DISCUSSION PAPER SERIES

No. 5095

LENDING BOOMS AND LENDING STANDARDS

Giovanni Dell'Ariccia and Robert Marquez

FINANCIAL ECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: www.cepr.org/pubs/dps/DP5095.asp

ISSN 0265-8003

LENDING BOOMS AND LENDING STANDARDS

Giovanni Dell'Ariccia, International Monetary Fund (IMF) and CEPR
Robert Marquez, University of Maryland

Discussion Paper No. 5095
June 2005

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 5095

June 2005

ABSTRACT

Lending Booms and Lending Standards*

This paper examines how the informational structure of loan markets interacts with banks' strategic behaviour in determining lending standards, lending volumes, and the aggregate allocation of credit. In a setting where banks obtain private information about their clients' creditworthiness, we show that banks may loosen lending standards when information asymmetries *vis à vis* other banks are low. In equilibrium this reduction in standards leads to a deterioration of banks' portfolios, a reduction in their profits, and an aggregate credit expansion. Furthermore, we show that although these low standards may increase aggregate surplus, they also increase the risk of financial instability. We therefore provide an explanation for the sequence of financial liberalization, lending booms, and banking crises that have occurred in many emerging markets.

JEL Classification: D82 and G21
Keywords: asymmetric information, banking competition and lending standards

Giovanni Dell'Ariccia
Asia and Pacific Department
International Monetary Fund
700 19th Street NW
Washington DC 20431
USA
Tel: (1 202) 623 8135
Fax: (1 202) 589 8135
Email: gdellariccia@imf.org

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=144737

Robert Marquez
Smith School of Business
University of Maryland
College Park
MD 20742
USA
Tel: (1 301) 405 8641
Fax: (1 301) 405 0359
Email: rmarquez@rhsmith.umd.edu

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=161760

*We would like to thank Patrick Bolton, Tito Cordella, José de Gregorio, Gianni De Nicoló, Paolo Fulghieri, Ilan Goldfajn, Pietro Garibaldi, Christa Hainz, George McCandless, Beatrix Paal, Bruno Parigi, Carmen Reinhart, David Webb, and seminar participants at the University of Minnesota, University of North Carolina, University of British Columbia, Wharton School of Business, Columbia University, the IMF, the Federal Reserve Banks of New York and San Francisco, the ECB, the 2004 Financial Intermediation Research Society Conference, the 2003 European University Institute conference on the 'Micro-Structure of Credit Contracts', the 2003 conference on 'Competition in Banking Markets' held at Leuven, and the First Workshop of the Latin American Finance Network (2003) for useful suggestions. A previous version of this paper was presented at the Wharton-CFS conference on bank competition. All remaining errors are ours. The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF or CEPR.

Submitted 16 May 2005

1 Introduction

Banks perform an important role of limiting adverse selection problems in the economy by screening out applicant borrowers that do not meet satisfactory lending standards. Failure to perform this function leads to riskier portfolios and weaker balance sheets, with potentially negative consequences for the stability of credit markets. The focus of this paper is on how the distribution of information about borrowers across banks interacts with banks' strategic behavior in determining lending standards, lending volumes, and the aggregate allocation of credit.

Our analysis shows that reducing information asymmetries across banks may lead to an easing of lending standards, with a consequent increase in the volume of lending. This "lending boom" is accompanied by a deterioration of bank portfolios as well as by lower and more volatile profits, making banks more prone to financial distress if the economy hits a downturn. Therefore, changes in the information structure of the market can have a significant impact on the likelihood of a banking crisis. Our work thus establishes a new explanation for the relationship between lending booms and episodes of financial distress highlighted in recent empirical studies.[1]

To study this issue formally, we present a model of a credit market where banks have private information about the creditworthiness of some borrowers ("known" borrowers) but not about others ("unknown" borrowers). For this latter set, banks can use collateral requirements to sort "good" from "bad" borrowers, or they can choose to lend with no such requirement. The informational asymmetries across banks and between banks and borrowers cause adverse selection problems and represent the main incentives for banks to screen loan applicants.

We show that, when the proportion of unknown borrowers in the market is sufficiently low, banks will choose in equilibrium to screen out bad borrowers by demanding a sufficiently high collateral requirement. However, when the proportion of unknown borrowers is high, banks will instead offer a contract with no collateral requirement, granting credit to all

[1] See, for example, Kaminsky and Reinhart (1999), Gourinchas et al. (2001), Tornell and Westermann (2001), and Demirgüç-Kunt and Detragiache (2002).

borrowers indiscriminately. The intuition is the following. When extending credit, banks are approached either by entrepreneurs with new or untested projects, or by those whose projects have been previously evaluated and rejected by competitor banks. To the extent that banks cannot distinguish between these two groups, when the proportion of new projects in the market increases, the distribution of borrowers applying to each bank improves as well. In this situation, banks find it profitable to attract customers by reducing collateral requirements, hoping to undercut their competitors and increase their market share.

An implication of these findings is that the switch from tight lending standards (enforced by collateral requirements) to a looser regime where all borrowers obtain credit leads to a credit expansion beyond the original increase in the demand for credit which triggered the shift in banks' lending strategies. In other words, it leads to a lending boom. Moreover, the pooling of borrowers that occurs is (second-best) efficient since it is optimal exactly when the costs associated with collateral liquidation exceed those associated with the financing of bad borrowers. Booms, therefore, by avoiding the inefficient liquidation of collateral, maximize aggregate surplus. There is a downside, however, in that the associated reduction in screening results in a banking system with a deteriorated loan portfolio and with lower profits. Moreover, the expansion in credit increases the sensitivity of bank profits to aggregate shocks, making the banking system more susceptible to downturns in the economy. A lending boom induced by a reduction in information asymmetries can therefore lead to a higher probability of a banking crisis. We thus demonstrate the existence of a trade-off between output and banking system stability.

The analysis in this paper is relevant for regulatory and competition policy, as it suggests that policies that bring an inflow of borrowers may reduce the amount of screening banks do and increase the probability of systemic financial distress. It also highlights possible negative aspects of the expansionary phases of the business cycle when more firms may be seeking credit. In both of these instances, the proportion of unknown borrowers (or projects) in a market increases. This proportion can also change due to the introduction of new technology or changes in the value of collateralizable assets. In all these occasions, banks may reduce their lending standards and expand credit, increasing aggregate surplus but, at the same time, increasing the probability of a banking crisis. Our results also suggest that lending booms and the associated weakening of bank portfolios can be the outcome of financial reforms that modify the competitive landscape of credit markets. This is particularly relevant given recent evidence that, in many instances, banking crises and periods of financial distress have been preceded by financial reforms without a concomittant strengthening of regulatory and supervisory frameworks (see, e.g., Gourinchas et al., 2001). For instance, we show that capital inflows, such as those that often accompany capital account liberalizations, reduce the cost of financing for banks and increase the likelihood of both a credit boom and a banking crisis. We also show that the introduction of the threat of competition into a protected monopolistic market may induce the incumbent to switch from the screening to the pooling of borrowers. This latter result is important for the analysis of the effects of financial liberalizations that allow new entry into previously regulated credit markets.

While our initial analysis assumes that banks can make maximal use of their private information, our results continue to hold even if banks share information about borrowers, such as the history of past defaults. This case of "black information" sharing is of particular interest since this information is often available through credit bureaus. We show that, although this kind of information sharing always increases aggregate output, in many instances it reduces bank profitability and may therefore not emerge endogenously. Furthermore, policies that mandate that banks collect and disseminate black information reduce bank profitability and increase lending volume, and may therefore increase the probability of a banking crisis. For completeness, we also examine the relationship between bank market concentration and borrower screening. We show that adverse selection and, therefore, the benefit from screening borrowers, is stronger in markets with a larger number of banks.

By establishing a link between the notion that banks' willingness to screen borrowers depends on the distribution of these potential borrowers and the idea that under asymmetric information competition generates an adverse selection problem for banks, this paper provides two main contributions.[2] First, it relates changes in bank lending standards and screening behavior to changes in credit demand and the informational structure of the mar-

[2] For models illustrating the former, see, for example, Bester (1985), Dasgupta and Maskin (1986), Besanko and Takor (1987), and Hellwig (1987). For the latter, see, for example, Broecker (1990), Dell'Ariccia (2001), Marquez (2002), and von Thadden (2004).

ket. Second, it provides a novel mechanism linking lending booms and banking crises to the quality of the projects financed by banks. Recent papers have related bank screening to an improvement in the prospects of businesses (Ruckes, 2004), or to attrition in the ranks of loan officers skilled at identifying bad loans (Berger and Udell, 2004). We show that changes in the information structure of the market may themselves play a role in transmitting macroeconomic shocks to the banking system. Furthermore, we show (in Appendix B) that this effect does not depend on the exact mechanism banks use for acquiring information, and that similar issues arise if instead of collateral requirements we focus, for instance, on costly credit screens as a means of generating information about borrowers.

Recent work has investigated the issue of credit cycles and variable credit standards. In Rajan (1994), bank managers with short-term concerns choose the bank's credit policies. When most borrowers are doing well, bank managers relax credit standards to hide losses on bad loans and protect their own reputation. When a common negative shock hits a sector, reputational considerations diminish and bank managers tighten credit standards. Ruckes (2004) presents a model where variations in the quality of borrowers over the cycle can affect the standards banks apply in lending. Similarly, Weinberg (1995) shows that an increase in the expected payoff of all borrowers' projects can lead banks to grant loans to borrowers with a lower success probability. In this paper we obtain switches in banks' screening behavior without assuming changes in the overall creditworthiness of borrowers.[3] Kiyotaki and Moore (1997) study how the interaction between asset prices and credit limits set by collateral amplifies the size and duration of shocks. In their model, however, the quality of loans banks finance does not vary over the cycle. Here, we identify an additional mechanism that magnifies credit swings through changes in the distribution of information, linking the average creditworthiness of banks' portfolios to the volume of credit that banks extend. More closely related is the recent work of Manove, Padilla, and Pagano (2001) on "lazy banks", which shows that the act of sorting borrowers through collateral requirements

[3] Our findings are also similar to those of Berlin and Butler (2002), who show that increasingly competitive markets can lead to less stringent collateral requirements. In our model, information asymmetries limit competition, so that reductions in these asymmetries lower the barriers to competition. See also Gorton and He (2003) and Gehrig and Stenbacka (2003), who identify alternative channels for swings in lenders' standards for granting credit.

may reduce additional bank screening. In our model the reduction in the use of collateral reflects the fall in lending standards and leads to a credit boom.

There is also a recent empirical literature on how banks' lending standards vary over the cycle and are related to the volume of lending and output.[4] By focusing on the effects of changes in the demand for credit, our model identifies one important channel through which macroeconomic cycles affect the banking system. However, since we purposefully hold fixed the creditworthiness of borrowers in order to isolate the effect of information, our framework does not explicitly address how banks behave over the business cycle (although see the discussion in Section 5.1). In the concluding section we discuss how the predictions of our model fit the findings of recent empirical work on the cyclicality of standards and on loan collateralization.

The paper proceeds as follows. Section 2 presents a model where banks compete for both known and unknown borrowers. Section 3 solves the model and examines its welfare implications. The implications of the analysis for banking crises are studied in Section 4. Section 5 discusses the role of bank market structure and contestability, and how our framework can be applied to the analysis of the business cycle. Section 6 extends the analysis to incorporate information sharing. In Section 7, we examine in greater detail the testable implications of our model as well as the recent empirical evidence.

2 Model

Consider an economy where there is a continuum of entrepreneurs of mass $1+\lambda$, each of which has a known end-of-period endowment W.[5] Each entrepreneur is endowed with a project that requires a capital inflow of \$1 and which gives a payoff of $\widetilde{y} = y > 0$ in case of success and $\widetilde{y} = 0$ in case of failure. There are two types of entrepreneurs: good and bad, with probability of success θ_g and θ_b, respectively, with $\theta_g > \theta_b$.[6] Good entrepreneurs are

[4]See, for example, Asea and Blomberg (1998), Lown and Morgan (2003), and Berger and Udell (2004).

[5]We assume throughout that $W \geq \frac{\theta_b\left(y\theta_g - \overline{d}\right)}{(1-\theta_b)\theta_g - \delta(1-\theta_g)\theta_b}$, which is a sufficient condition for borrowers to be able to meet any collateral requirement by the banks in equilibrium. We discuss the effect of loosening this restriction in Section 3.3.

[6]From now on, we will use the terms entrepreneur, project, and borrower interchangeably. Similarly, we will use the terms lender, intermediary, and bank interchangeably.

creditworthy while bad ones are not. Formally, this means $\theta_g y > \overline{d}$, and $\theta_b y < \overline{d}$, where $\overline{d}$ is the (risk-free) cost of funds for the banking system, such as the cost of insured deposits. We also assume that on average borrowers are creditworthy, $\overline{\theta} y > \overline{d}$,where $\overline{\theta} = \alpha\theta_g + (1-\alpha)\theta_b$.

The market for loans is composed of two groups of borrowers: a mass $\lambda \in [0, \infty)$ of unknown borrowers and a mass 1 of known borrowers. Known borrowers are those whose type is known to one of the banks; unknown borrowers are those whose type is unknown to any bank. We assume, however, that all borrowers know their own types. Both of these groups have the same distribution over types, with a fraction α of good projects and a fraction $1-\alpha$ of bad projects. When first approached by an applicant borrower, banks are unable to distinguish an unknown borrower from one whose type is known to a competitor bank.[7] We relax this assumption in Section 6.

There are N banks competing for borrowers. We consider the symmetric case where each bank possesses private information about a mass $\frac{1}{N}$ of borrowers, but the borrowers each bank knows are different. Therefore, each bank privately knows the type of a share $\frac{1}{N}$ of all the "known" borrowers, where these shares do not overlap.

We consider a three stage game. At stage 1, banks compete for the pool of customers whose type is unknown to them.[8] Banks can offer applicant borrowers a menu of loan contracts $\left\{ \left(R^k, C^k\right),\ k = g, b \right\}$, where $R \geq 0$ represents the repayment a bank obtains when the project succeeds, and $C \geq 0$ is the collateral a bank can liquidate when a project fails. Collateral liquidation is costly, so that the net value of the collateral to the bank is δC, with $\delta < 1$. The assumption of a positive liquidation cost reflects a setting where assets are more productive in use than under liquidation, and allows us to exclude the unrealistic case where banks pool borrowers by offering a contract with positive collateral and zero interest rate.

At stage 2, each bank observes the realization of stage 1 and can offer competitive con-

[7] This is a convenient way of introducing informational asymmetries among financial intermediaries. See Dell'Ariccia (2001) and Marquez (2002) for similar setups. An alternative interpretation is that all borrowers get evaluated in some way, but only a fraction $\frac{1}{1+\lambda}$ of these evaluations yield private information to a particular bank, with $\frac{\lambda}{1+\lambda}$ of them yielding inconclusive information, so that these borrowers' type is unknown to any lender. Similarly, $\frac{1}{1+\lambda}$ can also represent the probability that the success rate of any given borrower's project is correlated across time, so that the ratio $\frac{\lambda}{1+\lambda}$ represents the fraction of the population whose type will be unknown to any bank. All results go through exactly as stated under these alternative setups.

[8] For each bank, this pool consists of all the unknown entrepreneurs on the market seeking financing (mass λ), and the entrepreneurs known to competitor banks (mass $\frac{N-1}{N}$).

tracts to the borrowers whose type it knows. Borrowers then choose their preferred contract among those offered. This timing assumption captures the idea that borrowers are able to observe public offers made by all banks and can use them to bargain for better conditions from the bank that knows them. Finally, at the third stage, banks have the opportunity to reject borrowers' loan applications.[9] In case more than one bank offers the same contract to a group of borrowers, the following tie-break procedure is implemented: all the borrowers that would choose a contract offered by more than one bank are randomly allocated to one of these banks.[10]

Entrepreneurs are risk neutral and seek to maximize their own profit. The expected value to an entrepreneur of accepting a loan contract (R, C) is

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

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

$$\theta_k (y - R) - (1 - \theta_k) C \geq 0 \text{ for } k = g, b. \tag{2}$$

3 Equilibrium

We solve the game by backward induction. Stage 3 is trivial since banks will reject loan applications if and only if the expected quality of the set of borrowers accepting a given contract is too low to provide non-negative profits. Borrowers, choosing their preferred loan contract, cannot then coordinate on a contract in a way that would yield losses for the bank offering that contract. We elaborate on this below, since the logic will be useful for distinguishing between the two types of equilibria we discuss.

At stage two, banks observe the realization of stage one and choose to whom they should make competitive offers among the borrowers whose type they know. For each bank i, define

[9] The general structure of our model is as in Bester (1985), as extended by Hellwig (1987), with the important addition of asymmetric information among banks. The advantage of this approach is that it guarantees the existence of pure-strategy equilibria.

[10] This tie-breaking rule guarantees the existence of an equilibrium for all parameter values. See Simon and Zame (1990) for a general analysis of the role of the sharing rule in establishing the existence of an equilibrium.

(R^{-i}, C^{-i}) as the contract that good borrowers prefer among those offered at stage one by the competitors of bank i and which at least breaks even when accepted by good borrowers only. The following result characterizes the equilibrium of the subgame.

Lemma 1 *i) Each bank i will offer its known good borrowers a contract $\left(R_g^i, 0\right)$, where R_g^i is such that good borrowers are indifferent between $\left(R_g^i, 0\right)$ and (R^{-i}, C^{-i}); ii) each bank i will deny credit to its known bad borrowers.*

Proof. First, since the bank knows the type of these borrowers, it has no reason to include a costly collateral requirement in the contract. R_g is the highest interest rate the bank can charge these known good borrowers without losing them to the competition. Second, the expected return on bad borrowers is always negative. Hence, under no conditions will a bank lend to known bad borrowers. ■

We can now solve stage one. Lemma 1 implies that when choosing their strategy for stage one, banks have to take into account two facts. First, they will not be able to poach profitably from the pool of borrowers known to their rival banks. Second, the pool of potential borrowers unknown to a particular bank will consist of borrowers unknown to all banks as well as bad borrowers known to its competitors. Since our focus is on the case where banks are symmetric, we limit our analysis to the case of symmetric equilibria. As described in Besanko and Thakor (1987), a Nash equilibrium here is a profile of sets of contracts such that: (1) each bank makes non-negative profits on each contract; and (2) there exists no other set of contracts that would earn positive profits on aggregate if offered in addition to the original set, with each individual contract in the set earning non-negative profits. We will additionally require that the equilibrium be "robust" in the sense of satisfying the stability criterion of Kohlberg and Mertens (1986),[11] and will restrict attention to pure strategy equilibria.

3.1 Equilibrium with Borrower Screening

We first show that, for certain parameter values, the only stable equilibrium is one with screening, in which only high quality borrowers obtain credit, and all banks offer the same

[11] In principle, other (weaker) refinements of the equilibrium can be used and deliver the same results, as the stable equilibrium we derive is unique.

contract (we use the terms "separating" and "screening" equilibrium interchangeably). In this separating equilibrium, banks try to attract good borrowers and to screen out bad borrowers by offering a menu of contracts that satisfies the incentive compatibility (IC) and individual rationality (IR) constraints for the borrowers. If a set of contracts $\left(R^k, C^k\right)$, $k = g, b$, are offered, the IC constraints can be expressed as

$$\begin{aligned} \theta_g \left(y - R^g\right) - \left(1 - \theta_g\right) C^g &\geq \theta_g \left(y - R^b\right) - \left(1 - \theta_g\right) C^b \\ \theta_b \left(y - R^b\right) - \left(1 - \theta_b\right) C^b &\geq \theta_b \left(y - R^g\right) - \left(1 - \theta_b\right) C^g \end{aligned}$$

In our particular case, the IC constraint for the bad type is the same as its IR constraint, since no alternative contract is offered to bad borrowers as their projects have negative expected value. Hence, to find the competitive separating contract we need to satisfy only the IC constraint for the bad borrowers, which we do by setting their IR constraint to be satisfied with equality. Since we have competitive banks, we also impose that banks make zero profits on the contract. Formally, the competitive separating contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ is the solution to the following equations:

$$\begin{aligned} \theta_g R - \overline{d} + \left(1 - \theta_g\right) \delta C &= 0 && \text{(Zero profit for banks)} \\ \theta_b \left(y - R\right) - \left(1 - \theta_b\right) C &= 0 && \text{(IC for bad borrowers)} \end{aligned}$$

We need not be concerned about the good type's IC constraint, since only one contract will be offered. 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 accept this contract. Solving the two equations, we obtain $\widehat{R}_s = \frac{(1-\theta_b)\overline{d} - \delta(1-\theta_g)\theta_b y}{(1-\theta_b)\theta_g - \delta(1-\theta_g)\theta_b}$ and $\widehat{C}_s = \frac{\theta_b\left(y\theta_g - \overline{d}\right)}{(1-\theta_b)\theta_g - \delta(1-\theta_g)\theta_b}$. Note that this is a valid solution since the IR constraint for the good type is always satisfied by this contract.

An additional requirement for a strategy profile where all banks offer the contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ to be an equilibrium is that no bank can make positive profits by offering some other contract $\left(\widetilde{R}, 0\right)$ in which all borrowers are pooled. To check this, first consider that, since bad borrowers' projects have a negative expected value, to be profitable any pooling contract must attract unknown good borrowers. This is accomplished by setting the repayment on the loan, $\widetilde{R}$, sufficiently low that $\theta_g\left(y-\widetilde{R}\right) > \theta_g\left(y-\widehat{R}_s\right) - (1-\theta_g)\,\widehat{C}_s \Leftrightarrow$

$$\widetilde{R} < \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\ . \tag{3}$$

In addition, the payment specified in the contract must be such that the bank at least breaks even when financing all the unknown borrowers plus the bad borrowers rejected by competitor banks, that is $\lambda\left(\overline{\theta}\widetilde{R}-\overline{d}\right) + (1-\alpha)\left(\frac{N-1}{N}\right)\left(\theta_b\widetilde{R}-\overline{d}\right) \geq 0 \Leftrightarrow$

$$\widetilde{R} \geq \overline{d}\frac{\left(\frac{N-1}{N}\right)(1-\alpha)+\lambda}{\left(\frac{N-1}{N}\right)(1-\alpha)\,\theta_b+\lambda\overline{\theta}}\ . \tag{4}$$

Hence, we can obtain the necessary and sufficient condition for the strategy profile where all banks offer the single (separating) contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ to be a Nash equilibrium by combining conditions (3) and (4), which yields

$$\overline{d}\frac{(N-1)(1-\alpha)+\lambda N}{(N-1)(1-\alpha)\,\theta_b+\lambda\overline{\theta}N} \geq \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\ . \tag{5}$$

Note that condition (5) establishes a link between the proportion of unknown borrowers in the economy and the existence of a pure-strategy equilibrium where borrowers are screened. For λ sufficiently close to zero, condition (5) is always satisfied and offering the separating contract is an equilibrium: at the limit there are no unknown borrowers in the market, so that by offering a pooling contract each bank would attract only those bad borrowers rejected by its competitors. As this would always incur losses, no such equilibrium is possible and banks must instead screen borrowers. However, as the distribution of applicant borrowers faced by a deviating bank improves with λ, the viability of this equilibrium depends on the proportion of unknown borrowers. If, as the adverse selection problems caused by informational asymmetries among banks vanish, which occurs as $\lambda \to \infty$, it is profitable to deviate from the separating equilibrium, then the equilibrium set will depend on λ. Otherwise, the strategy profile with the separating contract will be always an equilibrium, as it would never be profitable to offer a pooling contract. By letting $\lambda \to \infty$ in condition (5) we can state the condition for the equilibrium set to depend on λ as

$$\frac{\overline{d}}{\overline{\theta}} < \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s \tag{6}$$

If this condition is satisfied, a pooling equilibrium will exist for a sufficiently high value of λ. High values of $\overline{\theta}$ make pooling contracts relatively attractive for banks, while high liquidation values of collateral (δ) make separating of borrowers relatively cheap. It follows that the minimum $\overline{\theta}$ for which condition (6) is satisfied is increasing in δ. This suggests that our analysis applies not only to mature markets with high average borrower quality, but also to riskier markets with relatively high liquidation costs, such as emerging economies with poor enforcement of property rights. We can now state the following result.

Proposition 1 *If condition (6) holds, then there exists* $0 < \widehat{\lambda} < \infty$ *such that: i) for* $\lambda \leq \widehat{\lambda}$*, the strategy profile where all banks offer the contract* $\left(\widehat{R}_s, \widehat{C}_s\right)$ *is the unique stable pure-strategy equilibrium of the game; ii) for* $\lambda > \widehat{\lambda}$*, no stable pure-strategy separating equilibrium exists.*

Proof. See Appendix.

For λ higher than $\widehat{\lambda}$, each bank suffers relatively less from the adverse selection of financing other banks' poor credit risks and the distribution of unknown applicant borrowers faced by each individual bank becomes too creditworthy for a 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, but also the cost of a higher collateral requirement. The need to post collateral generates an inefficiency since liquidation is costly. This inefficiency is essentially the cost of sorting and, if the average creditworthiness of applicant borrowers is good enough (as is the case for $\lambda > \widehat{\lambda}$), will exceed the benefits of sorting. In that case, the proposed separating contract is strictly dominated by some pooling contract $(R_p, 0)$, and no separating equilibrium exists.[12] We discuss this case in the next section. The proposition also establishes that the equilibrium is stable (in the sense of Kohlberg and Mertens, 1986). Furthermore, we note that it is also robust to most other refinements as it represents the unique stable equilibrium. It is worth emphasizing that changes in λ do not affect the average quality of the total pool of borrowers, only that of those applying in equilibrium to each bank. Overall, borrower quality remains constant and all the effects are driven purely by reductions in information asymmetries.

[12] This is as in Rothschild and Stiglitz (1976), Wilson (1977), and Hellwig (1987).

3.2 The Pooling Equilibrium

The same conditions that preclude the existence of a pure-strategy separating equilibrium guarantee the existence of an equilibrium that pools all borrowers and offers everyone credit on the same terms. Consider the break-even pooling contract $\left(\widehat{R}_p, 0\right)$, with

$$\widehat{R}_p = \overline{d}\frac{\left(\frac{N-1}{N}\right)(1-\alpha)+\lambda}{\left(\frac{N-1}{N}\right)(1-\alpha)\theta_b+\lambda\overline{\theta}} .$$

Proposition 2 *If condition (6) holds, then, for $\lambda > \widehat{\lambda}$, the strategy profile where all banks offer the contract $\left(\widehat{R}_p, 0\right)$ is the unique stable pure-strategy equilibrium of the game.*

Proof. See Appendix.

As before, if condition (5) does not hold, there exists a pooling contract which good borrowers prefer to the zero-profit screening contract and such that any bank offering it would make positive profits if no other bank also offers that contract. Hence, there is no separating equilibrium. However, there is a stable pooling equilibrium, as no contract with $C > 0$ can represent a profitable deviation from the pooling equilibrium contract $\left(\widehat{R}_p, 0\right)$, since all applications to the deviating contract would need to be rejected in the third stage as they would fail to draw a better-than-average pool of borrowers.[13]

The analysis from now on is based on the two equilibria characterized in Propositions 1 and 2. We can now compare these two scenarios, using the fact that bank profits in equilibrium are just the profits from their pool of known borrowers, since, as we just showed, banks make zero profits on unknown borrowers.

Proposition 3 *Relative to the separating equilibrium, in the pooling equilibrium:*

i) Banks' profits are lower;

ii) The average quality of banks' portfolios is lower;

iii) Aggregate credit is larger, even on a per-applicant borrower basis (after dividing by $1+\lambda$).

[13] For these parameter values, this model may admit other equilibria supported by beliefs off the equilibrium path that are not robust to most refinements. Indeed, only the proposed zero-profit pooling equilibrium survives the stability criterion of Kohlberg and Mertens (1986). We note that Wilson (1977) proposes an alternative equilibrium concept where the zero-profit pooling contract is also the only solution.

Proof. See Appendix.

The first result in Proposition 3 establishes a link between market information structure and bank profitability. Points (ii) and (iii) compare the properties of the two equilibria in terms of bank portfolio quality and aggregate credit. When screening takes place, only good borrowers obtain financing, so it is clear that the average quality of bank portfolios will be higher than in a pooling equilibrium, where credit is extended to all but a small fraction $\left(\frac{1}{N}\right)$ of bad borrowers.

The same considerations also imply that aggregate credit is larger when pooling than when screening, even controlling for differences in market size. For instance, all results so far continue to hold if λ instead represents the fraction of unknown borrowers out of a fixed market size of 1, with $1 - \lambda$ then being the mass of known borrowers. Note as well that banks' strategic behavior has a multiplier effect on the demand for credit. When demand is low ($\lambda < \widehat{\lambda}$), only good borrowers get financing, so that aggregate credit increases linearly with demand. However, if demand increases enough ($\lambda > \widehat{\lambda}$), the switch in equilibrium strategies from screening to pooling generates a credit boom with not only good but also bad borrowers obtaining financing.

The intuition for this result is the following. Each bank's market power is linked to its information, since profits stem solely from the adverse selection each bank generates for its competitors. Essentially, banks are able to extract rents from borrowers whose type they know due to these borrowers' difficulty in credibly signaling their quality to other lenders. When the proportion of unknown borrowers in the market increases, adverse selection becomes less severe and, hence, banks' market power over their known borrowers decreases. The finding that banks reduce their lending standards so that all borrowers obtain credit thus results from the improvement in the distribution of borrowers applying to any given bank. The result is thus similar to the finding in de Meza and Webb (1987) that "good borrowers may draw in bad ones," with the important difference that in our model the overall distribution of borrowers in the economy remains constant.

While the results in this section were derived for a fixed deposit rate, they continue to hold even if the deposit rate is increasing in the banking system's demand for funds as long as the supply of deposits is sufficiently elastic. As long the deposit rate does not increase too quickly or jump up when aggregate lending increase (as might be the case if the supply of deposits were fixed), there will be a value of λ such that the pooling contract will dominate the separating one even after taking into account the higher deposit rate associated with the increase in aggregate lending.

The negative relationship between aggregate credit and bank portfolio quality established in Proposition 3 sheds some light on why banking crises are often preceded by lending booms, as is well documented empirically. When the proportion of unknown borrowers increases, banks' strategic interaction may cause both a lending boom and a deterioration of bank portfolios, both of which are accompanied by a reduction in bank profitability. Under these conditions, an aggregate shock to the banking system will be more deleterious than in a situation where only good borrowers are financed and banks' profits are higher. We discuss this issue further in Section 4.

3.3 Welfare Analysis

In a separating equilibrium, economy-wide net output (or surplus) is the sum of the expected return from good projects, minus the cost of funds and the cost associated with the liquidation of the collateral for those projects that, although good, did not produce a positive return. This can be written as

$$W_s = \alpha\left(\theta_g y - \overline{d}\right) + \lambda\alpha\left(\theta_g y - (1-\delta)(1-\theta_g)\widehat{C}_s - \overline{d}\right).$$

In a pooling equilibrium, collateral requirements are zero, so that expected total surplus is just the sum of the net expected return of all borrowers who get financed. This can be written as

$$W_p = \alpha\left(\theta_g y - \overline{d}\right) + \left(\frac{N-1}{N}\right)(1-\alpha)\left(\theta_b y - \overline{d}\right) + \lambda\left(\overline{\theta} - \overline{d}\right).$$

Note that in both cases there is no welfare loss associated with financing known good borrowers, as for these borrowers asymmetric information represents a pure transfer from borrowers to lenders in the form of higher interest rates, but no inefficient liquidation of collateral.

We now examine whether the prevailing equilibrium maximizes total surplus or whether, instead, a social planner would want to intervene to restrict banks' strategies and impose a particular (and potentially different) outcome. In other words, if both equilibria were possible, we ask whether one is superior in terms of maximizing aggregate net output.

Proposition 4 *If condition (6) is satisfied, then there will exist a* λ^w *such that: i)* $W_p > W_s \Leftrightarrow \lambda > \lambda^w$*; ii)* $\lambda^w < \widehat{\lambda}$*.*

Proof. See Appendix.

The first part of this proposition states that output will be higher with pooling than with screening if and only if the proportion of unknown borrowers in the market is above a certain threshold. The intuition for this result is straightforward. On the one hand, the welfare loss associated with pooling consists of two parts: one due to the financing of some of the competing banks' known bad borrowers, the other due to the financing of unknown bad borrowers. While the latter grows linearly with λ, the former is constant, with its weight tending to zero as λ tends to infinity. On the other hand, the welfare loss when screening takes place consists entirely of the collateral liquidation cost, which grows linearly with λ. As a result of condition (6), pooling of borrowers will Pareto dominate whenever the adverse selection caused by the informational asymmetries among banks is low. Hence, there must be some positive λ such that the loss associated with collateral liquidation costs exceeds that associated with financing bad borrowers.

Proposition 4 also proves that if information asymmetries are sufficiently low that a pooling equilibrium exists, this equilibrium is also optimal from the perspective of maximizing aggregate output. The fact that $\lambda^w < \widehat{\lambda}$ is not surprising once one considers that at $\lambda = \widehat{\lambda}$, banks as well as good borrowers are indifferent between the pooling and the separating equilibrium, but bad borrowers are obviously better off under the pooling equilibrium.

All the results so far apply to the case where all borrowers have sufficient wealth W that they are able to post collateral if necessary and therefore no one is "under-served" in equilibrium (i.e., there is no true credit rationing). However, it is straightforward to show that similar, and in fact stronger, results obtain if instead some borrowers are unable to meet the collateral requirement of the bank and are therefore unable to obtain financing even if they have positive NPV investments. To see this, consider a simple extension to the model where we assume that some fraction γ of the borrowers has zero wealth ($W = 0$) and can therefore post no collateral. When banks screen via collateral requirements, borrowers with no wealth will be rationed out of the market. However, if λ is sufficiently high that banks instead pool all borrowers, the elimination of the collateral requirement allows good, but poor, borrowers that would otherwise be rationed to obtain credit. This reinforces our finding that aggregate output is maximized under the pooling equilibrium, even if the average quality of the banks' portfolio decreases.

The analysis in this section, as well as the other results in this paper, carry through in a model where banks screen borrowers through a costly creditworthiness test. In Appendix B we provide such a model and show that, in a setting where banks do not duplicate each other's screening, all our main results hold.[14] However, borrower wealth plays no role in that model, and hence the effect identified in the paragraph above is absent.

4 Macroeconomic Shocks and Banking Crises

The results in the previous section demonstrate that strategic interaction among banks creates a link between (1) market information structure, (2) the aggregate amount of credit in the economy, (3) bank portfolio quality, and (4) bank profitability. Here we show that, once a measure of aggregate uncertainty is incorporated into the model, the market's information structure has additional implications for the stability of the banking system. In the next section we discuss how business cycles and financial liberalizations, by changing either the information structure or the cost structure of the market, may affect the likelihood of observing a banking crisis.

A natural source of aggregate uncertainty arises from the banking system's function of maturity transformation, converting short-term deposits into longer-term loans. Since the availability, as well as the cost, of banks' liabilities may fluctuate even as their assets are tied up in commitments with longer-term maturity, there is an inherent risk associated with this maturity transformation function. We model this by assuming that, at the time they make their lending decisions, banks do not know with certainty their cost of funds, which is

[14] An analysis of the additional costs related to duplicated monitoring in banking can be found in von Thadden (1994). In particular, duplicated monitoring can introduce a social cost that is borne primarily by good borrowers.

a random variable $\tilde{d}$ with mean $\overline{d}$ and distribution $F(\tilde{d})$. The realized value of $\tilde{d}$ becomes known only at the end of stage 3, after loans have been granted. In terms of the extensive form of this game, this is equivalent to assuming that banks commit themselves to provide a loan before the deposit market has cleared, so that the realized interest rate on deposits is unknown. Alternatively, one can assume that the deposit rate is short term and can change before loans are repaid, and banks need to rollover their liabilities.

For simplicity, we assume that banks have unlimited liability, but that they fail whenever their profits drop below zero. The behavior of banks is therefore fully characterized by the distribution of the average of the cost of funds. Hence, all results obtained in the previous sections hold in expectation. However, since there is a degree of aggregate uncertainty in the economy, the realized outcome may differ from the expected one. We define a banking crisis as a situation where the aggregate banking system has negative profits, and thus negative capital.[15] This leads us to the main result of this section.

Proposition 5 *The probability of a banking crisis is nondecreasing in λ, the number of unknown borrowers in the market, and is strictly increasing for $\lambda \geq \widehat{\lambda}$.*

Proof. See Appendix.

This result stems from two separate effects. The first is directly linked to the credit boom. When λ increases enough, banks stop screening and extend credit to all applicant borrowers. This expansion in lending increases banks' exposure to shocks to their cost of funds. Since banks make positive profits only from known borrowers, the sensitivity of total profits to changes in the cost of funds is larger the greater is the volume of credit. This effect can most readily be seen at the cutoff value of $\widehat{\lambda}$, where bank profits are the same in the pooling and the separating equilibrium, but credit is discretely larger in the former. Hence, this proposition establishes that small changes in the information structure of the market can cause a discrete increase in the probability of a crisis if they lead banks to reduce their standards and switch from screening borrowers to pooling everyone together.

The second effect is analogous to that behind Proposition 3. When the proportion of unknown borrowers in the economy increases, banks lose some informational capital and the

[15] Alternatively, we could define a banking crisis as a situation where one or more banks makes ex-post losses. The main results would be the same.

market power that comes with it. Credit markets become more competitive, lowering banks' profits on known borrowers and reducing their ability to withstand negative shocks. Then, even within the region where no bank performs any screening, an increase in the number of unknown borrowers leads to an unambiguous increase in the probability that banks are insolvent. It is worth noting that while this second effect may arise in other models where bank profits are a buffer against aggregate uncertainty, the first effect is novel and specific to our framework based on an information-generated lending boom.

It bears emphasizing that the result in Proposition 5 holds even though there is no change in the aggregate quality as λ increases. The result stems purely from the fact that banks are better able to withstand macroeconomic downturns when more profitable and when granting loans to fewer, but relatively better, borrowers than when financing all borrowers indiscriminately and possibly earning lower profits. We therefore have an increased probability of a crisis for purely strategic reasons, even with rational and competitive banks. In other words, both the credit expansion and greater possibility of a banking crisis emerge as pure information-based phenomena. It is worth noting, however, that a banking crisis in our framework simply represents a collapse of a sufficiently large number of individual banks, and so does not speak to the issue of the possibility of contagion among banks, an issue which has dominated the recent debate on this topic. In particular, bank failures in our model stem from increased fragility at the bank level rather than from some underlying systemic instability.

This result highlights a trade-off between the output generated as a result of bank lending and banking system stability. While higher aggregate output is obtained when borrowers are pooled, it is also associated with a higher probability of a banking crisis.[16] Moreover, if banking crises involve an aggregate welfare loss beyond that suffered by the banking system, this analysis suggests that there may be scope for policy intervention. In particular, a social planner averse to volatility is confronted with a trade-off between enhancing either the output or the stability of the banking system when information asymmetries are low. In that context, policies like risk-based capital requirements which link banks' costs to the riskiness

[16] 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, and Allen and Gale, 2004).

of their portfolio may help extend the region where screening is feasible and thus reduce the probability of a crisis.[17] Minimum collateral requirements on bank lending would have a similar effect, but may introduce a distortion if regulators are less informed than banks about market conditions.

While the results in Proposition 5 were obtained for the case where the cost of deposits, $\tilde{d}$, is independent of bank behavior, one can show that similar results obtain if the deposit rate is endogenized so as to compensate depositors for the possibility of default by the bank. In other words, our qualitative results are unchanged if the deposit rate must be set to compensate depositors for the risk of bank failure, or of a banking crisis. In this instance, the deposit rate in equilibrium would be (weakly) increasing in λ, since a larger λ corresponds to an increased probability of bank failure. An increase in λ, therefore, further squeezes banks and increases the likelihood of a crisis.[18]

We note as well that $\widehat{\lambda}$, the upper bound for screening to be feasible, is a decreasing function of the cost of liquidation, $1-\delta$, so that markets with lower liquidation costs should find it easier to support borrower screening. Similarly, reforms aimed at improving bankruptcy laws and clarifying property rights should also increase the incidence of borrower screening by reducing liquidation costs. Furthermore, by reducing the cross-subsidization that occurs under a pooling equilibrium, the overall cost of borrowing can be reduced. Nevertheless, it is likely that some cost of liquidation will always remain as long as collateral is more valuable to the entrepreneur than to the financier.

Two main contributions from the analysis of this section can therefore be derived. First, our model proposes a rational bank-lending mechanism that explains bank fragility based on purely informational reasons. The literature on financial accelerators (e.g., Kiyotaki and Moore, 1997) typically identifies a small change in fundamentals as the initial catalyst for

[17] In addition, it is easy to show that in a model where banks have some market power in the market for unknown borrowers, policies aimed at limiting banks' lending capacity would have a similar effect.

[18] Issues arising from limited liability for the bank are immaterial in the context of this model, as there is no moral hazard problem for banks. Limited liability would only play a role here in case the projects are unsuccessful. In that case, we have that either $\delta C > \overline{d}$, or that $\delta C < \overline{d}$. In the first case, the discounted value of collateral is greater than the cost of deposits, so limited liability is not binding. In the latter case, there is insufficient collateral to pay depositors, in which case collateral plays no role for the bank, since its recovery in the bad states is just 0.

the crisis, which then becomes amplified through the financial system.[19] We identify a new channel that magnifies the impact that changes in macroeconomic conditions have on the probability of (rational) banking crises. Second, and more importantly, we provide a simple mechanism that links booms and crises to the quality of the projects that obtain bank financing, for a given aggregate distribution of borrowers. By contrast, recent papers have linked lending standards to business cycles through changes in aggregate borrower quality (Ruckes, 2004) or attrition in the ranks of loan officers skilled at detecting bad loans (Berger and Udell, 2004). However, these different effects may coexist to the extent that the factors responsible for an increase in the proportion of new borrowers also affect their aggregate quality.

5 Determinants of Equilibrium

We now turn to examining factors that, by either changing the proportion of unknown borrowers or by changing its threshold value, determine whether borrowers are screened or are pooled together. Changes in the propotion of unknown borrowers can be caused by the business cycle, the introduction of new technology, or changes in the value of collateralizable assets. From a cross-sectional perspective, differences in the fraction of unknown borrowers may be driven by differences in the maturity of the industry and the banking sector, or by the extent to which past information on project success correlates across time. Similarly, changes in the threshold value may be related to monetary policy, financial sector reforms, and changes in bank market structure. In what follows we study these issues in greater detail.

5.1 Business Cycle and Industry Effects

One possible source of changes in the aggregate demand for credit (λ) is the business cycle. During an upswing in the business cycle, market conditions are favorable for the expansion of existing businesses, yielding an increase in the demand for credit. A sufficiently large

[19] An example of such a change is the value of durable assets used as collateral. When this value increases, credit constraints are loosened and leverage increases. Because of the high leverage, the system becomes vulnerable to small shocks, and a small drop in the price of collateral may turn the boom into a crisis.

swing in the business cycle yields a switch in the equilibrium and a reduction in lending standards, resulting in a lending boom that is more than commensurate to the increase in the demand for credit.[20] The entry of new firms over the business cycle may have a similar effect if we assume, as mentioned previously, that banks conduct minimal credit screens of all customers, but such screens generate useful information only with probability $\frac{1}{1+\lambda}$. In that setting, as new firms enter (so that λ increases), information asymmetries across banks are reduced, thus fueling a lending boom.[21] In this model, therefore, even small business cycle swings can have large effects on the allocation of credit and on aggregate output (see Proposition 3).

Although our model focuses on adverse selection, it is straightforward to add a moral hazard dimension to the problem, as in Kiyotaki and Moore (1997). Then, a minimum amount of collateral would always be demanded to solve moral hazard problems, but collateral requirements would still be higher in the screening equilibrium than in the pooling one. In that context, the business cycle would have an additional effect through the asset price channel: an increase in the price of assets used as collateral would grant access to credit to entrepreneurs previously too wealth-constrained to post the minimum collateral necessary to apply for a loan, acting like an increase in λ.

The results of this model can also be used to study cross-sectional differences in lending to different market sectors, or different industries. It has been alleged that during the high-tech boom of the late 90's, investors (as well as lenders) were channelling funds to firms about which they had very little information, and that this kind of behavior lead to eventual collapse. Using λ to represent an inverse measure of the extent to which past information about a firm is indicative of future success (i.e., the extent to which the success of a firm's projects correlate across time), our model predicts precisely this kind of behavior when there is very little extant information about firms. While in this case information asymmetries

[20] It is worth noting that upswings in the business cycle are often accompanied by improved prospects for all firms. In our model, this would correspond to an overall improvement in the distribution of borrowers, an issue from which we abstract in order to focus purely on the role of information. See Ruckes (2004) for a study of lending standards as borrower quality changes.

[21] If these new firms could be perfectly identified as being unknown to all banks, then their entry would have no effect on the equilibrium incentives to screen. The market may be segmented in this case, with firms identified as being unknown to all banks being pooled separately from all other firms.

between banks and borrowers may remain large, those across banks are likely to be small since little of the information gathered from prior experiences will be reusable. We should thus have fairly competitive markets with loose credit standards, increasing the probability of an eventual collapse.

5.2 Financial Sector Reforms and Monetary Policy

Financial reforms, such as capital account liberalizations, are another factor that may trigger a change in lending standards by affecting banks' average cost of funds. This is shown in the following proposition.

Proposition 6 *The threshold* $\widehat{\lambda}$ *below which borrower screening is feasible is increasing in the expected cost of funds of the banking system* $\overline{d}$.

Proof. See Appendix.

The intuition for this result is that, when the expected cost of funding for the banking system increases, the promised repayment in the pooling equilibrium needs to increase enough to cover the losses associated with the loans to all borrowers, including those with a low probability of repayment. This results in a pass-through of the interest rate that is greater than one. For the case where borrowers are screened, the pass-through is smaller since only good type borrowers obtain financing. Moreover, the collateral obtained by banks helps them absorb some of the losses associated with failed projects. This difference in interest rate pass-throughs implies that when banks' cost of funds increases, borrower pooling becomes relatively more expensive and less attractive, and banks are more likely to retain high standards and screen loan applicants.

This result has two immediate interpretations. First, capital inflows that reduce the interest rate paid by banks to depositors and investors, such as those in the aftermath of a capital account liberalization, may cause a strategic reduction in lending standards and a lending boom. In that context, our model is consistent with the recent literature on the "twin crises" - balance of payments and banking - that identifies international movements in capital, arising often as a result of a financial liberalization, as a potential source of banking instabilities and financial vulnerability (see, e.g., Kaminsky and Reinhart, 1999).[22] Our result matches the empirical finding that lending booms are often preceded by financial reforms that reduce substantially banks' cost of financing through liberalization of capital flows and reductions of reserve requirements.

Second, this result suggests that changes in monetary policy that affect interest rates, and thus banks' borrowing costs, may trigger switches in banks' screening strategies. In our model, a monetary tightening will cause a flight to quality similar to that identified in agency cost models. However, here this effect is caused by an increase in the costs associated with adverse selection rather than by more severe agency problems.

5.3 Entry and Contestability

Here we examine the reaction of a monopolist incumbent to the introduction of a competitive threat. The study of this issue is of importance given recent literature suggesting that financial sector liberalization may lower the profitability and charter value of domestic banks, thus increasing systemic vulnerability (see Claessens et al., 2001). For this purpose, consider the case of a market consisting of a single bank protected from entry by regulation. It is straightforward to show that this monopolist will always screen out the bad borrowers by offering a separating contract.

Lemma 2 *There exists an* $\bar{\varepsilon} > 0$ *such that for all* $0 < \varepsilon < \bar{\varepsilon}$ *the separating contract* $\left(\widehat{R}_\varepsilon, \widehat{C}_\varepsilon\right)$, *with* $\widehat{R}_\varepsilon = y - \varepsilon$ *and* $\widehat{C}_\varepsilon = \varepsilon \frac{1-\theta_g}{\theta_g}$, *is more profitable than the pooling contract* $(y, 0)$.

Now consider a reform that allows new or foreign lenders with no private information about this market to compete with the incumbent. The presence of this competitive threat induces the incumbent to switch to a pooling strategy to exploit its informational advantage. This result is summarized in the following proposition:

Proposition 7 *Suppose an incumbent with an informational monopoly over the known borrowers faces a competitive fringe of potential entrants possessing no private information. In*

[22] There may, of course, be additional factors influencing the probability of a crisis. A recent paper by Goldstein (2004), for instance, suggests that strategic complementarities between depositors and currency speculators can cause a crisis in one sector to spiral into the other sector. Allen and Gale (2000) examine similar issues.

the unique stable pure-strategy equilibrium, the potential entrants offer the separating contract $\left(\widehat{R}_s, \widehat{C}_s\right)$, *the incumbent offers the pooling contract* $\left(\widehat{R}_m, 0\right)$, *where* $\widehat{R}_m = \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s$, *and all borrowers obtain credit from the incumbent.*

Proof. See Appendix.

The result demonstrates that in equilibrium the incumbent maintains its monopolistic position but with a market power that is now limited by the threat of entry. This result therefore extends that in Dell'Ariccia et al. (1999) on how an incumbent's informational advantage can create a limit to competition to a setting where banks can use alternative screening mechanisms, such as enforcing collateral requirements.

More importantly, Lemma 2 and Proposition 7 show that financial reforms introducing competition into previously protected monopolistic markets may trigger a change in the lending standards applied by the incumbent. To respond to the threat of entry the monopolist bank switches from screening to pooling so as to make the most of its informational advantage. This causes an increase in the volume of lending, a deterioration of the bank's loan portfolio, and a reduction in the incumbent bank's profits obtained from all borrowers. The results in this section therefore isolate an additional issue that arises purely from the informational structure of the market.

5.4 Market Structure

Recent literature has emphasized how changes in financial markets over the last decade have had broad implications for the banking industry, with consequent changes to banks' behavior and profitability.[23] These changes have often led to alterations in the structure of the industry through, for instance, increased incentives for entry or for consolidation. In this section, we analyze how bank market structure interacts with the informational characteristics of the market in determining banks' strategies.

Proposition 8 *For* $N > 2$, *the threshold proportion of unknown borrowers above which a pooling equilibrium exists is increasing in the number of symmetric banks:* $\widehat{\lambda}(N) < \widehat{\lambda}(N+1)$.

[23] Empirically, this has been studied in Berger and Mester (2003) and Petersen and Rajan (2002), among others. See Boot and Thakor (2000) for a theoretical analysis of the effects of competition on banks' lending practices.

Proof. See Appendix.

Changing the number of symmetric banks in the market has two competing effects. On the one hand, as the number of competing banks increases, the proportion of borrowers known to each bank shrinks, leading to a more severe adverse selection problem for each bank. This increases the incentive to screen applicant borrowers, and reinforces the separating equilibrium. On the other hand, with a larger number of competing banks there is a stronger temptation to deviate from a separating equilibrium since the extra market share a deviating bank can grasp increases. There is consequently an increased incentive to reduce lending standards by not screening borrowers. Since in equilibrium banks make zero profits on unknown borrowers, the first effects prevails, and the threshold value $\widehat{\lambda}$ increases with N. In other words, markets characterized by lower bank concentration permit a screening equilibrium for a larger proportion of unknown borrowers.

It is also straightforward to see, from inspection of equation (4), that whenever borrowers are pooled the equilibrium lending rate will be increasing in the number of banks. This somewhat counter-intuitive result is the combined product of Bertrand competition and the adverse selection caused by the informational asymmetry among banks. When there are a large number of banks, each bank has less information, thus raising the interest rate banks must charge to break even. This finding is consistent with recent theoretical results in Broecker (1990) and Marquez (2002) on competition in lending markets. This adverse-selection driven result is lent some empirical support by the finding that charge-off rates for bank commercial loans increase with the number of competing banks, as documented by Shaffer (1998). However, this evidence should not be seen as a direct test of our theory, since Proposition 8 also demonstrates that an increase in the number of banks can actually improve their portfolios if it leads them to switch to a screening equilibrium. That said, it is worth noting that the empirical results concerning loan chargeoffs and the number of banks do not extend to real-estate and consumer loans, for which, as Shaffer argues, collateral may play an important role.

6 The Role of Information Sharing

The existence of information asymmetries among banks is one key assumption of the framework presented in this paper. However, recent literature has emphasized that information sharing is a common element in credit markets.[24] In this section, we study some implications of allowing banks to share information about borrowers.

Under full information sharing, where banks provide each other with all relevant information concerning their known customers, banks would always offer the pooling contract to unknown borrowers and the break-even contract $(\frac{\bar{d}}{\theta_g}, 0)$ to good known borrowers, but would deny credit to bad known borrowers. Hence, full information sharing among banks would never arise endogenously in this model, since it leads to an equilibrium with zero profits as banks compete more aggressively when information is symmetric.

However, in a recent paper Bouckaert and Degryse (2004) show that the strategic disclosure of some, but not all, information may enhance profits in settings where information asymmetries among banks exist. In their model, the sharing of "black information", which constitutes the sharing of information about borrower defaults, has two effects. First, it increases bank competition (entry) by reducing adverse selection, since, for each bank, the type distribution of unknown borrowers with no record of defaulting improves. Second, it increases bank market power over those borrowers which, although good in type, were unlucky and defaulted. The net impact on bank profits depends on which of these two effects prevails. Since the most commonly available information through credit bureaus is that on borrower default history, in what follows we extend the main results in this paper to the case of black information sharing.

Consider the following simple extension of the model. Suppose that, prior to stage 1, there is a stage 0 where each of the N banks lends to a (different) mass $\frac{1}{N}$ of borrowers, and as a consequence learns their type. Borrowers invest in a project, which is independent and identical to that described for stages 1 to 3, that succeeds with probability θ_i, $i \in \{g, b\}$, and the lending bank also observes the outcome of this initial project. Suppose further that all banks are committed to share information about borrower default. In other words,

[24]For example, see Pagano and Jappelli (1993), and Padilla and Pagano (1997).

it becomes common knowledge whether a project of a particular borrower was successful ($\widetilde{y} = y$) or resulted in failure ($\widetilde{y} = 0$), so that the loan was not repaid. We now characterize the resulting equilibrium for stages 1 to 3. As before, assume that Condition (6) is satisfied.

Proposition 9 *Under "black information" sharing, there exists some* $\widehat{\lambda}^* < \infty$ *such that: i) for* $\lambda \leq \widehat{\lambda}^*$*, the unique stable equilibrium involves screening; ii) for* $\lambda > \widehat{\lambda}^*$*, the unique stable equilibrium involves the pooling of borrowers; iii) banks always offer unknown borrowers known to have defaulted a screening contract* (R_s, C_s)*; and iv)* $\widehat{\lambda}^* < \widehat{\lambda}$.

Proof. See Appendix.

This proposition extends the main result of this paper to the case where banks share borrower default information. The intuition is as follows. The sharing of black information divides the pool of unknown borrowers faced by each bank into two segments characterized by different borrower distributions. In the segment of "black-listed" entrepreneurs for any given bank, there are no new or unknown borrowers. This means that no pooling contract can make non-negative profits on this segment of the market, since some other banks which knows these borrowers' exact type will match any viable offer made to good borrowers, but will let bad borrowers go. In the other segment are all the unknown borrowers and previously evaluated bad borrowers who did not default in the past. Hence, the equilibrium for this segment is similar to that for the game without information sharing. The only difference is that the type distribution of unknown borrowers for this segment is better, which implies that the proportion of unknown borrowers required to support a pooling equilibrium is lower relative to the case without information sharing: $\widehat{\lambda}^* < \widehat{\lambda}$.

We can also examine the conditions under which banks would choose whether or not to share black information. To endogenize this choice, assume that, at the beginning of stage 1, banks choose whether they want to share their own information in exchange for that of their competitors.[25] This leads to the next result.

Proposition 10 *i) Bank profits with black information sharing will exceed profits without information sharing if and only if the proportion of unknown borrowers in the market exceeds*

[25] This is equivalent to determining the conditions under which banks would lobby for regulation forcing all banks to participate in an information sharing agreement.

a certain threshold, $\lambda \geq \lambda^*$*. ii) This threshold is greater than that required to support pooling in the absence of information sharing:* $\lambda^* > \widehat{\lambda}$*.*

Proof. See Appendix.

From Proposition 9, we know that information sharing lowers the threshold required for pooling to be optimal. Therefore, there is a range of values of λ for which, absent information sharing, only an equilibrium where borrowers are screened exists, but where with information sharing banks no longer find it feasible to screen and instead pool all borrowers. For this region, banks' profits are reduced. It follows that it will be profitable for banks to share information only when in the absence of information sharing the equilibrium would pool all borrowers.

The results in Propositions 9 and 10 imply that, when information sharing among banks emerges endogenously, it also increases the aggregate surplus. However, there are values of λ for which, although information sharing does not emerge endogenously, it would still increase the aggregate surplus either by expanding the region where a pooling equilibrium exists (for $\lambda \in \left(\widehat{\lambda}^*, \widehat{\lambda}\right)$), or by reducing the portion of bad borrowers financed in equilibrium whenever the pooling of borrowers is viable (for $\lambda \in \left(\widehat{\lambda}, \lambda^*\right)$). A policy-maker concerned with maximizing aggregate surplus would therefore find it optimal to collect and disseminate black information, perhaps by means of a public credit rating agency.

We note, however, that a policy of forcing the dissemination of black information may not be unambiguously beneficial if one is concerned about banking system stability in addition to pure output. When information sharing among banks emerges endogenously, it increases bank profitability and reduces the volume of credit being allocated to bad projects, thereby reducing the probability of a banking crisis. However, when such policies do not emerge endogenously among banks, forcing banks to disseminate black information may also reduce banks' profits, and therefore carries the risk of an increased probability of a crisis. In the notation of the model, one can show that there is a $\Delta > 0$ such that for $\lambda \in (\lambda^* - \Delta, \lambda^*)$, such policy would not only increase the aggregate surplus, but would also reduce the probability of a crisis. This is true since for values of λ just below λ^*, bank profits are only marginally affected by information sharing, but the improvement in credit allocation is of first order.

However, for λ near $\widehat{\lambda}$, forced information sharing has the opposite effect, since it moves the equilibrium away from one where banks screen their borrowers to one where all borrowers are pooled. Associated with this is a reduction in bank profits and an increase in the volume of credit to bad borrowers, and therefore an increase in the probability of a crisis.

7 Discussion and Conclusions

This paper presented a framework where bank strategic behavior interacts with market information structure in determining bank lending standards, which are here represented by the use of collateral requirements. Adverse selection problems stemming from informational asymmetries among lenders induce banks to screen applicant customers to avoid financing those borrowers rejected by their competitors. However, when the proportion of unknown projects in the economy increases, as may happen after a deregulation or during the expansionary phase of a cycle, such adverse selection problems become less severe, reducing banks' lending standards. This in turn results in lower bank profitability, higher aggregate credit, and higher vulnerability to macroeconomic shocks. These results continue to hold when banks share information about borrower defaults.

The model provides several testable implications which are well in line with existing empirical literature. First, the model predicts a negative relationship between new loan demand and lending standards. This has been established indirectly in Asea and Blomberg (1998), who find that in the U.S. lending standards tend to vary systematically over the cycle, with the probability of collateralization increasing during contractions and decreasing during expansions. Lown and Morgan (2003) also find that the lending standards banks apply vary over the cycle. In particular, they find that higher levels of past loans are associated with a tightening of current standards, which, to the extent that more prior lending reflects more private information, is consistent with the predictions of our model. More recently, Berger and Udell (2004) find evidence for the cyclicality of standards that is consistent with our results concerning changes in the distribution of information. While their focus is on a testing strategy and explanation at the bank-level, they recognize the importance of a system-wide rationale for the easing of lending standards, such as our information-based story.

A second empirical prediction of the model is that loan collateralization should decrease with the existence of a bank-borrower relationship that generates private information for the bank, while interest rates should increase. These are exactly the findings in Degryse and Van Cayseele (2000), who examine detailed contract information on nearly 18,000 bank loans to small Belgian firms (see also Degryse and Ongena, 2004). Also consistent with the model's prediction is the evidence on credit markets in Germany found in Harhoff and Korting (1998), who use relationship duration as a measure of the importance of the relationship and find that it has a negative effect on collateral requirements, and a positive, although not significant, effect on loan prices.

Finally, our model predicts that episodes of financial distress are more likely in the aftermath of periods of strong credit expansion. This chain of events, of which Argentina in 1980, Chile in 1982, Sweden, Norway, and Finland in 1992, Mexico in 1994, and Thailand, Indonesia, and Korea in 1997 are the most significant examples, has been well documented by a growing literature on banking crises. For example, Demirguc-Kunt and Detragiache (1998) find evidence that lending booms precede banking crises. Gourinchas, Valdes, and Landerretche (2001) examine a large number of episodes characterized as lending booms and find that the probability of having a banking crisis significantly increases after such episodes. Moreover, the conditional incidence of having a banking crisis depends critically on the size of the boom. Notably, in our model, when banks screen borrowers, it is only for increases in lending large enough to induce a change in lending strategies that the probability of a banking crisis increases.

We have shown that the information structure of loan markets plays a crucial role in determining banks' lending standards and consequently has important implications for systemic stability and the volume of credit provided to the economy. A natural extension is to examine in more detail the factors and mechanisms that determine this information structure; in other words, to endogenize λ. We leave that task for future research.

A Proofs

Proof of Proposition 1: The contract $\left(\widehat{R}_s, \widehat{C}_s\right)$ was obtained as the solution to the system

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

With this contract, we find that good borrowers' IR constraint is slack,

$$\theta_g \left(y - \widehat{R}_s\right) - (1-\theta_g)\,\widehat{C}_s > 0 \qquad (IR),$$

which implies that $y > \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s$, and, since by assumption we have $\theta_b y < \overline{d}$, it follows that $\frac{\overline{d}}{\theta_b} > \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s$. Then, from condition (5), this in turn implies that at $\lambda = 0$, we always have a separating equilibrium as no bank can profitably deviate from the zero-profit separating contract. Now, it is easy to see that the LHS of the inequality in (5),

$$\overline{d}\frac{(N-1)(1-\alpha)+\lambda N}{(N-1)(1-\alpha)\,\theta_b + \lambda\overline{\theta}N},$$

is continuous and decreasing in λ, and tends to $\frac{\overline{d}}{\overline{\theta}}$ as $\lambda \to \infty$. Hence, if condition (6) holds, there must exist a $\widehat{\lambda} > 0$ such that a separating equilibrium exists if and only if $\lambda \leq \widehat{\lambda}$. Moreover, the zero-profit condition guarantees that no bank can profitably deviate by offering a different separating contract. Finally, if condition (5) is violated, which occurs by assumption as $\lambda \to \infty$, then no pure-strategy separating equilibrium exists because of the standard Rothschild-Stiglitz argument. This demonstrates that the equilibrium in described above is the unique stable separating equilibrium, and exists if and only if $\lambda \leq \widehat{\lambda}$.

To show that no pooling equilibrium exists, note that condition (4) implies that the rate offered on any candidate pooling contract, call it $\widetilde{R}$, needs to be sufficiently high so as to satisfy $\lambda\left(\overline{\theta}\widetilde{R} - \overline{d}\right) + (1-\alpha)\left(\frac{N-1}{N}\right)\left(\theta_b\widetilde{R} - \overline{d}\right) \geq 0$ in order not to lose money. However, for $\lambda < \widehat{\lambda}$, condition (5) establishes that a bank could deviate by offering the contract $\left(\widehat{R}_s + \epsilon, \widehat{C}_s\right)$, with $\widehat{R}_s$ and $\widehat{C}_s$ as defined above and $\epsilon > 0$, attract only the good borrowers for ϵ sufficiently small, and make a profit. Therefore, no equilibrium that pools borrowers exists for $\lambda < \widehat{\lambda}$, thus completing the proof. ■

Proof of Proposition 2: The proof of the first part of the proposition is identical to that of Proposition (1). Consider what happens when all banks offer the contract $\left(\widehat{R}_p, 0\right)$, with

$$\widehat{R}_p = \overline{d}\frac{\left(\frac{N-1}{N}\right)(1-\alpha)+\lambda}{\left(\frac{N-1}{N}\right)(1-\alpha)\theta_b+\lambda\overline{\theta}}\ .$$

At stage 3, the rationing rule implies that one bank finances all unknown borrowers. This bank makes zero profits on this contract, as do all the other banks whose contracts were not accepted. The bad borrowers known to the winning bank are the only ones that do not get financing. It is obvious that no contract $(R, 0)$ with $R < \widehat{R}_p$ can make non negative profits. Similarly, no contract $(R, 0)$ with $R > \widehat{R}_p$ can make positive profits, as such a contract would not attract any borrowers. It remains to be shown that no contract with $C > 0$ can be profitable.

First, consider that, since for $\lambda > \widehat{\lambda}$ condition (5) is violated, good borrowers prefer $\left(\widehat{R}_p, 0\right)$ to the zero-profit separating contract $\left(\widehat{R}_s, \widehat{C}_s\right)$. Hence, any viable contract $\left(\widetilde{R}, \widetilde{C}\right)$ with $\widetilde{C} > 0$ preferred to $\left(\widehat{R}_p, 0\right)$ by good borrowers would have to violate the bad borrowers' IC constraint in the absence of $\left(\widehat{R}_p, 0\right)$. Now, following the argument in Hellwig (1987), we can show that $\left(\widetilde{R}, \widetilde{C}\right)$ is not a profitable deviation because under the equilibrium strategies all applications to $\left(\widetilde{R}, \widetilde{C}\right)$ will have to be rejected at stage three. In order to accept borrowers' applications, the deviating bank would have to receive applications from an above-average sample of the population. If that were the case, all other banks would reject all applications to $\left(\widehat{R}_p, 0\right)$, as that contract just breaks-even with the average population. However, considering that fact, all borrowers must apply to $\left(\widetilde{R}, \widetilde{C}\right)$, contrary to the assumption that a "better-than-average" group of borrowers applied to that contract. Hence, all applications to $\left(\widetilde{R}, \widetilde{C}\right)$ would have to be rejected, and consequently $\left(\widetilde{R}, \widetilde{C}\right)$ cannot represent a profitable deviation. Therefore, $\left(\widehat{R}_p, 0\right)$ constitutes an equilibrium. Moreover, an application of the stability criterion (Kohlberg and Mertens, 1986) establishes that this is the uniquely stable equilibrium. ■

Proof of Proposition 3: *i)* First, note that, because of competition, all banks make zero profits on unknown borrowers, under either the pooling or the separating equilibrium. Their profits therefore stem solely from their known borrowers. Denote the rate charged to each good known borrower as R_g^j, $j = s, p$ (separating or pooling). Following Lemma 1, each bank's profits on known borrowers can be written as

$$\Pi_k(R_g) = \frac{\alpha}{N}\left(\theta_g R_g - \overline{d}\right), \quad k = 1, ..., N$$

where $R_g = R_g^s = \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s$ in the separating equilibrium, and $R_g = R_g^p = \widehat{R}_p$ in the pooling equilibrium. From Proposition (2), we know that $\widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s > \widehat{R}_p$ for $\lambda > \widehat{\lambda}$. Hence, $\Pi_k\left(R_g^p\right) < \Pi_k\left(R_g^s\right)$.

ii) and *iii*) trivial, since all unknown borrowers obtain financing. ■

Proof of Proposition 4: To prove the first part, start by noting that at $\lambda = 0$ we have $W_p < W_s$. We now show that $W_p - W_s$ is continuously increasing in λ and $\lim_{\lambda\to\infty}(W_p - W_s) = +\infty$, so that there must exist a $\lambda^w > 0$ such that $W_p < W_s \Leftrightarrow \lambda < \lambda^w$. To see this, consider that

$$\lim_{\lambda\to\infty}(W_p - W_s) = \lim_{\lambda\to\infty}\lambda\left(\left(\alpha\theta_g y + (1-\alpha)\theta_b y - \overline{d}\right) - \frac{\alpha(\theta_g - \theta_b)\widehat{C}_s}{\theta_b}\right),$$

and

$$\frac{\partial(W_p - W_s)}{\partial\lambda} = \left(\alpha\theta_g y + (1-\alpha)\theta_b y - \overline{d}\right) - \frac{\alpha(\theta_g - \theta_b)\widehat{C}_s}{\theta_b}.$$

Condition (6) can be written as

$$\frac{\alpha(\theta_g - \theta_b)}{\theta_b}\widehat{C}_s < \frac{\alpha\theta_g\left(\overline{\theta}y - \overline{d}\right)}{\overline{\theta}},$$

which, since $\frac{\alpha\theta_g}{\overline{\theta}} < 1$, implies that $\lim_{\lambda\to\infty}(W_p - W_s) = +\infty$, and that $\frac{\partial(W_p - W_s)}{\partial\lambda} > 0$.

For the second part, consider, from the definitions of W_s and W_p, that $W_s < W_p \Leftrightarrow$

$$\lambda\alpha\left(\theta_g y - (1-\delta)(1-\theta_g)\widehat{C}_s - \overline{d}\right) < \left(\frac{N-1}{N}\right)(1-\alpha)\left(\theta_b y - \overline{d}\right) + \lambda\left(\overline{\theta}y - \overline{d}\right).$$

Now, we can rewrite $\lambda\alpha\left(\theta_g y - (1-\delta)(1-\theta_g)\widehat{C}_s - \overline{d}\right) = \frac{\alpha\lambda(\theta_g - \theta_b)\widehat{C}_s}{\theta_b}$. Hence, $W_s \leq W_p \Leftrightarrow$

$$\frac{\alpha\lambda(\theta_g - \theta_b)\widehat{C}_s}{\theta_b} \leq \left(\frac{N-1}{N}\right)(1-\alpha)\left(\theta_b y - \overline{d}\right) + \lambda\left(\overline{\theta}y - \overline{d}\right). \tag{7}$$

After substituting, we have $\widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s = y - \frac{(\theta_g - \theta_b)}{\theta_g\theta_b}\widehat{C}_s$. Therefore, condition (5), with the inequality reversed so that a pooling equilibrium exists, can be expressed as

$$\frac{\left(\frac{N-1}{N}\right)(1-\alpha)\left(\theta_b y - \overline{d}\right) + \lambda\left(\overline{\theta}y - \overline{d}\right)}{\frac{N-1}{N}(1-\alpha)\theta_b + \lambda\overline{\theta}} \geq \frac{(\theta_g - \theta_b)}{\theta_g\theta_b}\widehat{C}_s \tag{8}$$

Note that we can now also rewrite condition (7) as

$$\frac{\left(\frac{N-1}{N}\right)(1-\alpha)\left(\theta_b y-\overline{d}\right)+\lambda\left(\overline{\theta}y-\overline{d}\right)}{\alpha\lambda\theta_g}\geq\frac{(\theta_g-\theta_b)}{\theta_g\theta_b}\widehat{C}_s,$$

which, since $\frac{N-1}{N}(1-\alpha)\theta_b+\lambda\overline{\theta}>\alpha\lambda\theta_g$, implies that if condition (8) is satisfied, so will be (7), or in other words $\lambda^w<\widehat{\lambda}$. ■

Proof of Proposition 5: We first show that the probability of a banking crisis is greater under the pooling equilibrium than under the separating equilibrium. We then show that, for $\lambda>\widehat{\lambda}$ (for the region of the pooling equilibrium), the probability of a crisis is strictly increasing in λ. To begin, define d_j^*, $j=s,p$, as the realized value of d at which the entire banking system breaks-even under the separating or pooling equilibrium, respectively. Then, the probability of a banking crisis is $1-F(d_j^*)$.

We can write the ex-post total profits of the banking system as

$$\Pi^s(d)=\alpha\left(\theta_g R_g^s-d\right)+\lambda\alpha\left(\theta_g\widehat{R}_s+\delta\left(1-\theta_g\right)\widehat{C}_s-d\right)$$

for the separating equilibrium, and

$$\Pi^p(d)=\alpha\left(\theta_g\widehat{R}_p-d\right)+\lambda\alpha\left(\overline{\theta}\widehat{R}_p-d\right)+\frac{N-1}{N}(1-\alpha)\left(\theta_b\widehat{R}_p-d\right)$$

for the pooling equilibrium. From Proposition (3), we know that bank profits on known borrowers are higher in the separating equilibrium than in the pooling equilibrium. Then, as the zero profit condition on unknown borrowers holds for both equilibria at $d=\overline{d}$, we have $\Pi^s(\overline{d})>\Pi^p(\overline{d})$. Total profits are linearly decreasing in d, and it is easy to verify that $\left|\frac{\partial\Pi^s(d)}{\partial d}\right|<\left|\frac{\partial\Pi^p(d)}{\partial d}\right|$. Therefore, because of linearity , we can write

$$\begin{aligned} d_s^* &= \overline{d}+\frac{\Pi^s(\overline{d})}{\left|\frac{\partial\Pi^s(d)}{\partial d}\right|}, \\ d_p^* &= \overline{d}+\frac{\Pi^p(\overline{d})}{\left|\frac{\partial\Pi^p(d)}{\partial d}\right|}; \end{aligned}$$

so that $d_s^*>d_p^*$, which implies $1-F(d_s^*)<1-F(d_p^*)$.

Next, observe that the change in total profits with respect to an increase in λ under the pooling equilibrium is

$$\frac{\partial\Pi^p}{\partial\lambda}=\frac{\partial\widehat{R}_p}{\partial\lambda}\left(\alpha\theta_g+\lambda\alpha\overline{\theta}+\frac{N-1}{N}(1-\alpha)\theta_b\right)-d$$

Since

$$\frac{\partial \widehat{R}_p}{\partial \lambda} = \overline{d}\frac{\left(\overline{\theta}-\theta_b\right)(\alpha-1)(N-1)N}{\left((N-1)(1-\alpha)\theta_b+\lambda\overline{\theta}N\right)^2}<0,$$

this implies that $\frac{\partial \Pi^p}{\partial \lambda}<0$ for $\lambda>\widehat{\lambda}$, as desired.

Note finally that the marginal effect of λ on Π^p is magnified by the realized cost of funds, d. In other words, $\frac{\partial^2 \Pi^p}{\partial \lambda \partial d}<0$, implying that variability in the cost of funds is of greater consequence for larger values of λ, leading to a greater probability of a crisis. ■

Proof of Proposition 6: The condition that defines $\widehat{\lambda}$ is

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

Applying the Implicit Function Theorem, we obtain that

$$\frac{\partial\widehat{\lambda}}{\partial\overline{d}}=-\frac{\frac{\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p}{\partial d}}{\frac{\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p}{\partial \lambda}}. \tag{9}$$

We know that the denominator is positive, since $\widehat{R}_p$ is decreasing in λ while $\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)$ is constant. For the numerator, from the definitions of $\widehat{R}_s$ and $\widehat{C}_s$, we have

$$\frac{\partial\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)}{\partial\overline{d}}=\frac{\theta_g-\theta_b}{((1-\theta_b)\theta_g-\delta(1-\theta_g)\theta_b)\theta_g}>0$$

and for the pooling rate $\widehat{R}_p$ we have

$$\frac{\partial\widehat{R}_p}{\partial d}=\frac{\left(\frac{N-1}{N}\right)(1-\alpha)+\lambda}{\left(\frac{N-1}{N}\right)(1-\alpha)\theta_b+\lambda\overline{\theta}} \tag{10}$$

The numerator of (9) can therefore be written as

$$\frac{\left(\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p\right)}{\partial\overline{d}}=\frac{\theta_g-\theta_b}{((1-\theta_b)\theta_g-\delta(1-\theta_g)\theta_b)\theta_g}-\frac{\left(\frac{N-1}{N}\right)(1-\alpha)+\lambda}{\left(\frac{N-1}{N}\right)(1-\alpha)\theta_b+\lambda\overline{\theta}}$$

To sign this expression, consider that

$$\frac{\left(\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p\right)}{\partial\overline{d}}\overline{d}=\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p-\frac{(1-\delta)(1-\theta_g)\theta_b y}{(1-\theta_b)\theta_g-\delta(1-\theta_g)\theta_b}$$

Then, since by definition $\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p=0$ at $\widehat{\lambda}$, and the last term in the expression is positive, we have that $\frac{\left(\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p\right)}{\partial\overline{d}}\overline{d}<0$, implying that $\frac{\left(\left(\widehat{R}_s+\left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)-\widehat{R}_p\right)}{\partial\overline{d}}<0$ as well. This in turn means implies that $\frac{\partial\widehat{\lambda}}{\partial\overline{d}}>0$, as desired. ■

Proof of Proposition 7: Since the distribution of borrowers faced by the incumbent is better than that faced by the potential entrants (who face a mass $(1-\alpha)$ of bad borrowers rejected by the incumbent), the former will always be able to undercut any pooling contract offered by the latter, which would end-up financing only rejected borrowers. Competition will then necessarily lead these lenders to offer the zero-profit separating contract $\left(\widehat{R}_s, \widehat{C}_s\right)$. It follows that, by definition, there do not exist any separating contracts with which the incumbent can make positive profits on the pool of unknown borrowers. On the contrary, condition (6) guarantees that there exists a pooling contract with interest rate $R \in \left(\frac{\overline{d}}{\overline{\theta}}, \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s\right)$ which is is preferred by the good type to $\left(\widehat{R}_s, \widehat{C}_s\right)$ and that makes positive profits. Moreover, because of stage 3, this pooling contract cannot be undercut by a any profitable separating contract. ■

Proof of Proposition 8: The RHS of condition (5) does not depend on N, but the LHS clearly does. Define $\widehat{\lambda}_N$ as the proportion of untested borrowers at which (5) holds with equality when N banks are active in the market. Then, it easy to show that $\widehat{\lambda}_N < \widehat{\lambda}_{N+1}$: by definition, we have

$$\frac{(N-1)(1-\alpha)+\widehat{\lambda}_N N}{(N-1)(1-\alpha)\theta_b+\widehat{\lambda}_N\overline{\theta}N} = \frac{N(1-\alpha)+\widehat{\lambda}_{N+1}(N+1)}{N(1-\alpha)\theta_b+\widehat{\lambda}_{N+1}\overline{\theta}(N+1)},$$

which, after some rewriting, becomes

$$\widehat{\lambda}_N = \widehat{\lambda}_{N+1}\frac{N^{2}-1}{N^{2}},$$

thus establishing that $\widehat{\lambda}$ is increasing in N. ■

Proof of Proposition 9: First, in equilibrium, since the market for unknown borrowers is now segmented, borrowers who defaulted are offered the separating contract $\left(\widehat{R}_s, \widehat{C}_s\right)$. Moreover, this is the only contract that can be part of a stable equilibrium, as for this market segment no pooling contract can make non negative profits since there are no unknown borrowers.

Second, under information sharing, the break-even pooling rate is

$$\widehat{R}_p^* = \overline{d}\frac{(N-1)(1-\alpha)\theta_b+\lambda N}{(N-1)(1-\alpha)\theta_b^2+\lambda\overline{\theta}N}.$$

Banks are now able to identify bad borrowers who defaulted in the past, which means that only a proportion θ_b of bad borrowers known to competitor banks enter the pool of unknown borrowers. This implies $\widehat{R}_p^* < \widehat{R}_p$, which in turn implies $\widehat{\lambda}^* < \widehat{\lambda}$. The rest of the proof is the same as in Proposition (2). ■

Proof of Proposition 10: Start with the case where $\lambda < \widehat{\lambda}^* < \widehat{\lambda}$, so that the model admits a unique stable separating equilibrium either with or without information sharing. Then, bank profits on good known borrowers who have not defaulted in the past are the same in both cases. Bank profits on "black-listed" good borrowers are also the same as in the model without information sharing. Indeed, we know that $R_g^s = \widehat{R}_s + \left(\frac{1-\theta_g}{\theta_g}\right)\widehat{C}_s$ is the rate charged to these borrowers in equilibrium.

Second, consider the case where $\widehat{\lambda}^* < \widehat{\lambda} < \lambda$, so that both scenarios admit a pooling equilibrium. In this case, profits on good known borrowers who have not defaulted in the past are lower under information sharing than without. Indeed, we know from Proposition (9) that $\widehat{R}_p^* < \widehat{R}_p$ so that $R_g^{p*} < R_g^p$, where R_g^{p*} refers to the matching contract offered known good borrowers in the pooling equilibrium of that proposition. However, bank profits on "black-listed" good borrowers are higher, as under information sharing these borrowers are charged a rate $R_g^s > \widehat{R}_p = R_g^p$. For each bank, the difference in profits will be

$$\Pi^{sharing} - \Pi = \frac{\alpha\theta_g}{N}\left(\Pi\left(\widehat{R}_p^*\right) - \Pi\left(\widehat{R}_p\right)\right) + \frac{\alpha(1-\theta_g)}{N}\left(\Pi\left(R_g^s\right) - \Pi\left(\widehat{R}_p\right)\right). \tag{11}$$

Finally, for $\widehat{\lambda}^* < \lambda < \widehat{\lambda}$, the model with information sharing admits a pooling equilibrium, while without information sharing it has a separating equilibrium. In this case the difference in profits can be written as

$$\begin{aligned}\Pi^{sharing} - \Pi &= \frac{\alpha\theta_g}{N}\left(\Pi\left(\widehat{R}_p^*\right) - \Pi\left(R_g^s\right)\right) + \frac{\alpha(1-\theta_g)}{N}\left(\Pi\left(R_g^s\right) - \Pi\left(R_g^s\right)\right) \\ &= \frac{\alpha\theta_g}{N}\left(\Pi\left(\widehat{R}_p^*\right) - \Pi\left(R_g^s\right)\right) < 0.\end{aligned}$$

A necessary condition to have $\Pi^{sharing} > \Pi$ is therefore that $\widehat{\lambda}^* < \widehat{\lambda} < \lambda$. Hence, it must be that $\lambda^* > \widehat{\lambda}$.

Now at $\lambda = \widehat{\lambda}$, Eq. (11) becomes

$$\Pi^{sharing} - \Pi = \frac{\alpha\theta_g}{N}\left(\Pi\left(\widehat{R}_p^*\right) - \Pi\left(\widehat{R}_p\right)\right) < 0.$$

In addition, it is easy to see that the difference is increasing in λ, since $\frac{d\widehat{R}_p}{d\lambda} < 0$ and $\frac{d\left(\widehat{R}_p^* - \widehat{R}_p\right)}{d\lambda} < 0$. Also,

$$\lim_{\lambda\to\infty}\left(\widehat{R}_p^* - \widehat{R}_p\right) = 0,$$

and hence,

$$\lim_{\lambda \to \infty} \left(\Pi^{sharing} - \Pi \right) = \frac{\alpha \left(1 - \theta_g\right)}{N} \left(\Pi \left(R_g^s\right) - \Pi \left(\frac{\bar{d}}{\bar{\bar{\theta}}} \right) \right) > 0,$$

which implies that there exists a λ^* such that $\Pi^{sharing} - \Pi > 0$ if and only if $\lambda \geq \lambda^*$. ■

B An Alternative Model of Information Acquisition

As an alternative to screening via the use of collateral requirements, we consider a variant of the model where we instead allow banks to obtain information about borrowers directly by conducting creditworthiness tests. Suppose that banks can, at a cost of k, conduct a creditworthiness test that perfectly and privately reveals the type of the borrower. As before, banks are competitive, and offer contracts that specify a promised repayment, R, as well as whether or not a credit screen will be conducted. If a screen is conducted, the bank incurs the cost k of the credit screen, and the borrower receives a loan at the promised terms only if the screen reveals him to be of the good type, θ_g.[26] Otherwise, no test is performed. Formally, this means that banks offer contracts (R, η), where $\eta = 1$ if a credit screen will be conducted, and 0 otherwise. We assume that a borrower who is indifferent between being rejected for a loan and not applying will simply choose to not apply. This choice for a borrower can be easily justified by assuming that there is some (infinitesimally) small cost of applying that a borrower must bear, such as the time and effort of filling out an application, or if there is some reputation (i.e., non-pecuniary) loss to a borrower of being identified as a bad type.

Note that, since banks are competitive and only a borrower revealed to be of the good type will receive a loan if he is screened, the equilibrium rate that must be charged if screening takes place is the break-even rate for a good borrower, which must also compensate the bank for the cost of screening: $R_g = \frac{\bar{d}+k}{\theta_g}$. We maintain the same assumption as before regarding the tie-breaking rule, and assume that all the borrowers that would choose a contract offered by more than one bank are randomly allocated to one of these banks. The equilibrium contract is therefore $(R_g, 1)$, with only good borrowers obtaining financing and paying the

[26] The allocation of the cost of the test to either the bank or the borrower has no effect on the equilibrium incentive to screen a borrower. Specifically, all results go through exactly as stated if instead we assume that the borrower must pay the cost k of the credit screen.

cost of screening k.

We can now show that, as in the model provided in the main text, banks maintain high lending standards when the information asymmetries vis-a-vis each other's customers are severe, and low standards when they are not. In other words, we proceed to show that for high λ, banks move away from assessing borrowers' creditworthiness and instead grant credit to all borrowers indiscriminately. We start by showing that conducting a creditworthiness test can only be optimal if no bank has an incentive to offer to lend without incurring the cost of information acquisition k. Suppose therefore that some bank offers some other contract $\left(\widetilde{R}, 0\right)$ in which no credit screen is conducted and therefore no information is acquired. It is clear that this contract can only be successful in attracting good borrowers (and bad ones as well) if the rate offered is lower than what is offered by the contract that screens borrowers:

$$\widetilde{R} < \frac{\overline{d}+k}{\theta_g} \tag{12}$$

At the same time, the contract must not make losses for the bank that offers it, even assuming that all the unknown borrowers plus the bad borrowers rejected by competitor banks are financed. That is, $\lambda\left(\overline{\theta}\widetilde{R}-\overline{d}\right)+(1-\alpha)\left(\frac{N-1}{N}\right)\left(\theta_b\widetilde{R}-\overline{d}\right)\geq 0 \Leftrightarrow$

$$\widetilde{R} \geq \overline{d}\frac{\left(\frac{N-1}{N}\right)(1-\alpha)+\lambda}{\left(\frac{N-1}{N}\right)(1-\alpha)\,\theta_b+\lambda\overline{\overline{\theta}}} \tag{13}$$

(Note that Equation (13) specifies the exact same condition for the existence of an equilibrium with no information acquisition as condition (4) in the text.) Therefore, much as before, we can now state a necessary and sufficient condition for the strategy profile where all banks acquire information by offering the contract $(R_g, 1)$ to be a Nash equilibrium by combining conditions (12) and (13), which yields

$$\overline{d}\frac{(N-1)(1-\alpha)+\lambda N}{(N-1)(1-\alpha)\,\theta_b+\lambda\overline{\theta}N} \geq \frac{\overline{d}+k}{\theta_g} \tag{14}$$

We note that for λ converging to zero, condition (14) becomes $\frac{\overline{d}}{\theta_b} > \frac{\overline{d}+k}{\theta_g} \Leftrightarrow k < \overline{d}\left(\frac{\theta_g-\theta_b}{\theta_b}\right)$.

Letting $\lambda \rightarrow \infty$ in condition (14), we can now state a condition for equilibrium information acquisition to depend on λ as

$$\frac{\overline{d}}{\overline{\overline{\theta}}} < \frac{\overline{d}+k}{\theta_g} \tag{15}$$

Condition (15) will be satisfied if and only if $k > \overline{d}\left(\frac{\theta_g - \overline{\theta}}{\overline{\theta}}\right)$.

We can summarize this discussion with the following proposition, which extends the results from the text to the setting where banks can acquire information directly by conducting a credit screen. The proposition states that as long as the cost of screening is neither too large nor too small, banks will apply high standards in their lending decisions and will grant no loans without first conducting a credit screen on each loan applicants when information asymmetries are high (low values of λ). These standards, however, will be reduced as information asymmetries decrease (as λ increases), and banks will instead prefer to save on the cost of conducting the screen and will therefore obtain no information prior to lending. The proof of this result follows along the lines of Propositions 1 and 2 and is therefore omitted.

Proposition 11 *If the cost of screening* $k \in \left(\overline{d}\left(\frac{\theta_g - \overline{\theta}}{\overline{\theta}}\right), \overline{d}\left(\frac{\theta_g - \theta_b}{\theta_b}\right)\right)$*, then there exists* $0 < \lambda^{'} < \infty$ *such that: i) the strategy profile where all banks acquire information by offering the contract* $(R_g, 1)$ *is the unique stable pure-strategy equilibrium of the game if and only if* $\lambda \leq \lambda^{'}$*; and ii) the strategy profile where all banks offer the contract* $\left(\tilde{R}_p, 0\right)$ *is the unique stable pure-strategy equilibrium if and only if* $\lambda > \lambda^{'}$*.*

We note that, since known borrowers do not have to be screened, each bank can obtain positive profits in equilibrium by offering their known good borrowers a loan package with a rate higher than R_g but that requires no screening, with the rate set such that the borrower is indifferent between this contract and that offered by another lender.

Finally, Proposition 11 shows that an increase in adverse selection leads to increased screening. This differs from other models of bank competition where screening is often a decreasing function of adverse selection. In those models the incentive to screen derives from the rents each bank can obtain by acquiring private information, which are decreasing in the degree of adverse selection (see, e.g., Thakor, 1996). In the present model, banks obtain informational rents from their own known borrowers, but competitive screening of unknown borrowers does not provide banks with additional rents.

References

Allen, F., and D. Gale, 2000, "Optimal Currency Crises," *Carnegie-Rochester Conference Series on Public Policy*, 53, pp. 177-230.

Allen, F., and D. Gale, 2004, "Competition and Financial Stability," *Journal of Money, Credit and Banking*, Vol. 36, pp. 453-480.

Asea, P., and B. Blomberg, 1998, "Lending Cycles," *Journal of Econometrics*, Vol. 83, No. 1-2, pp. 89-128.

Berger, A. and G. Udell, 2004, "The institutional memory hypothesis and the procyclicality of bank lending behavior," *Journal of Financial Intermediation,* Vol. 13, pp. 458-495.

Berger, A. and L. Mester, 2003, "Explaining the Dramatic Changes in Performance of US Banks: Technological Deregulation, and Dynamic Changes in Competition," *Journal of Financial Intermediation,* Vol. 12, pp. 57-95.

Berlin, M. and A. Butler, 2002, "Collateral and Competition," Working Paper No. 02-22, Federal Reserve Bank of Philadelphia.

Besanko, D., and A. Thakor, 1987, "Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets," *International Economic Review,* Vol. 28, pp. 671-689.

Bester, H., 1985, "Screening vs. Rationing in Credit Markets with Imperfect Information," *American Economic Review,* Vol. 75, pp. 850-855.

Boot, A., and A. Thakor, 2000, "Can Relationship Banking Survive Competition?" *Journal of Finance* Vol. 55, n2, pp. 679-713.

Bouckaert, J., and H. Degryse, 2004, "Softening Competition by Inducing Switching in Credit Markets", *Journal of Industrial Economics,* Vol. 52, pp. 27-52.

Broecker, T., 1990, "Credit-worthiness Tests and Interbank Competition", *Econometrica,* pp. 429-452.

Claessens, S., A. Dermiguc-Kunt, and H. Huizinga, 2001, "How Does Foreign Entry Affect Domestic Banking Markets," *Journal of Banking and Finance,* Vol. 25, pp. 891-911.

Dasgupta, P., and E. Maskin, 1986, "The Existence of Equilibrium in Discontinuous Economic Games 2: Applications", *Review of Economic Studies,* Vol. 53, pp. 27-42.

Degryse, H., and P. Van Cayseele, 2000, "Relationship Lending within a Bank-Based System: Evidence from European Small Business Data," *Journal of Financial Intermediation,* Vol. 9, pp. 90-109.

Degryse, H., and S. Ongena, 2004, "Distance, Lending Relationship, and Competition," forthcoming, *Journal of Finance*.

Dell'Ariccia, G., Friedman, E., and R. Marquez, 1999, "Adverse Selection as a Barrier to Entry in the Banking Industry," *RAND Journal of Economics,* Vol. 30, Autumn.

Dell'Ariccia, G., 2001, "Asymmetric Information and the Structure of the Banking Industry", *European Economic Review,* Vol. 45, pp. 1957-1980.

de Meza, D., and D. Webb, 1987, "Too Much Investment: A Problem of Asymmetric Information," *Quarterly Journal of Economics,* Vol. 102, pp. 281-292.

Demirgüç-Kunt, A., and E. Detragiache, 2002, "Does Deposit Insurance Increase Banking System Stability? An Empirical Investigation", *Journal of Monetary Economics*, Vol. 49, pp. 1373-1406.

Gehrig, T., and R. Stenbacka, 2003, "Screening Cycles," mimeo, Universitat Freiburg and Swedish School of Economics.

Goldstein, I., 2004, "Strategic Complementarities and The Twin Crises," forthcoming, *Economic Journal*.

Gorton, G., and H. Ping, 2003, "Bank Credit Cycles," mimeo, University of Pennsylvania.

Gourinchas, P.O., Valdes, R., and O. Landerretche, 2001, "Lending booms: Latin America and the World", *Economia,* pp. 47-99.

Harhoff, D., and T. Korting, 1998, "Lending Relationship in Germany - Empirical Evidence from Survey Data," *Journal of Banking and Finance,* Vol. 22, pp. 1317-1353.

Hellwig, M., 1987, "Some Recent Developments in the Theory of Competition in Markets with Adverse Selection," *European Economic Review,* Vol. 31, pp. 319-325.

Kaminsky, G., and C. Reinhart, 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," *American Economic Review*, Vol. 89, pp. 473-500.

Kiyotaki, N., and J. Moore, 1997, "Credit Cycles", *Journal of Political Economy,* Vol. 105, pp.211-248.

Kohlberg, E., and J.F. Mertens, 1986, "On the Strategic Stability of Equilibria," *Econometrica,* Vol. 54, pp. 1003-1038.

Lown, C. and D. Morgan, 2003, "The Credit Cycle and the Business Cycle: New Findings Using the Loan Officer Opinion Survey," forthcoming, *Journal of Money, Credit, and Banking*.

Manove, M., Padilla, J., M. Pagano, 2001, "Collateral vs Project Screening: A Model of Lazy Banks," *RAND Journal of Economics,* Vol. 32, pp. 726-744.

Marquez, R., 2002, "Competition, Adverse Selection, and Information Dispersion in the Banking Industry," *Review of Financial Studies,* Vol. 15, No.3, pp. 901-926.

Matutes, C., and X. Vives, 1996, "Competition for Deposits, Fragility, and Insurance", *Journal of Financial Intermediation*, pp. 184-216.

Padilla, J., and M. Pagano, 1997, "Endogenous Communication among Lenders and Entrepreneurial Incentives," *Review of Financial Studies,* Vol. 10, pp. 205-236.

Pagano, M., and T. Jappelli, 1993, "Information Sharing in Credit Markets", *Journal of Finance,* pp. 1693-1718.

Petersen, M., and R. Rajan 2002, "Does Distance Still Matter? The Information Revolution in Small Business Lending," *Journal of Finance,* Vol. 57, pp. 2533-2570.

Rajan, R., 1994, "Why Bank Credit Policies Fluctuate: A Theory and Some Evidence," *Quarterly Journal of Economics,* Vol. 109, pp. 399-441.

Rothschild, M., and J. Stiglitz, 1976, "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information," *Quarterly Journal of Economics,* Vol. 90, pp. 629-649.

Ruckes, M., 2004, "Bank Competition and Credit Standards," *Review of Financial Studies,* Vol. 17, pp. 1073-1102.

Shaffer, S., 1998, "The Winner's Curse in Banking," *Journal of Financial Intermediation,* Vol. 7, pp. 359-392.

Simon, L. and W. Zame, 1990, "Discontinuous Games and Endogenous Sharing Rules," *Econometrica*, Vol. 58, pp. 861-872.

Thakor, A., 1996, "Capital Requirements, Monetary Policy, and Aggregate Bank Lending: Theory and Empirical Evidence," *Journal of Finance*, Vol. 51, pp. 279-324.

Tornell, A. and F. Westermann, 2001, "Boom/Bust Cycles: Facts and Explanation," mimeo UCLA

von Thadden, E.-L., 1994, "The Commitment of Finance, Duplicated Monitoring and the Investment Horizon," working paper, University of Lausanne.

von Thadden, E.-L., 2004, "Asymmetric Information, Bank lending and Implicit Contracts: The Winner's Curse," *Finance Research Letters*, Vol. 1, pp. 11-23.

Weinberg, J., 1995, "Cycles in Lending Standards?," *Federal Reserve Bank of Richmond Economic Quarterly,* Vol. 81, pp. 1-18.

Wilson, C., 1977, "A Model of Insurance Markets with Incomplete Information," *Journal of Economic Theory,* Vol. 16, pp. 167-207.