Learning by Lending, Competition, and Screening Incentives in the Banking Industry

(preliminary, comments welcome)

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Abstract

This paper shows that banks may have an incentive to reduce screening when the proportion of untested borrowers on the market increases, leading to a deterioration of their portfolios and a contraction of their profits. The paper addresses the issue in the context of a simple model where banks compete solely on screening and in a more complex model where banks compete by offering borrowers a menu of contracts. The results have policy implications with regard to financial liberalization, lending booms, and banking crises, as those occurred at different times in many emerging markets.

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1 Introduction

Banking crises and episodes of financial sector distress have been often preceded by strong credit expansion and financial deregulation. This paper presents a simple framework suggesting that, in the wake of financial reforms, changes in the informational structure of the market interacting with banks' strategic behavior may reduce project screening, increasing credit and deteriorating the quality of bank portfolios.[1]

Adverse selection problems stemming from informational asymmetries among lenders provide a motivation to screen applicant customers, as banks want to avoid financing borrowers rejected by their competitors. However, when the proportion of untested projects in the economy increases, as it may happen after a deregulation or during the expansionary phase of the cycle, such adverse selection problems become less severe, reducing banks' screening incentives. Consequently, in a context where screening is costly or where entrepreneurs prefer not to be screened, an increased proportion of untested projects in the market may lead banks to reduce screening, trading borrower quality for market share. To the extreme, banks competing for customers over screening standards may find themselves trapped in a "prisoner's dilemma" where the no-screening equilibrium is the only outcome. At the aggregate level this will result in a banking system with a deteriorated loan portfolio and, thus, more prone to incur in financial distress when the economy hits a downturn.[2]

We structure these ideas in two different models. First, we prove our main results in the context of a very simple model where banks compete solely over screening standards for applicant borrowers that prefer not to be screened. Second, we show that our findings are robust in a more complex model where banks compete over a menu of contracts where different collateral requirements are associated with different interest rates. In both cases we show that screening (or pure-strategy separating) equilibria are associated with low proportions of untested borrowers in the market, while non screening (mixed-strategy) equilibria are associated with high proportions of

[1] Evidence of a link between lending booms and banking crises is reviewed in section 4.

[2] Asea and Blomberg (1998) find a systematic tendency for bank lending standards to vary over the cycle. During contractions, banks tend to ask higher risk premia and collateral, while during expansions, banks tend to ask lower risk premia, grant larger loans and require less collateralization. This is also the direct implication of the model we present in the second part of the paper.

untested borrowers.

The intuition is the following. Banks are approached by applicant borrowers that may be either entrepreneurs with new untested projects, or entrepreneurs whose projects have been previously tested and rejected by competitor banks. To the extent that banks cannot separate the two groups, when the proportion of new untested projects in the pool increases, the distribution of applicant borrowers each bank faces improves as well. It follows that banks may find it profitable to try to attract customers by reducing screening standards, trading borrower quality for market share. At the aggregate level, the average quality of the entrepreneurs in the economy remains unchanged, and reduced screening results in increased credit, deteriorated bank portfolios, and lower bank profitability.

This paper puts together two concepts treated separately in the previous literature. First, the notion that the existence of separating equilibria depends on the type distribution of potential borrowers, or more generally, on the balance between costs and benefits of screening bank customers.[3] Second, the idea that, under asymmetric information, competition among banks generates an adverse selection problem that lowers the average creditworthiness of the pool of borrowers faced by each bank.[4] This paper interacts these two concepts to relate switches in bank screening standards to changes in credit demand and the informational structure of the market, obtaining the apparently paradoxical result that screening is increasing, rather than decreasing, in the amount of information the aggregate banking system possesses.

A recent literature has investigated the issue of credit cycles and variable credit standards. In Rajan (1994), bank managers with short-term concerns choose credit policies that influence and are influenced by other banks and by borrowers conditions. When most borrowers are doing well, bank managers relax credit standards in the attempt to hide the losses on bad borrowers and protect their own reputation. When a common shock hit a sector and most borrowers perform poorly, reputation effects are absent and bank managers tighten credit standards. In the model in Kiyotaki and Moore (1997) the interaction between credit limits (set by collateral) and asset prices amplifies size and duration of shocks. Similarly, the present paper suggests that in a dynamic context the strategic interaction among banks would amplify credit

[3]See, for example, Hellwig (1987), Besanko and Takor (1987), and Dasgupta and Maskin (1986).

[4]See, for example, Broecker (1990), Riordan (1993), and Dell'Ariccia, Friedman and Marquez (1999).

swings initiated by changes in the demand for new loans.

The present paper also examines the relationship between market concentration and screening, although without finding robust results. Increasing the number of active banks raises both costs and benefits associated with screening equilibria. Consequently, the sign of the relationship between market concentration and bank screening depends upon the assumed form of competition.[5] Similarly, Gehrig (1998a, 1998b) shows that the relationship between competition and screening incentives is ambiguous. In his model, a compression of lending margins reduces screening incentives if and only if the value of identifying good projects exceeds that of rejecting bad projects. In other words, the sign of the relationship between competition and screening incentives depends on whether banks are primarily concerned with detecting good or bad projects. Finally, another related paper is the model of "lazy banks" by Manove, Padilla and Pagano (1999), who show that the ability to pre-select borrowers through collateral requirements may reduce bank screening and lead to sub-optimal equilibria.

The analysis in this paper is relevant for regulatory and competition policy. First, it suggests that financial reforms bringing new categories of borrowers to credit markets may induce a reduction in bank screening (see the discussion of capital flows liberalization in section 4). Second, it also suggests (although less strongly) that policies aimed at stimulating competition and promoting entry in the credit industry may reduce banks' incentives to screen borrowers, worsening banks' portfolio quality, and diminishing their ability to sustain adverse macroeconomic shocks.[6] Consequently, banking supervision and prudential regulation would have to be improved when entry and capital flows were liberalized. In this sense, the results in the paper are consistent with the stylized fact that, in most cases, banking crises and periods of financial distress have been preceded by liberalizations of the banking industry that were not accompanied by the strengthening of regulatory and supervisory frameworks.

The paper proceeds as follows: section 2 presents a model with banks competing solely over simple screening strategies. Section 3 extends the analysis by allowing banks to compete over a menu of contracts with collateral requirements and interest rates as strategic variables. Section 4, discusses the

[5] In our first simple model, concentration increases screening; in the second one, it reduces it. This issue is discussed in more detail in section 5.

[6] To this extent this paper relates to the literature on the effects of competition on the stability of the banking system (see for example Matutes and Vives, 1996).

implications for financial liberalization policies. Section 5 examines the role of market structure. Section 6 concludes.

2 Model

Here we present a simple one-period game, but the analysis could be easily extended to a repeated game with overlapping generations of borrowers. Consider an economy where there is a mass $1 + \lambda$ population of entrepreneurs. Each entrepreneur is endowed with a project that requires a capital inflow of \$1.[7] Projects/entrepreneurs come in two types: good and bad, with probability of success/repayment θ_g and θ_b, respectively. Each entrepreneurial project gives a return of $\widetilde{y} = y > 0$, in case of success, and $\widetilde{y} = 0$, in case of failure.

The market for loans is composed by two groups of borrowers: a mass $\lambda \in [0, \infty)$ of "new", or untested, borrowers and a mass 1 of "old", or tested, borrowers. Both of these groups have the same distribution over types, with α percent good projects, and $1 - \alpha$ percent bad projects. Old borrowers are entrepreneurs whose type is known to one of the banks; new borrowers are entrepreneurs whose type is unknown to all banks.

When first approached by an applicant borrower, banks are unable to distinguish a new untested entrepreneur from an old borrower rejected by competitor banks.[8] However, banks are endowed with a screening technology. This technology is costless and fully efficient. When approached by applicant borrowers, banks can apply the technology and freely obtain full information about their type, or decide to provide credit indiscriminately to any applicant. In the latter case, banks learn the type of their clients over the course of their lending relationship, but only after having granted and disbursed the loan.[9] The result of this screening process is observable by both the bank and the entrepreneur but not contractible.

Entrepreneurs associate some disutility, c, to the process of being screened and prefer banks that practice a "no-question-asked" policy over those that choose to screen applicant borrowers. Then, banks compete for borrowers

[7] From now on, we will use the terms entrepreneur, project, and borrower interchangeably.

[8] This assumption is admittedly strong and serves the purpose of introducing an incumbent's informational advantage in the model (see also Dell'Ariccia *et al.*, 1999).

[9] See Pagano and Jappelli (1993) for a similar learning process.

over their screening strategies. As tie-break rule, we assume that if banks choose symmetric strategies the market will be split evenly. In addition, we assume that, for equal offers, old borrowers prefer to remain with their original bank.

The interpretation of this setup can be twofold. In the narrower sense, we can interpret entrepreneurs' aversion to screening as caused by some cost. For example, it may be that screening involves a time consuming process during which profitable opportunities may disappear. In the broader sense, we can interpret competition in screening as competition in all those instruments that contribute to limit banks' losses and that are often disliked by entrepreneurs. For example, in the presence of limited liability, it may be that some entrepreneurs know, or are afraid, that their projects are not creditworthy and, hence do not want to be screened. In Section 3, we present a model where banks compete over a menu of contracts with interest rate and collateral requirement as strategic variables, and show that the main results of this simple model remain valid in that more complex context.

In this simple setting we assume that banks charge a uniform monopoly gross interest rate (repayment) $R = y$ to all borrowers to whom they grant credit. This assumption is very strong and unrealistic. However, it serves the purpose of concentrating on banks' screening strategies. Moreover, some form of non competitive pricing is justified by the fact that banks gain market power over their clients by acquiring private information over their type.

In order to make loans, banks incur in a constant cost of funding f per dollar lent. To have a meaningful problem we assume that $\theta_g y > f > \theta_b y$. This means that when screened all good entrepreneurs are granted credit, and all bad entrepreneurs are denied credit (we also assume that $[\alpha\theta_g + (1-\alpha)\theta_b]y > f$, meaning that the economy as a whole is creditworthy).

The timing of the game is as follows. First, banks compete in a Nash fashion over screening strategies. Second, entrepreneurs observe banks' strategy and decide where to apply for credit. Finally, banks decide to which of their applicant concede or deny credit, and payoffs are determined.

2.1 Equilibria with Symmetric Banks

This section examines the case where there are two banks starting with identical market shares.

The informational advantage over their respective share of old entrepreneurs enables banks to retain their known good clients and reject their known bad ones, independently of the screening strategy each of the two banks chooses.[10] Consequently, each bank faces a pool of unknown entrepreneurs consisting of the entire population of new entrepreneurs plus the rejects of the competitor bank. The type distribution of that pool consists of $\lambda\alpha$ good entrepreneurs and $\left(\frac{1}{2}+\lambda\right)(1-\alpha)$ bad entrepreneurs.

Now we can compute the payoff of this game. In so doing, for sake of simplicity we disregard the profits that banks earn on loans to their own old good clients which do not affect the equilibrium. When both banks choose to screen applicant borrowers, they will grant credit to good entrepreneurs only. Each bank will end up screening fifty percent of the mass of new entrepreneurs, with an expected profit of

$$\Pi\left(s,s\right)=\frac{\lambda\alpha\left(\theta_g R-f\right)}{2}.$$

If both banks choose not to screen projects and grant credit to all applicant borrowers, each bank will finance half of the new entrepreneurs and all the rejects of its competitor. Hence, each bank's expected payoff will be

$$\Pi(d,d)=\frac{1}{2}[\lambda\alpha\left(\theta_g R-f\right)+\left(1+\lambda\right)\left(1-a\right)\left(\theta_b R-f\right)]\ .$$

Finally, if bank 1 (2) chooses to screen and bank 2 (1) chooses not to screen borrowers, bank 1 (2) will attract no borrower;[11] while bank 2 (1) will grant credit to all the new entrepreneurs and bank 1's rejects. The payoffs will be zero for bank 1 and

$$\Pi\left(s,d\right)=\lambda\alpha\left(\theta_g R-f\right)+\left(\frac{1}{2}+\lambda\right)\left(1-\alpha\right)\left(\theta_b R-f\right)$$

for bank 2 (1).

Letting $A=\alpha\left(\theta_g R-f\right)$ and $B=\left(1-\alpha\right)\left(\theta_b R-f\right)$, we can write the game in its normal form as

1\2	Screen	Do not Screen
Screen	$\frac{\lambda A}{2}$	$0,\ \lambda A+\left(\frac{1}{2}+\lambda\right)B$
Do not Screen	$\lambda A+\left(\frac{1}{2}+\lambda\right)B,0$	$\frac{\lambda A}{2}+\frac{(1+\lambda)B}{2}$

[10] Obviously, banks need not to screen previously tested clients, or borrowers whose type they have learned over the course of a lending relationship.

[11] Bank 2's rejects know that they would be denied credit if they applied. Hence, they will choose not to apply. The result would be the same if these entrepreneurs applied and were denied credit.

The existence of equilibria where banks choose not to screen applicant borrowers depends on the quality of the distribution of entrepreneurs, and it is determined by the following condition:

$$[\alpha\theta_g + (1-\alpha)\,\theta_b]R - f \;\; > -(1-\alpha)\,(\theta_b R - f) \qquad (1)$$

Depending on Condition 1 we can distinguish two cases. If the distribution of entrepreneurs is "bad enough" (Condition 1 is violated), for any $\lambda \in [0, \infty)$, the strategy profile $(s,\, s)$ is a Nash equilibrium for the game, and the profile $(d,\ d)$, is never the unique equilibrium. Conversely, if the distribution is "good enough" (Condition 1 holds), then depending on λ there can be three different outcomes. A unique "screening" equilibrium, a unique "no-screening" equilibrium, or multiple equilibria.

The intuition goes as follows. If bad projects represent a high proportion of the distribution, banks find it too costly not to screen applicant borrowers, as the losses associated with uncreditworthy entrepreneurs are too high. However, if the distribution of entrepreneurs is good enough, the equilibrium of the game depends on the proportion of tested to untested entrepreneurs, that is determined by λ. For "low" λs, each bank's rejects represent a large fraction of the entrepreneurs asking for credit to the other bank, reducing the average creditworthiness of the distribution of applicant borrowers. Hence, adverse selection problems are severe enough to induce banks to always screen unknown projects. For "high" λs, old rejects are a smaller fraction of the entrepreneurs population, so that less severe adverse selection may induce banks to choose not to screen applicants in the attempt to win the whole market. Finally, for "intermediate" λs, both equilibria exist.

More formally, we can prove the following result:

Lemma 1 *For any creditworthy distribution of entrepreneurs there will exist a* $\widehat{\lambda}_1 \in [0, +\infty)$, *such that the profile* $(d, d,)$ *represents a Nash equilibrium if and only if* $\lambda \geq \widehat{\lambda}_1$.

Proof. *See Appendix.*

Analogously, we can prove the following:

Lemma 2 *For any creditworthy distribution of entrepreneurs where "bad" types have a negative expected return, i) if condition 1 holds, there will exist a* $\widehat{\lambda}_2 > 0$ *such that the strategy profile* (s, s) *represents a Nash equilibrium if* *and only if* $\lambda \leq \widehat{\lambda}_2$; *ii) if condition 1 does not hold, the strategy profile* (s, s) *represents a Nash equilibrium for any* $\lambda \in [0, \infty)$.

Proof. *See Appendix.*

From Lemma 1 and Lemma 2 descends directly the following proposition:

Proposition 1 *The set of Nash equilibria for the game is fully determined by* λ : *i)If condition 1 holds: for* $\lambda > \widehat{\lambda}_2$, *the strategy profile* (d, d) *is the unique equilibrium; for* $\lambda < \widehat{\lambda}_1$, *the profile* (s, s) *is the unique equilibrium; and for* $\widehat{\lambda}_1 \leq \lambda \leq \widehat{\lambda}_2$ *there are both a "screening" and a "no-screening" equilibria in pure strategies and one equilibrium in mixed strategies. ii)If condition 1 does not hold: for* $\lambda < \widehat{\lambda}_1$, *the profile* (s, s) *is the unique equilibrium; and* $\widehat{\lambda}_1 \leq \lambda$ *there are both a "screening" and a "no-screening" equilibrium in pure strategies and one equilibrium in mixed strategies.*

Proof. *See Appendix.*

The interpretation of the result is straightforward. Large growth rates of the economy and of credit aggregates may be associated with lower screening standards by the banking system, resulting in deteriorated bank portfolios. Interestingly, this is not the result of limited capacity or other constraints, but rather the natural outcome of strategic interaction among financial intermediaries that operate in conditions of asymmetric information. Informational asymmetries among financial intermediaries generate adverse selection problems as they try to compete for new borrowers. In a boom, these problems are diminished as the mass of new borrowers to old borrowers increases. Hence, banks' incentives to screen applicant entrepreneurs decrease as well.

If banks could coordinate they would always choose the "screening" equilibrium, as $\Pi(s, s) > \Pi(d, d)$. However, in trying to compete for new borrowers they may end up in the bad outcome. During a recession adverse selection problems provide banks with the right incentive to stay in the "screening" equilibrium, while during a boom, banks find themselves locked in a "prisoner's dilemma" situation and are stuck with the "no-screening" equilibrium.

The case with N Banks In this section we extend the analysis to the case of N symmetric banks competing on the market. This extension is straightforward, but delivers some interesting results about the effects of market concentration on banks' incentives to screen applicant borrowers. We limit the analysis to symmetric equilibria.

As before, consider the case where each bank starts with an equal market share, $\frac{1}{N}$. Using the same notation as in the previous section, we can write the payoffs for bank i conditionally on the strategy played by the other banks $N-1$. When all banks choose to screen applicant borrowers, each bank i serves one Nth of the previously untested good entrepreneurs, obtaining

$$\Pi(s_i, \overline{s}_{-i}) = \frac{\lambda A}{N} \ .$$

When all banks choose not to screen applicant borrowers, they equally divide the market for new entrepreneurs. In addition, for any bank i, the other $N-1$ banks equally divide the rejects of bank i. That means that each bank ends up financing one Nth of the mass of bad entrepreneurs rejected by other banks. Hence, the payoffs are

$$\Pi(d_i, \overline{d}_{-i}) = \frac{\lambda A + \lambda B + B}{N} \ .$$

When bank i chooses not to screen, while the other $N-1$ banks decide to screen applicant borrowers, bank i attracts all the new entrepreneurs and all the old bad entrepreneurs rejected by the other banks. Bank $i's$ payoff will be

$$\Pi(d_i, \overline{s}_{-i}) = \lambda A + \lambda B + \frac{N-1}{N} B \ .$$

Finally, when bank i is the only one to choose to screen applicant borrowers its payoff is zero. The results obtained for the two bank case are easily extended to the N bank case. For brevity we limit the analysis to the case where Condition 1 holds. Then, we can state the following lemmas:

Lemma 3 *For any creditworthy distribution of entrepreneurs and any number of banks in the market, $N \geq 2$, there will exist a $\widehat{\lambda}_1(N) \in [0, +\infty)$, such that the strategy profile $(d, d, d, ..., d)$ represents a Nash equilibrium if and only if $\lambda \geq \widehat{\lambda}_1(N)$.*

Proof. *See Appendix.*

Lemma 4 *If Condition 1 holds, for any creditworthy distribution of entrepreneurs where "bad" types have a negative expected return and any number of banks in the market, $N \geq 2$, there will exist a $\widehat{\lambda}_2(N)$, such that the strategy profile $(s, s, s, ..., s)$ is a Nash equilibrium if and only if $\lambda \leq \widehat{\lambda}_2$.*

Proof. *See Appendix.*

Proposition 2 *If Condition 1 holds, the set of Nash equilibria for an industry with N banks is fully determined by* λ. *For* $\lambda > \widehat{\lambda}_2(N)$, *the strategy profile* $(d, d, d, ..., d)$ *is the unique Nash equilibrium for the game; for* $\lambda < \widehat{\lambda}_1(N)$, *the strategy profile* $(s, s, s, ..., s)$ *is the unique Nash equilibrium; and for* $\widehat{\lambda}_1 \leq \lambda \leq \widehat{\lambda}_2$, *both* $(d, d, d, ..., d)$ *and* $(s, s, s, ..., s)$ *are Nash equilibria in pure strategies, while one symmetric equilibrium in mixed strategies exists.*

Proof. *See Appendix.*

These results are the direct extension of the two-bank symmetric case. However, they allow us to study the effects of industry structure on banks' screening strategies. One important implication is that less concentrated banking industries are more prone to slip in the "prisoner's dilemma" state and be locked in the "no-screening" equilibrium, as the threshold growth rate that triggers the "screening war" is lower the larger is N. This is easily shown in the next lemma.

Lemma 5 *As N increases, i) the range of* λ *that allows the existence of "screening" equilibria shrinks; ii) the range where the "no-screening" equilibrium is unique increases.*

Proof. *See Appendix.*

In less concentrated markets, adverse selection problems are more severe, as each banks knows a smaller proportion of entrepreneurs. At the same time, the gain that each bank can make by deviating from the "screening" equilibrium is also larger, and more than compensates for the effect of adverse selection. Hence, the larger N, the lower the growth rate necessary to trigger a "screening war".

2.1.1 Equilibria with Asymmetric Banks

Consider the case where there are two banks, bank 1 and bank 2, with market shares γ and $1 - \gamma$, respectively. In this case, the smaller bank faces a more severe adverse selection problem, as the proportion of old entrepreneurs that it knows is smaller. Hence, there might be an equilibrium where the larger bank does not screen applicant borrowers, while the smaller one does. In other words, there might be an equilibrium where the larger bank keeps the smaller one out of the market, by virtue of its established informational dominant position. Its larger informational capital allows the dominant banks to take larger risks and not to screen applicant borrowers. Conversely, the smaller bank needs to screen perspective customers as it faces a worse distribution of unknown entrepreneurs.[12]

In the appendix we prove that depending on γ, there are two different sets of equilibria for the two-bank game. For γ close to $\frac{1}{2}$, that is for banks with similar market shares, the set of equilibria is the same as in the symmetric case: (s, s) for small λ, (d, d) for large λ, and multiple equilibria in the middle. For γ close to 1, that is for very asymmetric banks, the set of equilibria is different. The profile (s, s) is still an equilibrium for small λ, and the profile (d, d) an equilibrium for large λ. However, for intermediate λ, the unique equilibrium is one where the larger bank does not screen applicant borrowers, while the small bank does. We call this a blockaded entry equilibrium, as the larger bank prevents the small bank from attracting any customer by virtue of its better knowledge of the market.

This result has a straightforward implication in terms of financial sector liberalization policy. The entry or the threat of entry of new small banks can induce large incumbent banks to start a "screening" war with the intent to preserve their market share. In other words, by promoting competition, financial liberalization can push the system in a "no-screening" equilibrium.

3 Competition over Menu of Contracts

In this section we test the robustness of our findings by relaxing the assumption that banks compete solely over screening strategies. Here we consider a textbook model where banks are allowed to offer borrowers loan contracts with different interest rates associated to different collateral requirements. Banks are able to screen entrepreneurs by offering a menu of such contracts, as the indifference curves of bad and good borrowers on the collateral/interest rate plan have different slopes. It is our intuition that the results in this section would hold in a large variety of models where banks were endowed with a costly screening technology.

We modify the textbook model to consider informational asymmetries among financial intermediaries. As in the simple model of Section 2, we

[12] This result is similar to those in Dell'Ariccia, Friedman and Marquez (1999) that show that asymmetric information between financial intermediaries represents a barrier to entry in the banking industry.

assume that banks are able to learn the type of the entrepreneurs they finance through their bank-client relationship.

Consider the simple case where an entrepreneurial project gives a random return $\widetilde{y}$, and can either fail $(\widetilde{y}=0)$, or succeed $(\widetilde{y}=y)$. Entrepreneurs need an injection of $1 of external funds and are characterized by different probabilities of success: θ_g and θ_b, with $\theta_g > \theta_b$. As before we assume that good entrepreneurs are creditworthy while bad are not. That means that $\theta_g y > f$, and $\theta_b y < f$; where f is the risk-free gross interest rate for the banking system.

Banks can offer a menu of loan contracts $\left\{\left(C^k, R^k\right)\ k=g,b\right\}$. When a project fail banks can liquidate the collateral C at a cost $(1-\delta)\,C$, with $\delta<1$; when a project succeed banks obtain the repayment R.

To maintain a structure similar to that of our simplest model, we consider a two stage game. First, banks compete over a menu of contracts for the pool of customers whose type is unknown them.[13] Second, they are able to offer competitive contracts to their old clients whose type is known to them.

Entrepreneurs are risk neutral and profit maximizers. The expected profit per borrowers is

$$E(\Pi^k) = \theta_k\left(y - R^k\right) - (1-\theta_k)\,C^k;\ \text{for } k=g,b.$$

Finally, for simplicity, we assume that the reservation utility of the entrepreneurs is zero, as they have no access to non bank financing. Then, the individual rationality constraints can be written as

$$\theta_k\left(y - R^k\right) - (1-\theta_k)\,C^k = 0;\ \text{for } k=g,b.$$

3.1 Equilibrium

In this section, we establish a relationship between bank equilibrium strategies and the proportion of untested borrowers on the market.

We limit to the analysis of equilibria with symmetric banks. As described in Besanko and Thakor (1987), a Nash equilibrium is a profile of sets of contracts such that each bank makes non-negative profits on each contract, and there exists no other set of contracts that, if offered in addition to that set earns positive profits in the aggregate and non-negative profits individually.

[13]For each bank, this pool consists of all the new untested entrepreneurs seeking financing on the market, and the tested bad entrepreneurs rejected by competitor banks.

Under asymmetric information there are no "pooling" Nash equilibria (Rothschild and Stiglitz 1976), or in this case "no-screening" equilibria. Hence, in what follows we derive the conditions for the existence of a "screening" equilibrium, and we show that the spirit of the main result of the simple model presented in section 2 remains valid.

In a separating equilibrium, banks try to attract good borrowers and to screen out bad borrowers by offering a menu of contract that satisfy the IC constraint for the bad type and the IR constraint for the good type. In our particular case, the IC constraint for the bad type is also the IR constraint for the bad type as no alternative contract is offered to bad borrowers for their projects have negative present value. Hence, to find the competitive separating contract we have to impose the IR constraint for the bad type and the zero profit condition for the banks. Formally, the competitive separating contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ is the solution of the system[14]

$$\begin{aligned} \theta_g R - f + (1-\theta_g)\,\delta C &= 0 \qquad\qquad (Zero\ Profit) \\ \theta_b\,(y-R) - (1-\theta_b)\,C &= 0 \qquad\qquad (IC) \end{aligned}$$

The zero profit condition guarantees that no bank has an incentive to offer a different separating contract. The IC constraint guarantees that no bad borrower has an incentive to apply to this contract.

An additional requirement for a strategy profile where all banks offer the "separating" contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ to be an equilibrium is that no bank has to be able to make positive profits by offering a pooling contract $\left(\widetilde{R}, 0\right)$. This will establish a link between the proportion of untested borrowers in the economy and the existence of pure-strategy separating equilibria in this game.

First consider that, as bad borrowers' projects have a negative expected value, to be profitable any pooling contract has to attract new good borrowers, that is

$$\widetilde{R} < \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\ .$$

[14] Solving the system we obtain

$$\begin{aligned} \widehat{R}_s &= \frac{(1-\theta_b)\,f - \delta\,(1-\theta_g)\,\theta_b y}{(1-\theta_b)\,\theta_g - \delta\,(1-\theta_g)\,\theta_b}\ ; \\ \widehat{C}_s &= \frac{y\theta_b\theta_g}{(1-\theta_b)\,\theta_g - \delta\,(1-\theta_g)\,\theta_b} - \frac{\theta_b f}{(1-\theta_b)\,\theta_g - \delta\,(1-\theta_g)\,\theta_b}\ . \end{aligned}$$

In addition, the contract has to imply a payment such that the bank at least breaks even when financing all the new borrowers plus the old bad borrowers rejected by competitor banks, that is

$$\widetilde{R} \geq f \frac{\left(\frac{N-1}{N}\right)(1-\alpha)+\lambda}{\left(\frac{N-1}{N}\right)(1-\alpha)\,\theta_b+\lambda\overline{\theta}} \; ;$$

where $\overline{\theta}$ is the average market credit-worthiness: $\overline{\theta} = \alpha\theta_g + (1-\alpha)\theta_b$. Hence, we can write the necessary and sufficient condition for the strategy profile where all banks offer the single contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ to be a Nash equilibrium as

$$f \frac{(N-1)(1-\alpha)+\lambda N}{(N-1)(1-\alpha)\,\theta_b+\lambda\overline{\theta}N} \leq \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s \; . \tag{2}$$

As the distribution of applicant borrowers faced by the deviating bank improves with λ, the separating contract strategy profile will be always an equilibrium if no bank would deviate for $\lambda = \infty$. In other words, the separating solution is always an equilibrium if the type distribution is bad enough and the liquidation cost is low enough that pooling is non profitable even in the absence of adverse selection problems caused by informational asymmetries among banks. However, if at $\lambda = \infty$ it is profitable to deviate from the separating equilibrium, then the equilibrium set for the game will depend on λ. We can state this condition as

$$\frac{f}{\overline{\overline{\theta}}} \leq \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s \tag{3}$$

Symmetrically, the difference in creditworthiness between the two types and the bankruptcy cost $(1-\delta)$ have to be such that at $\lambda = 0$, banks have an incentive to screen borrowers. A sufficient condition for that is

$$(1-\delta) < \frac{\theta_g - \theta_b}{\theta_g} \tag{4}$$

meaning that the deadweight loss associated with the liquidation of collateral has to be smaller than the relative difference in the creditworthiness of the two types.

Then, we have the following lemma (corresponding to Lemma 2)

Lemma 6 *If condition 3 and 4 are verified, then there will exist a* $\widehat{\lambda}_2$ *such that the strategy profile where all banks offer the contract* $\left(\widehat{R}_s, \widehat{C}_s\right)$ *is an equilibrium for the game if and only if* $\lambda \leq \widehat{\lambda}_2$.

Proof. See Appendix.

For λ higher than $\widehat{\lambda}_2$, the distribution of unknown applicant borrowers faced by each individual bank becomes too creditworthy for a pure-strategy separating equilibrium to exist.

The intuition is the following. For good entrepreneurs, the perfect sorting of the separating equilibrium carries the advantage of a lower interest rate and the cost of a higher collateral (see Hellwig, 1987). The need to post a collateral generates an inefficiency to the extent that liquidation costs exist. That inefficiency can be seen as the cost of "sorting". If the average creditworthiness of applicant borrowers is good enough (as for $\lambda > \widehat{\lambda}_2$), the costs of sorting exceeds its benefits. In that case the separating contract constellation is strictly dominated by some pooling contract $(R_p, 0)$ and no pure strategy Nash equilibrium exists. Hellwig (1987) shows that a zero-profit pooling contract can be sustained as an equilibrium in an extended three stage version of the game, where banks may reject a loan application in the third stage.

The implications of this result are similar to those of the simpler model presented in the previous section. A larger proportion of new untested borrowers on the market improves the average quality of the population of applicant borrowers that each bank is facing. This diminishes the benefits associated with sorting applicant borrowers, and, hence, the incentive to screen bad from good borrowers. Consequently, for a small λ a separating equilibrium exists, for a large λ there is an equilibrium in mixed strategy where bad borrowers are financed with positive probability.

4 Financial Sector Liberalization

A growing literature has documented that episodes of financial distress are likely to follow periods of strong credit expansion. Goldfajn and Valdes (1998) and Drees and Pazarbasioglu (1998) report that strong credit growth was observed before most banking crises. Argentina 1980, Chile 1982, Sweden, Norway, and Finland 1992, Mexico 1994 and Thailand, Indonesia, and Korea 1997 are the most significant examples. In some, but not all cases, credit expansion was spurred by the deregulation of the financial sector that increased competition in the banking system and/or granted access to credit market to new subjects.

More formalized empirical results are in the econometric work by Demirguc-Kunt and Detragiache (1998) that find some evidence that lending booms precede banking crises. Similarly, Hardy and Pazarbasioglu (1998) find that there is robust evidence that credit to the private sector follows a boom and bust pattern in advance of banking crises. Finally, Gourinchas, Valdes, and Landerretche (1999) examine a large number of episodes characterized as lending booms and find that the probability of having a banking crises significantly increases after such episodes. Moreover, they find that the conditional incidence of having a banking crises depends critically on the size of the boom.

In this section, we analyze that evidence in the context of our model. In particular, we propose two different scenarios in which a financial sector liberalization may lead to reduced screening, lending booms, and the subsequent worsening of bank portfolio quality.

As first scenario, consider a situation where in addition to adverse selection there is moral hazard, meaning that borrowers obtain some private benefit from defaulting on their debt. In such a case, collateral requirements absolve two functions, first they serve to limit moral hazard, second (as in the model presented above) they serve to screen applicant borrowers limiting adverse selection.

In such a world, all loans would be subject to a minimum collateral requirement, independently from the strategy played by the banks.[15] Consequently, a capital account liberalizations could affect the financial sector equilibrium through the wealth effect stemming from the increase in the real value of the collateralizable goods in the economy.

In the presence of a non uniform distribution of wealth, capital inflows, by raising the value of collateralizable goods, would increase the number of new applicant borrowers in the economy. Indeed, "potential" entrepreneurs that previously would have not possessed enough wealth to post the minimum collateral requirement, would now find themselves in the position to apply for credit, increasing the proportion of new untested applicants in the market, λ. Furthermore, in a dynamic context, relatively small capital inflows could potentially start a multiplicative process similar to that in Kiyotaki and Moore (1997), with larger aggregate credit reflecting later in further increases in collateral value and so on; with the additional complication that in a dynamic version of our model, the original Kiyotaki and Moore mechanism

[15] In the absence of a minimum collateral requirement, no borrower would repay her debt. The size of such requirement would depend on the private benefits that entrepreneurs were able to obtain by defaulting on their debt.

would be amplified by the strategic behavior of financial intermediaries.

In the simple static framework presented in this paper, an increase in λ caused by capital inflows, if large enough, may switch the model from a separating to a screening equilibrium with two consequences. First, the multiplicative effect on credit demand would cause a lending boom, as in addition to new borrowers, also bad borrowers previously screened out would be now granted credit. Second, banks would see their loan portfolio deteriorated and their profit margins decline.

As second scenario, consider an economy where banks have a limited capacity to make loans. In such a situation, an injection of liquidity may induce banks to switch from a separating to a pooling strategy, by increasing their capacity to make new loans, .

Indeed, it easy to show that in the presence of binding capacity constraints the screening equilibrium may be a solution even with a large proportion of untested borrowers in the market, $\lambda > \lambda_1$. With limited lending capacity, the incentive to switch to a no-screening strategy is reduced as the deviating bank would no be able to finance all the newly attracted applicant borrowers. Then, to the extent that capital inflows increase the lending capacity of the banking system, they may trigger a switch from a screening to a no-screening equilibrium, generating a lending boom and a deterioration of bank portfolios.

5 The Role of Market Structure

Financial sector liberalizations may take the form of a relaxation of legal barriers to the entry of foreign banks (and new banks in general). Unfortunately, unlike for the other results in this paper, our predictions with regard to the relationship between market structure and bank screening seem to be rather dependent on the form of competition assumed in the model. In the simpler model in the first part of this paper, a less concentrated industry structure is associated with reduced room for screening equilibria. In the second, more complex, model, a less concentrated industry structure results in more room for pure-strategy separating equilibria.

The relationship between market structure and screening is the resultant of two effects. On the one hand, to a larger number of competing banks corresponds a more severe adverse selection problem (as the proportion of borrowers known to each bank shrinks), and a consequently increased incentive to screen applicant borrowers. On the other hand, to a larger number of competing banks also corresponds a stronger temptation to deviate from a screening equilibrium (as the extra market share a deviating bank would be able to grasp increases), and a consequently increased incentive to stop screening applicant borrowers. The sign of the relationship between market structure and screening incentives depends on the relative strength of these two forces.

The modality of competition among banks determines equilibrium profits and the relationship between profits and market share. The incentive to gain market share (and, hence, the incentive to deviate from a screening equilibrium) depends crucially on such relationship. In our first model, the absence of competition over interest rates makes the extra-profit motive prevail. In our second model, the extreme form of competition (Bertrand-like) makes the adverse selection effect prevail.

6 Conclusions

This paper presented a model where strategic interaction among banks leads the banking system as whole to behave perversely with regard to screening applicant borrowers, with high (low) proportions of untested borrowers associated with less (more) bank screening. The results in the paper may help interpreting stylized facts relative to lending booms and banking crises.

The framework presented in this paper is a simple single-period model. However, it could be easily extended to the multiperiod case, by considering a repeated game, where banks competed for overlapping generations of borrowers. Most results would remain qualitatively the same, but the model would result significantly more complex.

It is our intuition that the analysis of collusive equilibria would also be consistent with our results. Collusive equilibria would tend to collapse when the share of untested borrowers in the economy were high, in a way related to what happens in Rotemberg and Saloner (1986) when demand is high. From that point of view, in our model, adverse selection may be seen as playing the role of a coordinating device, forcing banks to screen applicant borrowers.

Appendix

A Two Bank Case

Lemma 1 *For any creditworthy distribution of entrepreneurs there will exist a* $\widehat{\lambda}_1 \in [0,+\infty)$, *such that the profile* $(d,d,)$ *represents a Nash equilibrium if and only if* $\lambda \geq \widehat{\lambda}_1$.

Proof. Assume that the distribution of entrepreneurs is creditworthy on average, meaning

$$[\alpha\theta_g + (1-\alpha)\,\theta_b]R > c$$

We know that

$$\Pi(d,d) = \frac{1}{2}[\lambda\alpha(\theta_g R - c) + (1+\lambda)(1-\alpha)(\theta_b R - c)]$$

In order for a "no-screening" equilibrium to exist it has to be

$$\Pi(d,d) = \frac{1}{2}[\lambda\alpha(\theta_g R - c) + (1+\lambda)(1-\alpha)(\theta_b R - c)] \geq 0$$

that can be rewritten as

$$\lambda \geq \frac{-(1-\alpha)(\theta_b R - c)}{\alpha(\theta_g R - c) + (1-\alpha)(\theta_b R - c)} = \widehat{\lambda}_1$$

q.d.e. ■

Lemma 2 *For any creditworthy distribution of entrepreneurs where "bad" types have a negative expected return, i) if condition 1 holds, there will exist a* $\widehat{\lambda}_2 > 0$ *such that the strategy profile* (s,s) *represents a Nash equilibrium if and only if* $\lambda \leq \widehat{\lambda}_2$ *; ii) if condition 1 does not hold, the strategy profile* (s,s) *represents a Nash equilibrium for any* $\lambda \in [0,\infty)$.

Proof. We know that

$$\Pi(s,s) = \frac{\lambda\alpha(\theta_g R - c)}{2}$$

in order for the profile (s,s) to be a Nash equilibrium, it has to be

$$\Pi(s,s) \geq \Pi(d,s)$$

that is

$$\frac{\lambda\alpha(\theta_g R - c)}{2} + \left(\frac{1}{2} + \lambda\right)\alpha(\theta_b R - c) \leq 0$$

that, under condition 1, rewriting becomes

$$\lambda \leq \frac{-(1-\alpha)(\theta_b R - c)}{\alpha(\theta_g R - c) + 2(1-\alpha)(\theta_b R - c)} = \widehat{\lambda}_2$$

or, alternatively, if condition 1 does not hold

$$\lambda \geq \frac{-(1-\alpha)(\theta_b R - c)}{\alpha(\theta_g R - c) + 2(1-\alpha)(\theta_b R - c)} = \widehat{\lambda}_2.$$

In the latter case $\widehat{\lambda}_2 < 0$ meaning that the distribution of entrepreneurs is "bad" enough to guarantee the existence of "screening" equilibria for any $\lambda > 0$. q.d.e. ■

Proposition 1 *The set of Nash equilibria for the game is fully determined by λ : i)If condition 1 holds: for $\lambda > \widehat{\lambda}_2$, the strategy profile (d, d) is the unique equilibrium; for $\lambda < \widehat{\lambda}_1$, the profile (s, s) is the unique equilibrium; and for $\widehat{\lambda}_1 \leq \lambda \leq \widehat{\lambda}_2$ there are both a "screening" and a "no-screening" equilibrium in pure strategies and one equilibrium in mixed strategies. ii)If condition 1 does not hold: for $\lambda < \widehat{\lambda}_1$, the profile (s, s) is the unique equilibrium; and $\widehat{\lambda}_1 \leq \lambda$ there are both a "screening" and a "no-screening" equilibrium in pure strategies and one equilibrium in mixed strategies.*

Proof. *i*) We know that

$$(1-\alpha)(\theta_b R - c) < 0,$$

it follows that

$$\widehat{\lambda}_1 < \widehat{\lambda}_2.$$

Hence, by applying Lemmas 1 and 2, we obtain Proposition 1 (*i*).

It easy to show that for $\widehat{\lambda}_1 \leq \lambda \leq \widehat{\lambda}_2$, in addition to the two pure strategy equilibria, it also exists an equilibrium in mixed strategies.

ii) From Lemma 2, we know that a "screening" equilibrium always exists when condition 1 is violated. From Lemma 1, we know that a "no-screening" equilibrium exists if and only if $\widehat{\lambda}_1 \leq \lambda$. The rest follows as in (*i*). q.d.e. ■

B *N*-Bank Case

Lemma 3 *For any creditworthy distribution of entrepreneurs and any number of banks in the market, $N \geq 2$, there will exist a $\widehat{\lambda}_1(N) \in [0, +\infty)$, such that the strategy profile $(d, d, d, ..., d)$ represents a Nash equilibrium if and only if $\lambda \geq \widehat{\lambda}_1(N)$.*

Proof. In order for a strategy profile where all banks choose not to screen applicant borrowers to be a Nash equilibrium, no one-sided profitable deviation must exists. That is for any $i \in [1, N]$ it has to be

$$\Pi_i(d_i, d_{-i}) \geq \Pi_i(s_i, d_{-i})$$

that solving for λ, gives

$$\lambda \geq \frac{-(1-\alpha)(\theta_b R - c)}{\alpha(\theta_g R - c) + (1-\alpha)(\theta_b R - c)} = \widehat{\lambda}_1$$

q.d.e. ■

Lemma 4 *If Condition 1 holds, for any creditworthy distribution of entrepreneurs where "bad" types have a negative expected return and any number of banks in the market,* $N \geq 2$*, there will exist a* $\widehat{\lambda}_2(N)$*, such that the strategy profile* $(s, s, s, ..., s)$ *is a Nash equilibrium if and only if* $\lambda \leq \widehat{\lambda}_2$ *.*

Proof. In order for a strategy profile where all banks choose not to screen applicant borrowers to be a Nash equilibrium, no one-sided profitable deviation must exists. That is for any $i \in [1, N]$ it has to be

$$\Pi_i(s_i, s_{-i}) \geq \Pi_i(d_i, s_{-i})$$

that solving for λ, gives

$$\lambda \leq \frac{-(1-\alpha)(\theta_b R - c)}{\alpha(\theta_g R - c) + \frac{N}{N-1}(1-\alpha)(\theta_b R - c)} = \widehat{\lambda}_2;$$

where $\widehat{\lambda}_2 > 0$ if condition 1 holds. q.d.e. ■

Proposition 2 *If Condition 1 holds, the set of Nash equilibria for an industry with* N *banks is fully determined by* λ*. For* $\lambda > \widehat{\lambda}_2(N)$*, the strategy profile* $(d, d, d, ..., d)$ *is the unique Nash equilibrium for the game; for* $\lambda < \widehat{\lambda}_1(N)$*, the strategy profile* $(s, s, s, ..., s)$ *is the unique Nash equilibrium; and for* $\widehat{\lambda}_1 \leq \lambda \leq \widehat{\lambda}_2$ *, both* $(d, d, d, ..., d)$ *and* $(s, s, s, ..., s)$ *are Nash equilibria in pure strategies, while one equilibrium in mixed strategies exists.*

Proof. The proof is the same as for the two-bank case, and follows directly from Lemmas 3 and 4. q.d.e. ■

Lemma 5 *As* N *increases, i) the range of* λ *that allows the existence of "screening" equilibria shrinks; ii) the range where the "no-screening" equilibrium is unique increases.*

Proof. *i)* $\widehat{\lambda}_2(N)$ is decreasing in N . *ii)* $\lim_{N \to \infty} \widehat{\lambda}_2(N) = \widehat{\lambda}_1(N)$. q.d.e. ■

C Equilibria with Asymmetric Banks

Consider the case with two banks, 1 and 2, with market shares γ and $1-\gamma$, respectively, with $\gamma \geq \frac{1}{2}$. Assume that condition 1 holds. For simplicity of exposition let us define, as before,

$$\begin{aligned} A &= \alpha(\vartheta_g R - f) > 0 \\ B &= (1-\alpha)(\vartheta_b R - f) < 0 \end{aligned}$$

then we can write the game in normal form as

$(\gamma) 1 \backslash 2\ (1-\gamma)$	Screen, s	Do not Screen, d
Screen, s	$\frac{\lambda A}{2}$, $\frac{\lambda A}{2}$	0, $\lambda A+\lambda B+\gamma B$
Do not Screen, d	$\lambda A+\lambda B+(1-\gamma) B$, 0	$\frac{\lambda(A+B)}{2}+(1-\gamma) B$, $\frac{\lambda(A+B)}{2}+\gamma B$

Hence, in order for the profile (s, s) to be a Nash equilibrium, no one-sided deviation must be profitable. The condition for the larger bank (bank 1) not to deviate from the screening equilibrium is more restrictive, as the smaller bank faces a more severe adverse selection problem. The condition is

$$\frac{\lambda A}{2}>\lambda A+\lambda B+(1-\gamma) B$$

that, under condition 1, solving for λ gives

$$\lambda \leq-\frac{2(1-\gamma) B}{A+2 B}=\widehat{\lambda}_{2 l}(\gamma)$$

The condition for the bank 2, the smaller one, under condition 1, is not binding and is

$$\lambda \leq-\frac{2 \gamma B}{A+2 B}=\widehat{\lambda}_{2 s}(\gamma)$$

where, given $\gamma \leq \frac{1}{2}$, we have

$$0<\widehat{\lambda}_{2 l}(\gamma) \leq \widehat{\lambda}_{2 s}(\gamma)$$

Hence, under condition 1, the strategy profile (s, s) is a Nash equilibrium for the two-bank game with shares $(\gamma, 1-\gamma)$, if and only if $\lambda \leq \widehat{\lambda}_{2 l}(\gamma)$.

If condition 1 does not hold the strategy profile (s, s) is a Nash equilibrium for any $\lambda \in[0, \infty)$. q.d.e. ■

Analogously, we can derive the conditions under which the strategy profile (d, d) is a Nash Equilibrium. For the smaller bank (bank 2), we can write

$$\frac{\lambda(A+B)}{2}+\gamma B \geq 0$$

that solving for λ, gives

$$\lambda \geq \frac{-2 \gamma B}{A+B}=\widehat{\lambda}_{1 s}(\gamma) \ .$$

The condition for the larger bank (bank 1) is not binding and is

$$\lambda \geq \frac{-2(1-\gamma) B}{A+B}=\widehat{\lambda}_{1 l}(\gamma) \ .$$

Hence, the profile (d, d) is a Nash equilibrium if and only if

$$\lambda \geq \widehat{\lambda}_{1 s}(\gamma) \geq \widehat{\lambda}_{1 l}(\gamma) \ .$$

q.d.e. ■

Blockaded equilibrium?

Depending on γ, we have two possible chains of inequalities. For γ not too far from $\frac{1}{2}$, that is

$$\frac{\gamma}{1-\gamma} < \frac{A+B}{A+2B}$$

we have

$$\widehat{\lambda}_{1l}(\gamma) \ \leq \widehat{\lambda}_{1s}(\gamma) \leq \widehat{\lambda}_{2l}(\gamma) \leq \widehat{\lambda}_{2s}(\gamma)$$

and, hence, the same set of equilibria as in the symmetric case. For very asymmetric banks, that is

$$\frac{\gamma}{1-\gamma} > \frac{A+B}{A+2B}$$

we have

$$\widehat{\lambda}_{1l}(\gamma) \ \leq \widehat{\lambda}_{2l}(\gamma) \leq \widehat{\lambda}_{1s}(\gamma) \leq \widehat{\lambda}_{2s}(\gamma) \ .$$

In that case, for $\lambda \in \left[\widehat{\lambda}_{2l}(\gamma), \widehat{\lambda}_{1s}(\gamma)\right]$ the strategy profile (d, s) is the unique Nash equilibrium. In other words, there is an equilibrium where the larger bank blockades out the smaller one by virtue of its market share. The smaller bank faces an adverse selection problem so severe that it has to screen applicant borrowers independently from the strategy of the larger bank. For $\lambda \in \left[\widehat{\lambda}_{1s}(\gamma), \infty\right)$, the profile (d, d) is the unique Nash equilibrium, while for $\lambda \in \left[0, \widehat{\lambda}_{2l}(\gamma)\right]$ the strategy profile (s, s) is the unique equilibrium.

D Competition over Menu of Contracts

Lemma 6 *If $\frac{f}{\theta} < \widehat{R}_s + \left(\frac{1-g}{g}\right)\widehat{C}_s$ and $(1-\delta) < \frac{\theta_g - \theta_b}{\theta_g}$, then there will exist a $\widehat{\lambda}_2$ such that the strategy profile where all banks offer the contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ is an equilibrium for the game if and only if $\lambda \leq \widehat{\lambda}_2$.*

Proof. *The zero profit condition on screening contracts can be written as*

$$\theta_g \widehat{R}_s + \delta\left(1-\theta_g\right)\widehat{C}_s - f = 0$$

that means

$$\frac{\theta_g\left(1-\theta_b\right)f - \delta\left(1-\theta_g\right)\theta_g\theta_b y}{\left(1-\theta_b\right)\theta_g - \delta\left(1-\theta_g\right)\theta_b} + \frac{y\theta_b\theta_g\left(1-\theta_g\right)}{\left(1-\theta_b\right)\theta_g - \delta\left(1-\theta_g\right)\theta_b}$$

$$-\frac{f\theta_b\left(1-\theta_g\right)}{\left(1-\theta_b\right)\theta_g - \delta\left(1-\theta_g\right)\theta_b} - f = 0$$

for ease of exposition define

$$\begin{aligned} D &= \left(1-\theta_b\right)\theta_g - \delta\left(1-\theta_g\right)\theta_b \\ \mu &= \frac{N-1}{N} \end{aligned}$$

then we have

$$\frac{(\theta_g - \theta_b) f}{D} + \frac{y\theta_b\theta_g (1-\theta_g)(1-\delta)}{D} - f = 0$$

Hence,

$$fD = (\theta_g - \theta_b) f + y\theta_b\theta_g (1-\theta_g)(1-\delta)$$

Condition 2 can be rewritten as

$$\lambda \left(\overline{\theta} f (\theta_g - \theta_b) + \overline{\theta}(1-\delta)(1-\theta_g) y\theta_b\theta_g - f\theta_g D\right) \leq$$

$$-f(\theta_g - \theta_b)\mu(1-\alpha)\theta_b - (1-\delta)(1-\theta_g)\mu(1-\alpha) y\theta_b^2\theta_g + f\mu(1-\alpha)\theta_g D$$

given

$$\frac{f}{\overline{\overline{\theta}}} < \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s$$

we can rewrite condition 2 as

$$\lambda \leq \frac{-f(\theta_g - \theta_b)(\mu(1-\alpha)\theta_b) - (1-\delta)(1-\theta_g) y\theta_b\theta_g(\mu(1-\alpha)\theta_b) + f(\mu(1-\alpha))\theta_g D}{\left(\overline{\theta} f (\theta_g - \theta_b) + \overline{\theta}(1-\delta)(1-\theta_g) y\theta_b\theta_g - f\theta_g D\right)}$$

that substituting from the zero profit condition for the separating contract becomes

$$\lambda \leq \frac{\frac{N-1}{N}(1-\alpha) fD(\theta_g - \theta_b)}{\overline{\theta} f (\theta_g - \theta_b) + \overline{\theta}(1-\delta)(1-\theta_g) y\theta_b\theta_g - f\theta_g D}$$

that is positive as long as condition 4 holds. q.d.e.

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