

$$E(\bar{\gamma} - \gamma_s^{NB}) > p_G [(1 - \gamma_s^{NB}) D_s^{NB} - (1 - \bar{\gamma}) D]. \quad (17)$$

The left hand side of (17) is the advantage that non-banks have from lower equity cost. The right hand side is the non-bank disadvantage from higher debt financing costs. Using

(12) and (2), it can be shown that the inequality implies a contradiction as long as  $p_G > p_B$ , 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  $p_B$ . The result generalizes for  $IP \in (0, IP_s^f)$ , but the algebra is more cumbersome.

### 3.2 Pooling Equilibrium with Non-Banks

Can non-banks offer a pooling contract to compete with banks? Recall that the pooling contract banks offer 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 when they offer pooling contracts,  $(1 - \alpha)$ , 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 non-bank debt given a pooling non-bank portfolio,  $D_p^{NB}$ , such that they break even with their outside option  $D' = 1$ , i.e.,

$$D_p^{NB} = D' \frac{1 - \alpha + \lambda}{(1 - \alpha)p_B + \lambda p_\mu}, \quad (18)$$

where  $D_p^{NB}$  is the cost of non-bank debt for a pooling portfolio strategy. The first term in the denominator is the repayment probability from funding all bank borrowers known to be bad (as before banks will keep their known good borrowers by offering a more competitive contract in stage 2 of the game). The second term is repayment probability from funding all unknown borrowers. Using (18) and  $D = 1 + IP$ , we can derive the fair insurance premium equating the cost of non-bank debt and bank deposits for pooling contracts:

$$IP_p^f = \frac{1 - (1 - \alpha)p_B - \lambda p_\mu}{(1 - \alpha)p_B + \lambda p_\mu}. \quad (19)$$

Then, the market-based non-bank capital for a pooling loan portfolio,  $\gamma_p^{NB}$ , is given by

substituting (18) in (12). The corresponding capital requirement for the pooling regime is,  $\bar{\gamma}_p^{NB} (D_p^{NB})$ , and is given by (12).

The best pooling contract that non-banks can offer while breaking even is

$$R_p^{NB} = \frac{(1 - \alpha) [\bar{\gamma}_p^{NB} E + (1 - \bar{\gamma}_p^{NB}) D_p^{NB} p_B] + \lambda [\bar{\gamma}_p^{NB} E + (1 - \bar{\gamma}_p^{NB}) D_p^{NB} p_\mu]}{\lambda p_\mu + (1 - \alpha) p_B}. \quad (20)$$

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 (11) determines whether non-bank competition is feasible. It is straightforward to show that  $\lim_{\lambda \rightarrow 0} (R_p - R_p^{NB}) < 0$  and  $\lim_{\lambda \rightarrow \infty} (R_p - R_p^{NB}) < 0$ . There are two reasons for these results. First, non-banks have an information disadvantage and charge a higher loan rate 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, similarly to the separating contracts, the underpriced deposit insurance,  $IP < IP_p^f$ , 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  $\frac{\partial R_p^{NB}}{\partial \lambda}, \frac{\partial R_p}{\partial \lambda} < 0$ , which means 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 6** *Under the microprudential capital requirements for banks in Proposition 1 and the market-based capital ratios for non-banks in Proposition 5, non-banks cannot compete with banks in any equilibrium allocation and lending standards are unaffected.*

Note that under fairly priced deposit insurance, banks and non-banks have the same overall cost of 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  $IP = 0$  is without loss of generality.

### 3.3 Numerical Example Continued

Recall that the separating contract banks offer is  $(R_s, C_s) = (1.235, 0.241)$ . The cost of non-bank debt and non-bank equity ratio for this separating portfolio strategy are  $D_s^{NB} = 1.413$  and  $\gamma_s^{NB} = 0.1038$ , using (15) and (12). Then, the minimum loan rate non-banks can competitively offer is equal to  $\gamma_s^{NB}E/p_G + (1 - \gamma_s^{NB})D_s^{NB} = 1.533 > R_s$ , implying that non-banks cannot compete in separating contracts. For a pooling portfolio strategy, the cost of non-bank debt and non-bank equity ratio depend on the value of  $\lambda$ . For the threshold,  $\bar{\lambda} = 0.129$ , banks switch from separating to pooling,  $D_p^{NB} = 1.884$ ,  $\gamma_p^{NB} = 0.050$ , and the minimum pooling rate non-banks can competitively offer is equal to 1.917 using (20) and (12). For  $\lambda \rightarrow \infty$ ,  $D_p^{NB} = 1.482$ ,  $\gamma_p^{NB} = 0.096$ , and the minimum pooling rate non-banks can competitively offer is equal to 1.596. Both non-bank pooling rates are higher than the respective pooling rates offered by banks for  $\lambda = \bar{\lambda}$  and  $\lambda \rightarrow \infty$ , which are equal to 1.339 and 1.2, respectively. Hence, in addition to non-banks being unable to compete through separating contracts, they are cannot compete with banks under pooling contracts.

## 4 Macprudential Capital Requirements

Sections 3.1 and 3.2 show that the threat of non-bank competition alone does not alter equilibrium lending standards under the microprudential capital requirement in Proposition 1. Banks have both a funding advantage over non-banks due to deposit insurance and an information advantage due to their pre-existing relationships with borrowers. However, if the capital requirement for banks increases beyond its microprudential level, the cost advantage of banks may start to erode and non-banks may be able to compete with them. Higher capital requirements can be justified by macroprudential considerations, such as minimizing the aggregate loss of resources from funding negative net present value projects. Sections 4.1 and 4.2 below derive the effect of exogenously setting macroprudential capital requirements on lending standards with and without non-bank presence. Section 5 provides

microfoundations for macroprudential capital requirements and derives the optimal level.

#### 4.1 Macroprudential Regulation and Banks

Let the macroprudential capital requirement be exogenously given by  $\gamma \in (\bar{\gamma}, \gamma_{max})$ , and assume that non-banks are not present in the economy.<sup>11</sup> Even so, macroprudential requirements will increase the cost of funding for banks and, thus, affect the nature of competition among banks and the determination of lending standards.

First, we examine how increasing  $\gamma$  affects the contractual terms in separating allocations. Replacing  $\bar{\gamma}$  with  $\gamma$  in Proposition 2, the separating contract terms as a function of general  $\gamma$  can be written as  $R_s(\gamma) = \gamma E/p_G + (1-\gamma)D$  and  $C_s(\gamma) = [p_B/((1-p_B)p_G)][p_GB - (\gamma E + (1-\gamma)Dp_G)]$ . Taking the derivatives with respect to  $\gamma$  results in the following Proposition.

**Proposition 7** *Consider the separating loan contract  $(R_s(\gamma), C_s(\gamma))$ . Then,  $\partial R_s(\gamma)/\partial \bar{\gamma} > 0$ ,  $\partial C_s(\gamma)/\partial \bar{\gamma} < 0$ , and  $\partial[R_s(\gamma) + [(1-p_G)/p_G]C_s(\gamma)]/\partial \gamma > 0$ .*

Hence, loan rates are increasing in capital requirements, but the collateral requirement is decreasing. The intuition is that the cost of higher capital requirements are passed on to borrowers through higher loan rates. But, higher loan rates raise the profitable hazard rate for bad projects, which tightens bad borrowers' individual rationality constraint (4), making it easier for banks to separate good from bad borrowers. The resulting collateral requirement is loosened to keep competing banks from poaching known good borrowers. However, the effective borrowing cost for good firms,  $R_s(\gamma) + [(1-p_G)/p_G]C_s(\gamma)$ , is increasing in  $\gamma$ .

We now turn to how macroprudential capital requirements impact lending standards by changing the thresholds  $\bar{\alpha}$  and  $\bar{\lambda}$  derived in Proposition 2. Similarly, replace  $\bar{\gamma}$  with  $\gamma$  to get the pooling rate derived in Proposition 4 as a function of macroprudential capital requirements, i.e.,  $R_p(\gamma)$ . The results are summarized in the following Proposition.

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<sup>11</sup>The maximum requirement  $\gamma_{max}$  is such that it is profitable for banks to offer a separating contract that will be accepted by good borrowers. In other words, the effective rate on a separating contract is not higher than the payoff of the good project, i.e.,  $G = R_s(\gamma_{max}) + [(1-p_G)/p_G]C_s(\gamma_{max})$ . See below for a detailed derivation of separating contract terms under general macroprudential capital requirement  $\gamma$ .

**Proposition 8** *Absent non-bank competition, macroprudential capital requirements tighten lending standards by increasing the domain over which the equilibrium strategy profile is the separating contract  $(R_s(\gamma), C_s(\gamma))$  relative to the pooling contract  $(R_p(\gamma), 0)$ . Specifically,  $\partial\bar{\alpha}(\gamma)/\partial\gamma > 0$  and  $\partial\bar{\lambda}(\gamma)/\partial\gamma > 0$ .*

A higher  $\gamma$  makes pooling less attractive, which manifests as an increase in the equilibrium value of  $\bar{\alpha}$ . Intuitively, macroprudential capital requirements increase intermediation costs and, in conjunction with the fact that pooling all borrowers attracts unknown bad borrowers rejected by other banks, generates losses. Consequently, the quality of the average borrower in the pool of applicants must be higher if banks are to fund all projects with low lending standards, even when the adverse selection problem between banks is eliminated (recall that  $\bar{\alpha}$  is defined for  $\lambda \rightarrow \infty$ ).

In addition, for  $\alpha > \bar{\alpha}$ , increasing  $\gamma$  makes it more likely that banks screen borrowers and thus raise lending standards, i.e.,  $\bar{\lambda}$  goes up. As shown in Proposition 7, screening with separating contracts is more expensive as the effective borrowing cost goes up. Yet, Proposition 8 shows that the borrowing cost under pooling contracts increases even further, requiring a higher credit demand such that banks cease to screen and lend to bad borrowers as well. The reason is that macroprudential regulation requires banks to hold more equity capital not only against their loans to good borrowers, but also against the loans to bad borrowers making pooling relatively more expensive for given loan demand.

## 4.2 Macroprudential Regulation and Non-banks

Having established that macroprudential regulation unambiguously improves lending standards when only banks are present, we turn to how non-bank competition affects this result.

We know from Proposition 6 that non-banks cannot compete under the microprudential capital requirement  $\bar{\gamma}$ . By continuity, there exists  $\gamma > \bar{\gamma}$  such that non-banks continue to be unable to compete with banks and lending standards are determined as in Proposition 8. However, macroprudential 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.

The crucial point that determines how lending standards are affected is whether non-banks start competing first in separating or pooling contracts as macroprudential requirements tighten. Recall that lending standards are determined by the threshold for  $\lambda$  where the economy switches from a separating to a pooling equilibrium. If non-banks start competing first in pooling contracts, they will eventually push lending standards down. The reason is that the cost for banks of offering a separating contract, to compete with non-banks pooling contract, goes up with macroprudential regulation, while non-banks funding costs are unaffected. On the contrary, if non-banks start competing first in separating contracts, lending standards may tighten with macroprudential regulation. The reason is that it is costlier for banks to offer a pooling contract to compete with the separating contract offered by non-banks.

Hence, we focus on two thresholds for macroprudential capital requirements. The first threshold, denoted by  $\hat{\gamma}$ , indicates the level of bank capital requirement at which non-banks become able to compete with banks in separating contracts. The second threshold, denoted by  $\hat{\hat{\gamma}}$ , indicates the level of bank capital requirement at which non-banks start to become able to compete with banks in pooling contracts. We will show that  $\hat{\gamma} < \hat{\hat{\gamma}}$ , thus non-banks start competing first in separating contracts as macroprudential requirements increase.

Consider first the possibility that non-banks can compete through separating contracts, which happens for macroprudential regulation higher than  $\hat{\gamma}$ . Following the same steps as in Section 4.1,  $\hat{\gamma}$  is the solution to  $E(\hat{\gamma} - \gamma_s^{NB}) = p_G [(1 - \gamma_s^{NB}) D_s^{NB} - (1 - \hat{\gamma}) D]$ , or

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

where  $\gamma_s^{NB}$  and  $D_s^{NB}$  are given by (12) and (15) for  $\hat{C}_s = C_s(\gamma_s^{NB}) = [p_B / [(1 - p_B)p_G]] [p_G B - (\gamma_s^{NB} E + (1 - \gamma_s^{NB}) D_s^{NB} p_G)]$  (note that  $C_s(\gamma_s^{NB}) = C_s(\hat{\gamma})$ ). Solving for  $\gamma_s^{NB}$ ,  $D_s^{NB}$ , and  $\hat{C}_s$  jointly, we can substitute their values in (21) to get  $\hat{\gamma}$ . Any capital requirement set above that level allows non-banks to enter the loan market and compete with banks in separating contracts.

Now consider the possibility that non-banks can compete with banks through pooling

contracts that do not require collateral, which occurs for macroprudential requirements  $\gamma \geq \hat{\gamma}$ . The corresponding pooling contract that banks offer borrowers at  $\hat{\gamma}$ ,  $(\widehat{R}_p, 0)$ , must satisfy the following break-even condition:

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

What is the level of  $\lambda$  that non-banks will first be able to compete with banks in pooling contracts? In other words, will  $\hat{\gamma}$  equate  $\widehat{R}_p$  and  $R_p^{NB}$ , given by (22) and (20) respectively, for low or high  $\lambda$ ? As discussed in section 3.2, non-banks are at a disadvantage compared to banks at offering a pooling contract because they do not have private information and also because they do not enjoy a deposit insurance subsidy. When the demand for credit is at its maximum, i.e.,  $\lambda \rightarrow \infty$ , banks' information advantage is eliminated. Additionally, the cost advantage from deposit insurance is at its lowest level and which can be seen by the fact that  $D_p^{NB}$  is decreasing in  $\lambda$  and is at its minimum for  $D_p^{NB}|_{\lambda \rightarrow \infty} = D/p_\mu$  (or equivalently, the deposit insurance subsidy in (19) is decreasing in  $\lambda$ ). Hence, non-banks will first start competing with banks in pooling contracts for  $\lambda \rightarrow \infty$  as macroprudential capital requirements increase. In other words,  $\hat{\gamma}$  is determined by equating  $\widehat{R}_p$  and  $R_p^{NB}$  for  $\lambda \rightarrow \infty$  yielding

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

where  $\bar{\gamma}_p^{NB}$  is given by (12) for  $D^{NB} = D/p_\mu$ .

The following proposition ranks  $\hat{\gamma}$  and  $\hat{\hat{\gamma}}$ .

**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 underlying the result in Proposition 9 can be explained in the following way: the relative advantage of banks over non-banks accrues from the deposit insurance subsidy. For separating contracts, the subsidy is smaller the higher is the recovery value of collateral  $\kappa$ . For pooling contracts, as  $\lambda \rightarrow \infty$ , the subsidy is smaller the lower is the portion of bad borrowers, i.e. the higher  $\alpha$  is. Note that for  $\kappa \rightarrow 0$  and  $\alpha \rightarrow 1$ ,  $\hat{\gamma} = \hat{\hat{\gamma}}$ . As

$\kappa$  increases from zero,  $\hat{\gamma}$  decreases because the cost advantage from the deposit insurance subsidy that banks enjoy becomes smaller and, thus, it can be eroded with a smaller increase in macroprudential requirements. On the contrary, as  $\alpha$  decreases from one,  $\hat{\gamma}$  increases because the deposit insurance subsidy for banks becomes more important and, thus, a higher macroprudential requirement is needed to erode the cost advantage accruing from it.

Note that the information advantage banks possess does not play a role in Proposition 9 as it erodes for  $\lambda \rightarrow \infty$ . As macroprudential requirements continue to increase beyond  $\hat{\gamma}$ , the informational advantage of banks will start being depleted and non-banks will be able to compete in pooling contracts for even lower  $\lambda$ 's than that in Proposition 9.

Our next result shows that capital requirements in excess of  $\hat{\gamma}$  may dis-intermediate banks from funding any unknown borrowers, allowing non-banks to fund all unknown borrowers in the economy, for any  $\lambda$ . Define by  $\tilde{\gamma}$  the macroprudential requirement that allows non-banks to compete in pooling contracts for any  $\lambda$ , i.e.,  $R_p(\tilde{\gamma}, \lambda) \geq R_p^{NB}(\lambda)$  for all  $\lambda$ . Given that  $R_p(\tilde{\gamma}, \lambda)$  is increasing in  $\tilde{\gamma}$  and the difference between  $R_p$  and  $R_p^{NB}$  is decreasing in  $\lambda$  Proposition 6,  $\tilde{\gamma}$  is given by,

$$\begin{aligned} & \frac{(1 - \alpha) \frac{N-1}{N} [\tilde{\gamma}E + (1 - \tilde{\gamma}) Dp_B] + \tilde{\lambda} [\tilde{\gamma}E + (1 - \tilde{\gamma}) Dp_\mu]}{(1 - \alpha) \frac{N-1}{N} p_B + \tilde{\lambda} p_\mu} \\ &= \frac{(1 - \alpha) \left[ \gamma_p^{NB}(\tilde{\lambda})E + (1 - \gamma_p^{NB}(\tilde{\lambda}))D_p^{NB}(\tilde{\lambda})p_B \right] + \tilde{\lambda} \left[ \gamma_p^{NB}(\tilde{\lambda})E + (1 - \gamma_p^{NB}(\tilde{\lambda}))D_p^{NB}(\tilde{\lambda})p_\mu \right]}{(1 - \alpha)p_B + \tilde{\lambda} p_\mu}, \end{aligned} \quad (24)$$

where  $\gamma_p^{NB}(\tilde{\lambda})$  and  $D_p^{NB}(\tilde{\lambda})$  are given by (12) and (18) for  $\lambda = \tilde{\lambda}$ . Because of Proposition 9 non-banks compete first in separating allocations as macroprudential requirements increase, thus  $\tilde{\lambda}$  is the loan demand that makes non-banks switch from offering separating to pooling contracts (absent competition from banks), i.e.,

$$R_s^{NB} + \frac{1 - p_G}{p_G} C_s^{NB} = R_p^{NB}(\tilde{\lambda}), \quad (25)$$

where  $R_s^{NB} = \gamma_s^{NB}E/p_G + (1 - \gamma_s^{NB})D_s^{NB}$  and  $C_s^{NB} = [p_B/[(1 - p_B)p_G]][p_GB - (\gamma_s^{NB}E + (1 - \gamma_s^{NB})D_s^{NB}p_G)]$ —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 (24) and (25) we also get that  $R_s^{NB} + (1 - p_G)/p_GC_s^{NB} = R_p(\tilde{\gamma}, \tilde{\lambda})$ , 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,  $R_s^{NB} + (1 - p_G)/p_GC_s^{NB} > R_p(\gamma', \tilde{\lambda})$ , and hence the threshold  $\lambda'$  that equate the two is strictly less than  $\tilde{\lambda}$ . From (25), 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  $\lambda$ , i.e.,  $\tilde{\lambda} > \hat{\lambda}$ , and that for  $\lambda > \tilde{\lambda}$  banks do not fund any unknown borrowers.

The following proposition summarizes the above results on how macroprudential regulation impacts the competition between banks and non-banks both in separating and pooling contracts.

**Proposition 10** *There exist three thresholds for macroprudential capital requirements:  $\hat{\gamma} < \hat{\gamma} < \tilde{\gamma}$ . For i)  $\gamma < \hat{\gamma}$ , non-banks cannot compete and banks fund all borrowers; ii)  $\hat{\gamma} \leq \gamma < \hat{\gamma}$ , non-banks compete in separating contracts; iii)  $\hat{\gamma} \leq \gamma < \tilde{\gamma}$ , non-banks compete in separating contracts and in pooling contracts for  $\lambda \rightarrow \infty$ ; iv)  $\gamma \geq \tilde{\gamma}$ , 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 equilibrium lending standards. Recall that lending standards are captured by the threshold  $\lambda$  at which the economy switches from a separating to a pooling equilibrium. Each threshold for the macroprudential capital requirement in Proposition 10 is associated with different determination of the  $\lambda$  threshold. The following proposition fully characterizes the economy's lending standards conditional on the capital requirement and demand for credit. For  $\gamma \in [\tilde{\gamma}, \hat{\gamma})$  the threshold  $\bar{\lambda}(\gamma)$  is the level of loan demand that equalizes the effective rate that banks offer on separating contracts to the one they offer on pooling contracts (see

Proposition 8). For  $\gamma \in [\hat{\gamma}, \tilde{\gamma})$ , the threshold  $\hat{\lambda}(\gamma)$  equalizes the effective rate that non-banks offer on separating contracts to the one that banks offer on pooling contracts. For  $\gamma \geq \tilde{\gamma}$ , the threshold  $\tilde{\lambda}(\gamma)$  equalizes the effective rate that non-banks offer on separating contracts to the one that they themselves offer on pooling contracts.

The following proposition ranks these thresholds for  $\lambda$  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,  $d\hat{\lambda}(\gamma)/d\gamma > d\bar{\lambda}(\gamma)/d\gamma > 0$  and  $\bar{\lambda}(\hat{\gamma}) = \hat{\lambda}(\hat{\gamma})$  and  $\hat{\lambda}(\tilde{\gamma}) = \tilde{\lambda}(\tilde{\gamma})$ .*

Proposition 11 establishes that non-bank competition amplifies the positive effect of macroprudential regulation on lending standards. Before non-banks are able to compete, banks tighten their standards for higher  $\gamma$  to protect their equity as shown in Proposition 8. Because non-banks will first be able to compete in separating contracts, lending standards will continue to improve because the cost of separating contracts offered by non-banks is not affected by macroprudential regulation, while the cost of pooling contracts offered by banks increases. Note that the result would be the opposite and lending standards could deteriorate with macroprudential regulation if non-banks were first able to compete in pooling contracts. To reiterate the intuition, this important result derives from the fact that the deposit insurance subsidy, which banks enjoy and generates a cost advantage over non-banks, is higher for pooling allocations where bad projects are funded. Note also that the non-bank competition amplifies the greater the increase in lending standards for a given increase in  $\gamma$ , i.e.,  $d\hat{\lambda}(\gamma)/d\gamma > d\bar{\lambda}(\gamma)/d\gamma$ . Finally, for high enough macroprudential capital requirements, banks are completely disintermediated and lending standards are kept at their higher level,  $\tilde{\lambda}(\tilde{\gamma})$ .

In sum, Proposition 6, 8, and 11 establish the remarkable result that neither non-bank competition or macroprudential regulation, even if coupled together, erode lending standards. On the contrary, lending standards monotonically tighten with higher macroprudential requirements and the effect is *stronger* in the presence of non-bank competition.

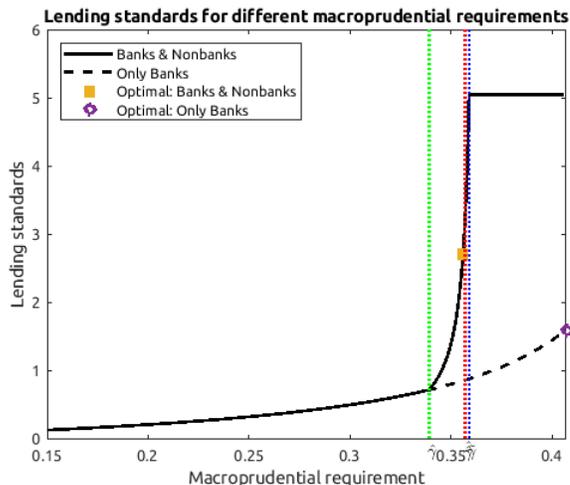
Before turning to the determination of the optimal macroprudential capital requirement, we illustrate these results through our numerical example.

### 4.3 Numerical Example Continued

The numerical example thus far has helped demonstrate that under microprudential capital requirements, non-banks cannot compete with banks in any equilibrium allocation and lending standards are therefore unaffected at  $\bar{\lambda} = 0.129$ . Figure 1 plots the relationship between lending standards (y-axis) and macroprudential capital requirement (x-axis). By continuity and given Proposition 8, lending standards increase monotonically from  $\bar{\lambda}$  as  $\gamma$  increases from the microprudential capital requirement  $\bar{\gamma}$ . As  $\gamma$  crosses the  $\hat{\gamma} = 0.339$  threshold, lending standards are determined by the threshold value  $\hat{\lambda} = 0.716$ . After this point, non-banks start competing in separating contracts and lending standards continue to improve but at a higher degree. The slope of the line linking lending standards to macroprudential requirements increases after  $\hat{\gamma}$ , while in the absence of non-bank competition lending standards would have continued to improve at the previous trajectory (the dashed-line in the figure). Lending standards continue to tighten until  $\gamma$  reaches  $\tilde{\gamma} = 0.359$  reaching their maximum level  $\tilde{\lambda} = 5.045$ . Two things are worth noting. First, the response of lending standards to macroprudential requirements does not change at the  $\hat{\gamma} = 0.357$  threshold as banks start competing in pooling contract only for  $\lambda \rightarrow \infty$ . Second, lending standards continue to tighten with or without non-bank competition, but the presence of non-banks results in much tighter lending standards. This surprisingly counterintuitive result, which is quantitatively significant in our example, is due to the fact that macroprudential regulation only increases the cost for banks, which can only compete in pooling contracts after sufficiently high  $\gamma$ . Note that we only consider values of  $\gamma$  such that the effective lending rate is not prohibitively high for good borrowers, i.e.,  $R_s(\gamma) + (1 - p_G)/p_G C_s(\gamma) \leq G$ .

Figure 1 also reports the optimal macroprudential requirement for the two cases. As it can be seen, the optimal macroprudential requirement is lower in the presence of non-banks. This is a general result, which we turn to in the next section.

Figure 1: The relationship between lending standards and macroprudential capital requirements



## 5 Optimal Macroprudential Regulation

The macroprudential capital requirements  $\gamma > \bar{\gamma}$  in Section 4 were taken as exogenous. In this section, we derive the optimal macroprudential requirement under both the presence and absence of non-banks. We consider a planner that maximizes the overall surplus in the economy without caring about how this surplus is distributed across agents, i.e., a planner that has access to lump-sum transfer to implement the desirable income redistribution. Hence, the planner's problem is to maximize the ex-ante net surplus from funding firm projects, which is the sum of returns accruing to firms, banks/outside investors, depositors/creditors, and the deposit insurance fund over the distribution for loan demand across the separating and pooling regimes.<sup>12</sup>

In the separating regime, the net surplus to firm projects is the expected net return to all good projects minus the expected loss from the inefficient collateral liquidation, which is equal to  $(1 - p_G)(1 - \kappa)C_s(\gamma)$  for bank contracts and  $(1 - p_G)(1 - \kappa)C_s(\gamma_s^{NB})$  for non-bank contracts. The total mass of good projects funded is  $\alpha(1 + \lambda)$ , but only  $\alpha\lambda$  are required to post collateral as long as banks are willing to lend to their known good borrowers. The latter is true up to macroprudential requirement  $\tilde{\gamma} < \gamma_{max}$  given by the maximum loan

<sup>12</sup>As mentioned in Section 4, we focus on time-invariant macroprudential capital requirements, i.e.,  $\gamma$  is set before the realization of the loan demand  $\lambda$ . The analysis can be extended to time-varying macroprudential regulation whereby  $\gamma$  is a function of  $\lambda$ .

rate banks can charge their known good borrowers without losing them to non-banks, i.e.,  $R_s(\tilde{\gamma}) = R_s^N B + (1 - p_G)/p_G C_s^{NB}$ . For the sake of brevity, we will consider that  $\tilde{\gamma} > \tilde{\gamma}$ , but our analysis can easily be adjusted otherwise and all the results continue to hold; because  $\tilde{\gamma} \in (\hat{\gamma}, \gamma_{max})$  as it will become clear.

In the pooling regime, the net surplus to firm projects is the expected net return to funding all projects with mass  $(1 + \lambda)$ , except the fraction  $1/N$  of bad projects in the case of bank contracts.

We start with the welfare analysis when only banks are present. The total welfare in the economy that the planner chooses  $\gamma$  to maximize is given by

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

subject to  $\bar{\gamma} \leq \gamma$  and  $\gamma \leq \gamma_{max}$ . The first line corresponds to the level of demand where the separating regime obtains, i.e.,  $\lambda < \bar{\lambda}$ . Only good projects get funding, which have mass  $\alpha(1 + \lambda)$  and expected net payoff  $p_G G - 1$ . The expected loss from collateral liquidation is  $\alpha\lambda(1 - p_G)(1 - \kappa)C_s(\gamma)$ , because banks do not require collateral from their know good borrowers. The second line corresponds to the level of demand where the pooling regime obtains, i.e.,  $\lambda \geq \bar{\lambda}$ . All good projects with mass  $\alpha(1 + \lambda)$ , with expected net payoff  $p_G G - 1$ , are funded, while all but  $1/N$  bad projects, with expected net payoff  $p_B B - 1$ , are funded.

Denoting by  $\underline{\psi}$  and  $\bar{\psi}$  the Lagrange multiplier of  $\bar{\gamma} \leq \gamma$  and  $\gamma \leq \gamma_{max}$ , respectively, we get the following optimality condition with respect to  $\gamma$

$$\frac{\partial \bar{\lambda}(\gamma)}{\partial \gamma} \left[ -\alpha \bar{\lambda}(\gamma) (1 - p_G) (1 - \kappa) C_s(\gamma) + (1 - \alpha) \left( \frac{N - 1}{N} + \bar{\lambda} \right) (1 - p_B B) \right] - \frac{dC_s(\gamma)}{d\gamma} \frac{(\bar{\lambda}(\gamma))^2}{2} \alpha (1 - p_G) (1 - \kappa) + \underline{\psi} - \bar{\psi} = 0. \quad (27)$$

Equation (27) has the following intuitive interpretation. The term on the first line says that increasing the capital requirement expands the separating region, because  $d\bar{\lambda}(\gamma)/d\gamma >$

0 from Proposition 8. This imposes an inefficient liquidation cost, but at the same time, reduces the number of negative net present value projects that bad firms undertake in the pooling region. The first term on the second line captures the incremental effect of higher  $\gamma$  on the total amount of collateral banks require to screen all unknown good borrowers. The collateral requirement is decreasing in the capital requirement from Proposition 7 implying that the total inefficiency arising from liquidating good-firms' collateral falls as capital requirements rise. In an interior solution these forces balance each other, i.e., the inefficient collateral liquidation from an expanded separating region due to higher  $\gamma$  is outweighed by the lower collateral required to screen good projects as well as the smaller loss from funding bad projects in the pooling region. If the former force dominates for all  $\gamma \leq \gamma_{max}$ , then  $\underline{\psi} > 0$  and the planner would not set capital requirement above their microprudential level. If the latter force dominates, then  $\overline{\psi} > 0$  and the planner would set the macroprudential capital requirement at its maximum to expand the separating region as much as possible.

The planner's problem in the presence of non-bank competition is similar, but the planner needs to take into consideration the various thresholds at which the economy switches for the separating regime to the pooling regime derived in Section 4.2. In particular, the

planner chooses  $\gamma$  to maximize the piecewise function  $W^{NB} =$

$$\left\{ \begin{array}{l}
 \int_0^{\bar{\lambda}(\gamma)} [\alpha(1+\lambda)(p_G G - 1) - \alpha\lambda(1-p_G)(1-\kappa)C_s(\gamma)] d\lambda \\
 + \int_{\bar{\lambda}(\gamma)}^{\infty} [\alpha(1+\lambda)(p_G G - 1) + (1-\alpha)\left(\frac{N-1}{N} + \lambda\right)(p_B B - 1)] d\lambda \quad \text{if } \gamma \in [\bar{\gamma}, \hat{\gamma}) \\
 \\
 \int_0^{\hat{\lambda}(\gamma)} [\alpha(1+\lambda)(p_G G - 1) - \alpha\lambda(1-p_G)(1-\kappa)C_s^{NB}] d\lambda \\
 + \int_{\hat{\lambda}(\gamma)}^{\infty} [\alpha(1+\lambda)(p_G G - 1) + (1-\alpha)\left(\frac{N-1}{N} + \lambda\right)(p_B B - 1)] d\lambda \quad \text{if } \gamma \in [\hat{\gamma}, \hat{\hat{\gamma}}) \\
 \\
 \int_0^{\hat{\hat{\lambda}}(\gamma)} [\alpha(1+\lambda)(p_G G - 1) - \alpha\lambda(1-p_G)(1-\kappa)C_s^{NB}] d\lambda \\
 + \int_{\hat{\hat{\lambda}}(\gamma)}^{\infty} [\alpha(1+\lambda)(p_G G - 1) + (1-\alpha)\left(\frac{N-1}{N} + \lambda\right)(p_B B - 1)] d\lambda \\
 + \int_{\tilde{\lambda}}^{\infty} [\alpha(1+\lambda)(p_G G - 1) + (1-\alpha)(1+\lambda)(p_B B - 1)] d\lambda \quad \text{if } \gamma \in [\hat{\hat{\gamma}}, \tilde{\gamma}) \\
 \\
 \int_0^{\tilde{\lambda}} [\alpha(1+\lambda)(p_G G - 1) - \alpha\lambda(1-p_G)(1-\kappa)C_s^{NB}] d\lambda \\
 + \int_{\tilde{\lambda}}^{\infty} [\alpha(1+\lambda)(p_G G - 1) + (1-\alpha)(1+\lambda)(p_B B - 1)] d\lambda \quad \text{if } \gamma \in [\tilde{\gamma}, \tilde{\tilde{\gamma}}) \\
 \\
 \int_0^{\tilde{\tilde{\lambda}}} [\alpha(1+\lambda)(p_G G - 1) - (1+\alpha\lambda)(1-p_G)(1-\kappa)C_s^{NB}] d\lambda \\
 + \int_{\tilde{\tilde{\lambda}}}^{\infty} [\alpha(1+\lambda)(p_G G - 1) + (1-\alpha)(1+\lambda)(p_B B - 1)] d\lambda \quad \text{if } \gamma \in [\tilde{\tilde{\gamma}}, \gamma_{max}]
 \end{array} \right. \quad (28)$$

Before describing the components in (28), let us remind the reader what the different regions of  $\gamma$  correspond to:  $\bar{\gamma}$  is the microprudential capital requirement;  $\hat{\gamma}$  is the threshold for the 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 loan 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;  $\tilde{\tilde{\gamma}}$  is the threshold where banks cannot even lend to their known good borrowers;  $\gamma_{max}$  is the threshold where banks cannot lend separating contracts even in the absence of non-banks.

The first leg in (28) is the same as in (26) given that non-banks cannot compete for

these levels of  $\gamma$ , which implies an equivalence between the optimal solutions. The switch from the separating to the pooling regime happens for loan demand  $\lambda \geq \bar{\lambda}(\gamma)$ . The second leg captures the region of  $\gamma$ 's where non-banks lend through the separating regime and banks in the pooling regime. The differences between the first and the second legs are that the collateral is given by  $C_s(\gamma^{NB})$  for all  $\gamma \geq \hat{\gamma}$  rather than  $C_s(\gamma)$  (recall that  $C_s^{NB} = C_s(\gamma^{NB}) = C_s(\hat{\gamma})$ ), and that the switch from separating to pooling regime happens for loan demand higher than  $\hat{\lambda}(\gamma)$  rather than  $\bar{\lambda}(\gamma)$ . The third leg captures the region of  $\gamma$ 's where non-banks start being able to compete in the pooling region for loan demand  $\lambda \geq \hat{\lambda}(\gamma)$ , where the threshold  $\hat{\lambda}(\gamma)$  is given by the point where the pooling contract banks offer becomes as expensive as the one offered by non-banks, i.e.,  $R_p(\gamma, \hat{\lambda}(\gamma)) = R_p^{NB}(\hat{\lambda}(\gamma))$ . The separating region still obtains for  $\lambda < \hat{\lambda}(\gamma)$  given that banks continue to offer the pooling contract for loan demand  $\lambda \in [\hat{\lambda}, \hat{\lambda}]$ . Thus, the difference between the second and third leg is that non-banks fund all bad projects conditional on high demand for loans. The fourth leg captures the region where banks are disintermediated both in the separating and pooling regimes, but can still lend to their known good borrowers. The difference between the third and fourth leg is that all bad borrowers receive lending in the latter. Finally, the fifth leg captures the region where banks cannot even lend to their known good borrowers. The difference between the fourth and fifth legs is that collateral is required from all good borrowers in the latter.

The question we ask is what is the relationship between the optimal capital requirement the planner sets when non-banks can and cannot compete with banks. The planner will never set  $\gamma \geq \tilde{\gamma}$ , because she can do better by setting  $\gamma = \tilde{\gamma}$  given that lending standards are unaffected because non-banks intermediate the whole market. Similarly, there is no scope to set  $\gamma$  higher than  $\tilde{\gamma}$ , because the planner can achieve the same level of welfare by setting  $\gamma \rightarrow \tilde{\gamma}$ , since  $\hat{\lambda}(\tilde{\gamma}), \hat{\lambda}(\tilde{\gamma}) \rightarrow \tilde{\lambda}$ . Thus, the optimal solution when non-banks are present is between  $\bar{\gamma}$  and  $\tilde{\gamma}$ . In this region, let the optimal macroprudential capital requirement without and with non-banks be denoted by  $\gamma^*$  and  $\gamma^{**}$ , respectively. The following analysis shows that the optimal solution to the piece-wise maximization problem in (28) is never greater than the solution to (26).

Consider first  $\gamma^* \in [\bar{\gamma}, \hat{\gamma})$ . Clearly, (28) is the same as (26) and, trivially,  $\gamma^* = \gamma^{**}$ . Next, consider  $\gamma^* \in (\hat{\gamma}, \hat{\gamma}]$ . Using (27) we get that

$$\begin{aligned} & -\alpha\lambda^*(\gamma^*)(1-p_G)(1-\kappa)C_s(\gamma^*) + (1-\alpha)\left(\frac{N-1}{N} + \lambda^*(\gamma^*)\right)(1-p_BB) \\ &= \left(\frac{\partial\lambda^*(\gamma^*)}{\partial\gamma}\right)^{-1} \left[ \frac{dC_s(\gamma^*)}{d\gamma} \frac{(\lambda^*(\gamma^*))^2}{2} \alpha(1-p_G)(1-\kappa) - \underline{\psi} \right] < 0, \end{aligned} \quad (29)$$

which also implies that

$$\begin{aligned} & -\alpha(1-p_G)(1-\kappa)C_s(\gamma^*) + (1-\alpha)(1-p_BB) < 0 \\ \& \quad \& -\alpha(1-p_G)(1-\kappa)C_s^{NB} + (1-\alpha)(1-p_BB) < 0, \end{aligned} \quad (30)$$

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

Evaluating the first-order optimality condition for (28) at  $\gamma = \gamma^*$  yields

$$\begin{aligned} & \frac{\partial\hat{\lambda}(\gamma^*)}{\partial\gamma} \left[ -\alpha\hat{\lambda}(\gamma^*)(1-p_G)(1-\kappa)C_s^{NB} + (1-\alpha)\left(\frac{N-1}{N} + \hat{\lambda}(\gamma^*)\right)(1-p_BB) \right] \\ & < \frac{\partial\lambda^*(\gamma^*)}{\partial\gamma} \left[ -\alpha\lambda^*(\gamma^*)(1-p_G)(1-\kappa)C_s(\gamma^*) + (1-\alpha)\left(\frac{N-1}{N} + \lambda^*(\gamma^*)\right)(1-p_BB) \right] < 0, \end{aligned} \quad (31)$$

because  $C_s^NB = C_s(\hat{\gamma}) > C_s(\gamma^*)$  and  $\hat{\lambda}(\gamma^*) > \bar{\lambda}(\gamma^*)$  from Proposition 11. Moreover, the last term in (31) is negative due to (29). Hence,  $\gamma^*$  cannot be an optimal solution to (28). Given that  $\gamma^* \in (\hat{\gamma}, \hat{\gamma}]$ , the expression in (29) is positive for  $\gamma = \hat{\gamma}$  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 (31) can be either positive or negative at  $\hat{\gamma}$  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  $\gamma$ , 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  $\gamma^{**} = \hat{\gamma}$ . Thus,  $\gamma^{**} < \gamma^*$  if  $\gamma^* \in (\hat{\gamma}, \hat{\gamma}]$ . Using similar logic we can show that the same is true for  $\gamma^* \in (\hat{\gamma}, \tilde{\gamma}]$ . Finally, note that  $\gamma^{**} = \gamma^*$  if  $\gamma^* \in [\bar{\gamma}, \hat{\gamma}]$ , while  $\gamma^{**} < \gamma^*$  if

$\gamma^* \in (\tilde{\gamma}, \gamma_{max})$  because  $\gamma^{**}$  will never be set higher than  $\tilde{\gamma}$ .

The following Proposition characterizes the relationship between the optimal macroprudential requirement in the absence and in the presence of non-banks,  $\gamma^*$  and  $\gamma^{**}$ .

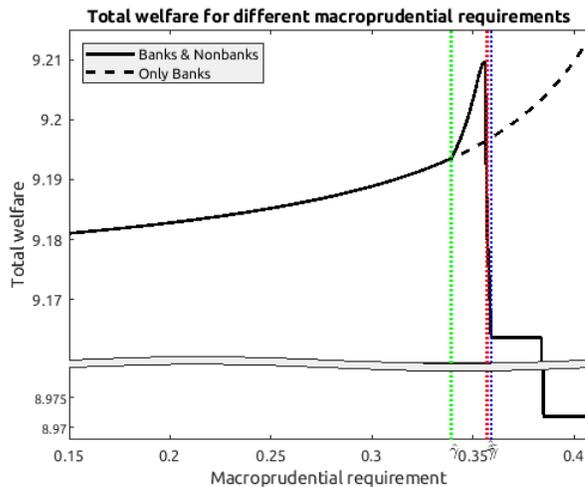
**Proposition 12** *In the presence of non-banks, the optimal macroprudential requirement does not exceed that without non-banks, and it is strictly lower if non-banks are active in the loan market.*

Proposition (12) establishes that non-bank competition restricts the ability of the planner to tighten lending standards by increasing macroprudential capital requirements. It is true that non-bank competition results in tighter standards for the same level of macroprudential capital requirements, as shown in Proposition 11. But, tightening standards are more costly with non-banks and, thus, the planner will choose a lower macroprudential requirement. These two forces will interact to determine whether the equilibrium lending standards will be tighter or looser, which will depend on the parameterization of the economy. In the next section, we show that in our numerical example optimal lending standards are looser in the presence of non-bank competition.

## 5.1 Numerical Example Continued

Figure 5.1 plots total welfare with and without banks, given by (28) and (26), for different levels of  $\gamma \in [\bar{\gamma}, \gamma_{max}]$ . Absent non-banks, the benefit from tightening standards is very strong and the planner imposes the highest level for macroprudential capital requirements. On the contrary, separation becomes more costly after a point with non-bank competition and total welfare is maximized for lower  $\gamma$ . Note the entrance of non-banks in separating contracts coincides with a faster increases in welfare as  $\gamma$  increases. The reason is that non-bank competition helps support tighter standards. Yet, the effect starts reversing after a point, which, in our example, coincides with the level of  $\gamma$  after which non-banks start competing in pooling contracts. This result is intuitive as non-banks offer credit also to known bad borrowers. As such, higher macroprudential regulation destroys the positive value of banks' access to private information. Finally, from Figure 5.1, optimal lending

Figure 2: Total welfare and macroprudential capital requirements



standards are looser in the presence of non-banks.

## 6 Discussion and Conclusion

This paper shows that capital requirements can allow non-bank intermediaries to enter loan markets and compete with banks. However, non-bank competition does not *per se* cause lending standards to fall. Our analysis shows that non-banks find it profitable to enter lending markets with low standards when the demand for credit is high, instead of the other way around. Moreover, we show that higher capital requirements may actually tighten rather than loosen lending standards. Higher capital requirements force banks to have more skin in the game, for which they are compensated only when their loans are profitable. Banks are more likely to lend to only profitable projects when they tighten lending standards. Lastly, we show that the social planner chooses macro prudential capital requirements no higher when non-banks are present than when they are absent, and in some cases, sets capital requirements strictly lower. This implies that optimal macroprudential capital requirements should be lower in jurisdictions with more non-bank competition, such as the U.S., than in many European countries where banks remain the dominant intermediary type.

Avenues to explore in future work may include divergence away from a perfectly com-

petitive market for banks and/or non-banks. A recent contribution in this dimension is Parlour, Rajan and Zhu (2020). Another possibility would be a general equilibrium setting in which households form a portfolio of debt and equity to fund intermediaries rather than the segmented markets approach adopted in this paper.

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## Appendix

The proofs of Propositions 1, 5, 7, and 12 are immediate from the text.

**Proof.** *Proposition 2*

The equilibrium separating contract terms  $R_s$  and  $C_s$  are derived by solving jointly (4) and (5) given that the bank defaults in the bad state, i.e.,  $\kappa C_s - (1 - \bar{\gamma})D < 0$ . We proceed to verify that this is true for sufficiently low  $\kappa$ . We, first, examine the case that this condition is true for all  $\kappa \in [0, 1)$ . Take  $\kappa \rightarrow 1$  and assume that  $C_s = p_B / (1 - p_B)(B - R_s) \geq 1 - \bar{\gamma}$ , which implies that  $R_s \leq B - (1 - p_B) / p_B(1 - \bar{\gamma})$ . Using the equilibrium value of  $R_s$  and  $D = 1$ , this can only be true for  $\bar{\gamma} \leq p_G(p_B B - 1) / (p_B E - p_G) < 0$  if  $E > p_G / p_B$ , or  $\bar{\gamma} \geq p_G(1 - p_B B) / (p_G - p_B E) > 1$  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  $\bar{\gamma}$ , but for any level of admissible capital requirement  $\gamma$ . For  $E < p_G / p_B$  and  $E < p_G B$ , there may exist  $\gamma$  such that  $C_s > (1 - \gamma)D$ . In such cases, we will impose that  $\kappa < \bar{\kappa}_\gamma \equiv (1 - \gamma)D / C_s$ , such that the bank defaults if the bad state realizes.

■

**Proof.** *Proposition 3*

We first establish the existence of the threshold  $\bar{\alpha}$  only above which condition (9) is satisfied. The L.H.S is decreasing in  $\alpha$  and the R.H.S is independent of  $\alpha$ . 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 (9) and taking  $\alpha \rightarrow 0$  as

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

which always holds because  $B > G$ . Hence, there is no pooling equilibrium even for sufficiently high  $\lambda$  for  $\alpha = 0$ . Letting  $\alpha \rightarrow 1$ , condition (9) becomes  $p_G (R_s - (1 - \bar{\gamma}) D) + (1 - p_G) C_s > \bar{\gamma} E$ , which always holds because  $\bar{\gamma} E = p_G (R_s - (1 - \bar{\gamma}) D)$ . Hence,  $\exists 0 < \bar{\alpha} < 1$  for which condition (9) holds, and equilibrium is always pooling when for sufficiently high  $\lambda$  and  $\alpha$ . Putting this together with the fact that there is no pooling equilibrium for  $\lambda \rightarrow 0$ , part i) follows immediately. To establish the threshold  $\bar{\lambda}$  in part ii), note that the L.H.S of (8) is continuous and decreasing in  $\lambda$  and approaches  $\frac{\bar{\gamma} E}{p_B} + (1 - \bar{\gamma}) D$ . Thus, if (9) holds, then there must be a  $\bar{\lambda} > 0$  such that equilibrium is separating if  $\lambda \leq \bar{\lambda}$ . 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 (8) is violated. Therefore, part iii) shows the conditions for violating condition (8) while preserving condition (9) 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 (7) holds. But, for  $\lambda < \bar{\lambda}$ , condition (8) 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  $\lambda < \bar{\lambda}$ . Lastly, for  $\alpha < \bar{\alpha}$ , 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 while still preserving the relationship  $\frac{\bar{\gamma} E}{p_\mu} + (1 - \bar{\gamma}) D > R_s + \epsilon + \frac{1 - p_G}{p_G} C_s$ . ■

**Proof.** *Proposition 6*

Equation (17) 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 through separating contracts.

Now consider pooling contracts. For  $\lambda \rightarrow 0$ , substituting the equilibrium values of  $\bar{\gamma}$ ,  $\gamma^{NB}$ , and  $D_p^{NB}$  into equations (11) and (20) yields  $R_p = R_p^{NB}$ . Thus,  $\lim_{\lambda \rightarrow 0} (R_p - R_p^{NB}) = 0$ . Note that for  $\lambda \rightarrow 0$ , the separating contract always dominates the pooling contract for banks. This is because under separating, all good projects are known to at least one bank and thus receive funding. All remaining (unfunded) firms offer negative NPV projects and

thus banks cannot do better by offering a pooling contract when  $\lambda \rightarrow 0$ . Additionally, we have shown that non-banks cannot compete with banks through separating contracts under microprudential capital requirements. Thus for  $\lambda \rightarrow 0$ , non-banks cannot compete with banks.

For  $\lambda \rightarrow \infty$ , substituting the equilibrium values of  $\bar{\gamma}$ ,  $\gamma^{NB}$ , and  $D_p^{NB}$  into equations (11) and (20) yields  $R_p < R_p^{NB}$  for  $p_\mu < 1$ , which holds by definition. Thus,  $\lim_{\lambda \rightarrow \infty} (R_p - R_p^{NB}) < 0$  and non-banks cannot compete with banks through pooling contracts.

For intermediate values of  $\lambda$ , we apply the quotient rule to equation (11), to obtain:

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

Similarly, we apply the quotient rule to equation (20), to obtain  $\frac{\partial R_p^{NB}}{\partial \lambda} = \frac{(1-\alpha)\gamma^{NB}E(p_B-p_\mu)}{[\lambda p_\mu + (1-\alpha)p_B]^2}$ .

In both cases, since  $p_B < p_\mu$ ,  $\frac{\partial R_p}{\partial \lambda} < 0$  and  $\frac{\partial R_p^{NB}}{\partial \lambda} < 0$ .

Recall,  $\lim_{\lambda \rightarrow 0} (R_p - R_p^{NB}) = 0$  and  $\lim_{\lambda \rightarrow \infty} (R_p - R_p^{NB}) < 0$ . Additionally, since  $\frac{\partial R_p}{\partial \lambda} < 0$  and  $\frac{\partial R_p^{NB}}{\partial \lambda} < 0$ , we see that non-banks cannot compete through pooling contracts for any value of  $\lambda$  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.** *Proposition 8:* The equilibrium value of  $\hat{\lambda}$  is implicitly defined by indifference condition of the pooling and separating contracts:  $R_s(\hat{\lambda}) = \tilde{R}(\hat{\lambda})$ . Totally differentiating,  $\frac{dR_s}{d\gamma} = \frac{\partial \tilde{R}}{\partial \gamma} + \frac{\partial \tilde{R}}{\partial \lambda} \frac{\partial \hat{\lambda}}{\partial \gamma} \Rightarrow \frac{\partial \tilde{R}}{\partial \lambda} \frac{\partial \hat{\lambda}}{\partial \gamma} = \frac{dR_s}{d\gamma} - \frac{\partial \tilde{R}}{\partial \gamma}$ . Re-writing the equilibrium price of the pooling contract,

$$\tilde{R} = \frac{\gamma R^E \left( \hat{\lambda} + (1-\alpha) \frac{N-1}{N} \right) + (1-\gamma) R^D \left( \hat{\lambda} \bar{p} + (1-\alpha) \frac{N-1}{N} p_B \right)}{\hat{\lambda} \bar{p} + (1-\alpha) \frac{N-1}{N} p_B} \quad (32)$$

It is straightforward to see that  $\frac{\partial \tilde{R}}{\partial \lambda} = \frac{(1-\alpha)\frac{N-1}{N}(\gamma R^E(p_B-\bar{p}))}{(\cdot)^2} < 0 \Rightarrow p_B < \bar{p}$ . Therefore,  $\text{sign}\left(\frac{\partial \hat{\lambda}}{\partial \gamma}\right) = -\text{sign}\left(\frac{dR_s}{d\gamma} - \frac{\partial \tilde{R}}{\partial \gamma}\right)$ . The equilibrium separating contract is given by  $R_s = R(\gamma) + \frac{1-p_G}{p_G} C_s$ , where  $C_s = \frac{p_B(B-R(\gamma))}{1-p_B}$  and  $R(\gamma) = \bar{\gamma} \frac{R^E - p_G R^D}{p_G} + R^D$ . Plugging in terms and rearranging we obtain

$$R_s = \left[ \gamma \left( \frac{R^E}{p_G} - R^D \right) + R^D \right] \frac{p_G - p_B}{p_G(1-p_B)} + \frac{(1-p_G)}{p_G} \frac{p_B}{(1-p_B)} B. \quad (33)$$

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

$$\left( \frac{dR_s}{d\gamma} - \frac{\partial \tilde{R}}{\partial \gamma} \right) = -\frac{(1-p_G)p_B}{p_G(1-p_B)} B + \frac{(1-p_G)p_B}{p_G(1-p_B)} R^D < 0 \Leftrightarrow B > R^D. \quad (34)$$

To conclude,  $\frac{\partial \hat{\lambda}}{\partial \gamma} > 0$ . ■

**Proof.** Proposition 9:

$\hat{\gamma}(\hat{\gamma}|\lambda \rightarrow \infty)$  is the capital requirement that equates bank and non-bank participation constraints when offering separating (pooling) contracts given by equations (21) and (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  $\lim_{\lambda \rightarrow \infty} D_p^{NB} = \frac{D}{p_\mu}$ ,  $\hat{\gamma}$  can be expressed as

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

Showing that  $\hat{\gamma} > \hat{\gamma}$  as rewritten above is sufficient. Based on the relationship established above, we have the following:  $\frac{\gamma_p^{NB} (E - D) + D(1 - p_\mu)}{E - p_\mu D} > \frac{\gamma_s^{NB} (E - D) + D(1 - p_G)}{E - p_G D} \Rightarrow \gamma_p^{NB} (E - p_G D) - \gamma_s^{NB} (E - p_\mu D) + D(p_G - p_\mu) > 0$ . Using (12) for the respective separating and pooling non-bank equity requirements, the sufficient 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. If the resulting inequality holds, 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  $p_G D \geq p_B B$  and maintain sufficiency. Hence, substitute  $p_G D$  for  $p_B B$  and re-group to obtain  $(E - p_G D) [D(p_G - p_\mu) - p_B(D_P^{NB} - D_S^{NB})] > 0$ .

Using

$$\lim_{\lambda \rightarrow \infty} D_P^{NB} = \frac{D}{p_\mu}$$

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  $(E - p_G D) [D(p_G - p_\mu) - \frac{p_B}{p_G p_\mu} (p_G - p_\mu) D] > 0$  because the second term inside the bracket becomes a larger quantity. 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 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  $\alpha \geq \bar{\alpha}$  derived in Proposition 2, which gives the minimum level of  $\alpha$  such that there can exist a pooling equilibrium for high enough  $\lambda$ . The intuition is simple. Note that if  $\alpha < \bar{\alpha}$  only the separating equilibrium is possible and, thus, non-banks necessarily can only compete in separating contracts.

■

**Proof.** *Proposition 11:* From Proposition 8, we know that  $d\bar{\lambda}(\gamma)/d\gamma = (\partial R_p/\partial \gamma)(dR_s/d\gamma - dR_p/d\gamma) > 0$ . 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  $d\hat{\lambda}(\gamma)/d\gamma > d\bar{\lambda}(\gamma)/d\gamma$ . Finally, because  $R_s(\hat{\lambda}) = R_s^{NB}$  and by continuity, we have that  $R_p(\bar{\lambda}(\hat{\gamma})) = R_p(\hat{\lambda}(\hat{\gamma}))$ , and thus  $\bar{\lambda}(\hat{\gamma}) = \hat{\lambda}(\hat{\gamma})$ . Similarly,  $\hat{\lambda}(\tilde{\gamma}) = \tilde{\lambda}(\tilde{\gamma})$  as a

direct consequence of (24). ■