

Financial Liberalization, Competition and Sound Banking: Theoretical and Empirical Essays

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Abstract

Previous studies seem to agree that increased competition would cause riskier banking behavior. This dissertation shows that when competition intensifies, banks have greater incentives for screening loan applicants, and thus loan quality may improve. In addition, competition fosters banks to rely less on collateral requirements. Hence, banks may be less vulnerable to asset price shocks. The empirical chapter finds evidence of loan quality improvement after removing cross-border entry restrictions in the EU. There is also evidence that banks' behavior across EU countries has converged.

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Introduction

The literature on financial stability often argues that increased competition causes riskier banking behavior and deteriorates bank assets, and therefore, financial liberalization is a source of financial instability. Examples are Chan et al. (1986), Riordan (1993), Gehrig (1998), Schnitzer (1999), Dell’Ariccia (2000), and Hellmann et al. (2000). Despite such a consensus, the empirical findings regarding the effects of increased competition on risk are mixed. On the one hand, there is evidence of a link between financial crises and financial liberalization¹. On the other hand, among the European emerging economies, it seems that those banking sectors with better performances are those that greatly reduced their entry restrictions. Lifting intrastate restrictions of the US banking sector also contributed to the substantial improvement in loan quality, according to Jayaratne and Strahan (1996). This raises the issue whether the current consensus regarding the relationship of banking competition and risk taking is justified.

This issue is directly related to the on-going effort of building sound banking systems. In the past two decades, many financial markets have resorted to financial liberalization in order to foster financial deepening. In the mean-time, the frequency and degree of severeness of financial crises have increased. The question is whether there are inherent trade-offs between efficiency, indicated by lower loan rates, and safety of the financial system, and between financial deepening and stability. If there are such trade-offs, is increased competition a source, as has been widely accepted?

Policy makers have gradually realized that the role of regulation is limited in building a sound banking system. Establishing an effective incentive structure is an equally important concern. One aspect is to improve banks’ incentives for acquiring information. Needless to say, this role of banks is

¹See, e.g., Demirgüç-Kunt and Detragiache (1998) and Gruben et al. (1999).

crucial in achieving financial stability and in allocating financial resources efficiently. Again, the question raised here is what role market structure plays in banks' incentives for acquiring information.

The following three essays attempt to contribute to our understanding of these issues. The first essay considers an imperfect screening technology whose variable costs increase with the screening level. We assume that a bank has an advantage in screening its former clients relative to the screening of new clients which have been affiliated with the other bank. In fact, we assume that it is not worthwhile to the bank to screen new clients beyond a costless routine check which we identify with a screening level of zero and which classifies each applicant from the pool as "good" or "bad" with equal probability, but eliminates certain not further specified extremely bad risks. If a bank chooses a very low, albeit positive screening level for its traditional clients, then those of them with "good" projects have a slightly better chance of getting a loan when staying with the bank than when switching banks. In this case, the other bank needs to set its loan rate just a little bit lower than the first bank's rate in order to attract the first bank's former "good" clients. The first bank can make it more difficult for the second bank to lure away these good clients by choosing a higher screening level. For then the second bank has to increase the loan rate differential in order to induce these clients to switch. This suggests that screening can mitigate price competition and, therefore, a duopolist might engage in more screening than a monopolist.

The second essay considers a credit market where an incumbent bank faces the threat of losing market share to a new entrant. It incorporates some stylized facts regarding foreign bank entry. Specifically, it takes into account the asymmetric positions of incumbent banks and new entrants in a local credit market regarding screening loan applicants. The advantage of an incumbent bank is characterized by its lower screening cost and modeled by allowing only the incumbent bank to possess the screening technology. It also considers a simple model where collateral is allowed. The first model shows that the marginal benefit of screening increases when there is competition. Thus, a bank's screening incentive is higher when there is an entry threat even if loan rates are driven lower. The second model demonstrates that a bank facing competition has lower opportunity cost of screening and thus is more likely to screen loan applicants rather than require collateral.

The analyses in both essays carry a similar distinctive feature, which is to allow for interactions between banks' loan rate decision and screening

activities. The banking literature often assumes, explicitly or implicitly, that banks' screening activities do not affect banks loan rate decision (e.g., Chan et al. (1986) and Gehrig (1998)) . This one-direction analysis leads to the conclusion a that lower loan rate resulting from increased competition lowers the marginal benefit of screening and hence the incentives for screening. In our analyses, feedback of a bank's screening activities on its loan rate decision is allowed. Since good loan applicants prefer their status to be revealed, raising the screening level can benefit good loan applicants and thus reduce the pressure of cutting loan rates in the process of competing for good applicants. Thus, our conclusion is exactly the opposite to most of the literature: increased competition enhances banks' incentives for screening loan applicants and improves loan quality.

The model incorporating a collateral option in the second essay has additional implications. As is well known, banks tend to be overly optimistic about collateralized loans and to ignore their potential risk². It has also been recognized that excessively relying on collateral exposes banks to asset price shocks and causes instability. The model shows that a bank facing potential competition is more likely to rely on information processing instead of a collateral requirement. It follows that a competitive banking system may be less vulnerable to asset price shocks and in a better position in dealing with market risk.

The third essay is an empirical piece. The idea is to seek evidence from the EU banking markets supporting the above theoretical findings. In the mid-1990's, the cross-border entry restrictions in the EU have been removed due to the adoption of the Second Banking Directives. The hypothesis to be tested is that increased competition induced by banking deregulation improves loan quality, which is a direct result of banks' greater incentives for screening loan applicants. The data shows evidence of loan quality improvement after removing cross-border banking restrictions in the EU, indicated by the decline of loan loss provisions. The analysis using non-performing loans as an indicator for loan quality with a smaller sample size also does not find support for a positive relationship between risky behavior and financial deregulation.

In view of these studies, it can be concluded that competition may increase banks' incentives for screening loan applicants, improve bank asset

²For example, the difficulties that the Japanese banking sector is experiencing is partly due to this reason.

quality, and reduce banks' vulnerability to asset price shocks. It may be true that financial liberalization has contributed to past financial crises in some ways. However, we shall separate the factors that are inherent and permanent from those that are avoidable and temporary. As some researchers point out, incomplete reforms such as retaining soft budget constraints, imperfect legal systems and shocks of regime changes that introduce inexperienced and unskilled players³ can all contribute to the weakness of the banking sector. All in all, the causes and effects of banking distress and crises still need to be better understood.

³See, e.g., Lingdren, et al. (1996), pp. 100, and Honohan (1997).

Chapter 1

Banking Competition and Screening of Loan Applicants

Xiaofen Chen and Hans Haller

Abstract

The model takes into account the two-way interaction between a bank's loan rate and screening expenditure decisions. It is shown that screening can reduce competitive pressure and, hence, competition can provide an incentive for more intense screening. Although compared with monopoly, loan rates are lower in the equilibrium with duopolistic banking competition, banks expend more screening effort and, thus, the overall loan quality may be improved. This finding is different from the results in the literature which predict less screening under competition.

1.1 Introduction

It has been widely accepted that banks play a crucial role in economic growth and development. One of their key functions is to improve financial resource allocation, in particular the channeling of savings to investment projects. There is little doubt that competition impacts on how well banks perform this task. There appears to exist consensus that competition is beneficial insofar as it fosters efficiency by reducing interest rate spreads. There is

some concern that it might be harmful to the extent that it causes banks to engage in riskier behavior. In this paper we address the latter concern and, in contrast to the literature, show that increased competition can have a positive effect on banks' screening of loan applicants and result in less exposure to risk.

Bad risk management can be detrimental to the economy, indeed, if it leads to substantial volatility of financial markets and causes disruptions and distress as a consequence of defaults. This is not to say that banks should be discouraged from providing funds for risky investment projects under all circumstances. The main rationale for taking major risks is that high risk often comes along with high expected returns. In that case avoidance of high risk projects would eliminate the potential for rapid economic growth. A further rationale for funding high risk projects is based on diversification. Namely, an individual project that is extremely risky and lacks a commensurable return, can still be worth financing, provided that the bank can sufficiently diversify risks across projects. In either case, the efficiency-volatility trade-off would only be of secondary concern.

In the sequel we shall focus on a scenario where the efficiency-volatility tradeoff ought to be of primary concern. We analyze a model with two types of investment projects: low risk and high risk projects. We assume that low risk projects have positive net expected returns, hence are "good" whereas high risk projects have negative net expected returns and, therefore, are "bad". Under these circumstances, the screening and monitoring activities of banks become important and slackness of the banking sector in performing these activities becomes an issue. In particular, banks can and should resort to screening of loan applicants to weed out bad projects, provided that screening is not prohibitively costly.

The recent trend of financial market integration raises the question of how competitive pressure in the banking sector affects the risk management of banks and, more specifically, how increased competition influences the screening activities of banks. On theoretical grounds, the effect of competition on the amount of the effort which banks devote to screening loan applicants has been examined by several authors. The prevailing view in the literature has been that enhanced competition reduces the incentives for screening. The standard argument for this conclusion is that a more competitive market environment leads to lower loan rates which in turn reduce the marginal benefit of screening and, consequently, the level of screening that

a bank deems optimal. The argument is absolutely correct, provided that it accurately describes the causality of events. The argument ignores, however, a possible reverse causality: that the amount of screening performed by a bank affects the rate of interest its competitor(s) can charge. In a nutshell, our point is that screening alleviates competitive pressure, because a higher screening level makes it harder for competitors to lure away good loan applicants. Contrary to the prevailing view, we find that enhanced competition can lead to intenser screening of loan applicants.

The standard argument appears first in Chan, Greenbaum and Thakor (1986) who emphasize the reusability of information and use the loan rate to parameterize competition intensity. They show that the marginal benefit of screening will be reduced when the loan rate decreases (due to competition) and hence the screening effort will be lower. Riordan (1993) asserts, informally, that competition may undermine banks' incentives for information acquisition because it reduces profitability. In line with the standard argument, he states that the screening effort depends solely on loan profitability. Gehrig (1998) studies the effect of competition on banks' ex ante information production and shows that competition may reduce screening efforts, in fact can lead to zero screening — which is tantamount to disintermediation under certain circumstances. He implicitly takes the loan rate as a variable independent of screening levels, like in the model of Chan, Greenbaum and Thakor (1986) and the informal analysis of Riordan (1993). In Schnitzer (1999), one of the banks in a duopoly banking market may have the same screening level as a monopoly bank. However, the second bank must not engage in screening activity in order for the first bank to have an incentive for screening. It follows that the overall loan quality would still deteriorate as in the three other papers.

The prevailing view has been reaffirmed in three recent papers. In Cao and Shi (2000), banks first screen and then bid for a single project. An increase in the number of banks exacerbates the winner's curse and in response induces banks to reduce their screening probabilities. Dell'Ariccia (2000) focuses on the relationship between the informational structure of loan markets and banks' screening activities. He shows that competition may lead to reduced screening under certain conditions. Hellmann *et al.* (2000) consider deposit competition with assets of different but observable risk and conclude that increased competition lowers banks' franchise value and thus encourages risky behavior.

Here we forward the opposite view that increased competition among financial intermediaries can lead to higher standards in client selection, in particular that increased competition in the banking sector may have a positive effect on banks' screening efforts. In that case concerns about deteriorating banking assets would be unwarranted. The only social cost of increased competition would be higher expenditures on screening. Thus the efficiency-volatility tradeoff becomes obsolete, even when it cannot be dismissed on traditional grounds such as a high-risk high-return linkage or diversification opportunities. In quite a different context, Santos and Scheinkman (2000) also conclude that competition among financial intermediaries (specifically exchanges) does not necessarily lead to lower standards (specifically minimum margin requirements).

The model presented here considers an imperfect screening technology whose variable costs increase with the screening level. Moreover, we allow for a reverse causality between the banks' loan rate and screening expenditure decisions. We demonstrate that screening can reduce competitive pressure and, hence, competition may provide an incentive for screening. In the equilibrium with duopolistic competition, although loan rates decline, both banks expend more screening effort than in the monopoly bank case and thus the overall loan quality is improved.

To develop better intuition for this result, let us elaborate on an essential detail of our analysis. We assume that a bank has an advantage in screening its former clients relative to the screening of new clients which have been affiliated with the other bank. In fact, we assume that it is not worthwhile to the bank to screen new clients beyond a costless routine check which we identify with a screening level of zero and which classifies each applicant from the pool as "good" or "bad" with equal probability, but eliminates certain not further specified extremely bad risks. If a bank chooses a very low, albeit positive screening level for its traditional clients, then those of them with "good" projects have a slightly better chance of getting a loan when staying with the bank than when switching banks. In this case, the other bank needs to set its loan rate just a little bit lower than the first bank's rate in order to attract the first bank's former "good" clients. The first bank can make it more difficult for the second bank to lure away these good clients by choosing a higher screening level. For then the second bank has to increase the loan rate differential in order to induce these clients to switch. This suggests that screening can mitigate price competition and, therefore, a duopolist might engage in more screening than a monopolist.

In the next section, we introduce the model and carry out the formal analysis. In the final section, we discuss the assumptions underlying our result as well as possible extensions and ramifications. We also report on the empirical literature.

1.2 Model and Analysis

The model has a basic set-up similar to the model of Gehrig (1998) and Broecker (1990). All firms and banks are risk neutral. Each firm is endowed with a project which needs 1 unit of investment and can only be funded by borrowing from a bank. There are two types of firms: good firms (g) and bad firms (b). A good firm's project generates a positive return z with probability π_g and a return 0 with probability $1 - \pi_g$; a bad firm's project has the same return z with a lower probability π_b and a return 0 with probability $1 - \pi_b$. Firms know about their own types while banks do not. However, banks can observe the results of projects and enforce repayments from borrowers of successful projects. If a project fails, the firm pays nothing to the bank. For simplicity, let the measure of firms be normalized to one, and the proportion of good firms be one half.

Banks are identical and have unlimited funding with a gross flat rate, r . Assume $\pi_g z - r > 0$, and $\pi_b z - r < 0$, so that funding a good project is beneficial for the economy, while funding a bad project is inefficient. Also assume π_g large enough so that

$$(\pi_g z - r) + (\pi_b z - r) = (\pi_g + \pi_b) z - 2r > 0, \quad (1.1)$$

that is, overall projects are worth funding. This condition serves to ensure competitive pressure among competitors in our analysis as will become clear later.

Banks can acquire information about a firm's status only by screening or by observing informative switching behavior (from which a bank can infer a firm's status). They are endowed with identical screening technologies with the following features. Screening a firm costs $c(s)$, where $s \in [0, 1]$ represents the screening level. Assume $c'(0) = 0$, $c'(s) > 0$ for $s > 0$, $c''(s) > 0$, and $c(1) = \infty$ so that it is never optimal for banks to screen at the level $s = 1$. The information acquired from screening is private to the bank. Based on its

available information, a bank assigns applicants to two categories: good (G) and bad (B). Only those in category G can get a loan. The probability of a good firm and a bad firm being assigned to category G is $p(G|g) = l_g(s)$, $p(G|b) = l_b(s)$, respectively, and depends on the screening level s . Assume $l'_g > 0$, $l''_g < 0$, $l'_b < 0$, $l''_b > 0$; and $l_g(1) = 1$, $l_b(1) = 0$.

When $s = 0$, banks determine a firm's category by observing noisy signals without a cost. The probabilities of banks' observing good signals for good and bad firms are both $1/2$, i.e., $l_g(0) = l_b(0) = \frac{1}{2}$. Thus $l_g(s) > \frac{1}{2}$, $l_b(s) < \frac{1}{2}$ for $s > 0$. Assume that when choosing a zero screening level, banks will apply the costless signaling device instead of simply lending to every applicant. This renders a bank's profit function continuous in terms of its screening level s . We believe it is a reasonable assumption that can be justified in the following circumstance. Suppose there is a third type of firms that have a very low probability of success, and whose presence would cause an overall loss if a bank simply lent to all applicants. However, this type of firms is also easy to discard. Namely, banks can get rid of them by applying the costless signaling device and have a positive expected profit. This device assigns all those firms to category B with certainty, while other firms are categorized as G or B with equal probability.

In a typical credit market, firms can borrow from a bank repeatedly. During previous lending processes, banks can collect information that could reflect potential changes in the firm's future profits, for example, the usage of loans, its organizational structure adjustment, and changes in its important financial ratios that reflect its liquidity, leverage and profitability. That kind of information is more convenient and less costly to collect by a firm's current bank than by other banks. This is especially true for small and medium sized firms and firms in a less developed capital market, since outsiders are more likely to lack access to specific information about these firms. Therefore, a firm's current bank has an advantage in screening the firm's future prospects. For analytical simplicity, we assume that screening takes place only at the firm's current bank. Furthermore, let us assume for simplicity that each firm has been affiliated with a bank in the past, and each bank has inherited the same proportion of good and bad firms to begin with.

The timing of the borrowing procedure is as follows. First, banks decide on screening levels. Second, banks announce loan rates. The specific order of moves (determination of screening levels prior to loan rates) differs from the literature and allows for the reverse causality between loan rates

and screening levels that drives our main result. Screening levels and loan rates are common knowledge but screening results are not revealed to other banks. In the third stage of the procedure, firms make one of the following three choices: 1) Staying with their traditional bank, in which case they will be screened and each firm knows its probability of getting a loan from its current bank based on the screening level and its type. 2) Switching to another bank, in which case their credit category will be determined at random unless switching itself is a bad signal – as will be the case in the equilibrium determined below. 3) Staying out of the credit market in which case their utilities will be zero. Finally, banks issue loans to those applicants who are considered worthy of lending to, that is, those assigned to category G .

1.2.1 Banking Monopoly

A monopoly bank maximizes its profit with respect to the loan rate p it charges and the screening level s it chooses:

$$\Pi_m(p, s) = \frac{1}{2}l_g(s)(\pi_gp - r) + \frac{1}{2}l_b(s)(\pi_bp - r) - c(s) \quad (1.2)$$

Notice that the loan rate p must not exceed z : when $p \leq z$, all firms that qualify will take a loan, otherwise no firm will take a loan. Since

$$\frac{\partial \Pi_m}{\partial p} = \frac{1}{2}l_g\pi_g + \frac{1}{2}l_b\pi_b > 0, \quad (1.3)$$

a monopoly bank will choose the highest possible loan rate:

$$p_m^* = z \quad (1.4)$$

The first order condition with respect to s at $p = z$ is:

$$l'_g(\pi_gz - r) + l'_b(\pi_bz - r) = 2c' \quad (1.5)$$

Notice that in equation (5), the L.H.S. is a decreasing function of s , and the R.H.S is an increasing function of s . Hence, the profit function is a strictly concave function of s . In particular, it first increases, then decreases in s , since $l'_g(0) > 0, l'_b(0) < 0, c'(0) = 0, c(1) = \infty$. Therefore, the optimal screening level s_m^* is interior and can be obtained by solving (5).

1.2.2 Banking Duopoly

There are two banks, denoted $i = 1, 2$. Bank i chooses screening level s_i and charges loan rate p_i . Since no firm will take a loan if $p > z$, only the case $p_i \leq z$ is considered.

After banks announce screening levels and loan rates, firms make the decision whether to stay with the same bank or switch to the other bank to maximize their utilities.

A good type firm and a bad type firm with bank i expect they can get a loan from bank i , where $i = 1, 2$, with probability $l_{g,i}$ and $l_{b,i}$ respectively, and from the other bank, bank j , with probability $1/2$ each when switching to it unless switching provides a bad signal. This is because bank j does not screen them and can only assign them to good or bad categories by observing noisy signals unless it can extract information from observing firms' switching decisions. A good firm will switch from bank 1 to bank 2 if

$$\frac{1}{2}(z - p_2) > l_{g,1}(z - p_1), \quad (1.6)$$

i.e.,

$$p_2 < p_1 - (2l_{g,1} - 1)(z - p_1). \quad (1.7)$$

A bad firm will switch from bank 1 to bank 2 if

$$\frac{1}{2}(z - p_2) > l_{b,1}(z - p_1), \quad (1.8)$$

i.e.,

$$p_2 < p_1 + (1 - 2l_{b,1})(z - p_1). \quad (1.9)$$

Thus, for a good firm to switch to bank 2, p_2 must be lower than p_1 while satisfying (7), but a bad firm will switch even if p_2 exceeds p_1 as long as (9) holds. Whenever bank 2's price is lower than p_1 by the margin shown in (7), it is optimal for both good and bad firms to switch banks.

When p_2 satisfies (9), but not (7), i.e.,

$$p_1 - (2l_{g,1} - 1)(z - p_1) \leq p_2 < p_1 + (1 - 2l_{b,1})(z - p_1), \quad (1.10)$$

only bad firms have the incentive to switch. However, since no good firm changes banks, a bad firm's status will be revealed if it does switch. Hence, bad firms will stay with the same bank in this situation.

As a result, the decision rule for both good and bad firms historically with bank 1 is Q^* :

- Switch to bank 2 when p_2 is lower than p_1 by a margin such that

$$p_1 - p_2 > (2l_{g,1} - 1)(z - p_1). \quad (1.11)$$

- Stay with bank 1 otherwise.

The decision rule for bank 2's existing clients is analogous.

Equation (1) assures that it is profitable for a bank to lend to the other banks' traditional firms as long as its loan rate is higher than $2r/(\pi_g + \pi_b)$. Therefore, on the one hand, both banks choose their loan rates and screening levels so that they can keep their traditional firms and maximize their profits from lending to them; on the other hand, they also have an incentive to undercut and attract new firms from the other bank if it is profitable to do so. The equilibrium loan rates and screening levels should reflect the outcome of this kind of competition.

As can be seen in (11), the loan rate bank 2 needs to set to lure away bank 1's traditional firms depends on bank 1's loan rate and screening level. When bank 1's screening level is very low (i.e., $l_{g,1}$ close to $1/2$), or when its price is very high (i.e., p_1 close to z), bank 2 can set its loan rate just a little bit lower than p_1 and attract all firms from bank 1. When p_1 gets lower, or when s_1 is higher, it will be more difficult for bank 2 to attract bank 1's traditional firms, since it increases the margin by which p_2 has to be lower than p_1 . Then bank 2 will incur a larger foregone profit from its traditional firms, and make a lower profit from the new firms it attracts when it undercuts bank 1. Therefore, given p_2 , from bank 1's standpoint, in order to keep its traditional firms from being enticed by bank 2, it can either lower its loan rate or raise its screening level to the point where bank 2's profit from attracting new firms from bank 1 just covers the foregone profit from its own traditional firms, that is

$$\frac{1}{4}l_{g,2}\pi_g(p_2 - \tilde{p}_2) + \frac{1}{4}l_{b,2}\pi_b(p_2 - \tilde{p}_2) = \frac{1}{2}\left[\frac{1}{4}(\pi_g\tilde{p}_2 - r) + \frac{1}{4}(\pi_b\tilde{p}_2 - r)\right] \quad (1.12)$$

where $\tilde{p}_2 = p_1 - (2l_{g,1} - 1)(z - p_1)$. The R.H.S. in (12) is bank 2's profit from attracting firms from bank 1, the L.H.S. is its foregone profit if it charges p_2 .

For (12) to hold, the assumed order of moves is crucial: The banks first commit to screening levels. Then they determine interest rates. In practice,

loan rates may be easier to adjust than screening levels in which case the assumed order of moves is quite plausible.

Our argument further hinges on the assumption that a bank charges the same loan rate to all borrowers it accepts. This means that when it lowers its rate in order to attract the other bank's former firms, it forfeits some of the rent it could extract from its own former clients. Arguably, it could charge a higher rate to repeat customers than to new customers. Attempts at this sort of price discrimination can be observed even in markets where switching costs are negligible. For instance, long-distance phone companies tend to offer rates to new customers which are below the rates they are charging most existing customers. Some banks automatically "roll over" certificates of deposits at interest rates below the advertised rates for new certificates. However, in all this cases, the old customers can get the better deal by threatening to leave or, in many cases, simply asking for it. This sort of scheme relies on the fact that for whatever reasons, some customers will not react. It is unlikely that this sort of price discrimination will work with commercial customers. There is no evidence that it exists in the commercial loan market.

Simplifying (12) yields:

$$(l_{g,2}\pi_g + l_{b,2}\pi_b)(p_2 - \tilde{p}_2) = \frac{1}{2}(\pi_g + \pi_b)\tilde{p}_2 - r \quad (1.13)$$

Likewise, bank 2 must also set its price p_2 low enough in order to keep its traditional firms from being lured away by bank 1:

$$(l_{g,1}\pi_g + l_{b,1}\pi_b)(p_1 - \tilde{p}_1) = \frac{1}{2}(\pi_g + \pi_b)\tilde{p}_1 - r \quad (1.14)$$

where $\tilde{p}_1 = p_2 - (2l_{g,2} - 1)(z - p_2)$.

Solving (13) and (14) gives the optimal prices p_1^* and p_2^* as functions of screening levels s_1 and s_2 :

$$p_i^* = z - \frac{(mz - r)[n_j + 2l_{g,j}(n_i + m)]}{4l_{g,i}l_{g,j}(n_i + m)(n_j + m) - n_i n_j}, \quad (1.15)$$

where $m = \frac{1}{2}(\pi_g + \pi_b)$, $n_i = (l_{g,i}\pi_g + l_{b,i}\pi_b)$, $i = 1, 2$, $j \neq i$. Notice that, because $mz - r = \frac{1}{2}(\pi_g + \pi_b)z - r > 0$ (from (1)), p_i^* is lower than the monopoly price p_m^* .

Given p_i^* , if $p_j > p_j^*$, bank j will lose all of its customers; if $p_j < p_j^*$, bank j can raise its profit by increasing p_j , where $i, j = 1, 2, j \neq i$. With these loan rates, both banks will keep their traditional firms. The optimal screening levels, s_i^* , are then the solutions of:

$$\text{Max}_{s_i \in [0,1]} \Pi_i = \frac{1}{4}l_g(s_i)(\pi_g p_i^* - r) + \frac{1}{4}l_b(s_i)(\pi_b p_i^* - r) - \frac{1}{2}c(s_i) \quad (1.16)$$

Thus, an equilibrium $\{p_i^*, s_i^*, i = 1, 2; Q^*\}$ has the following feature: p_i^* are given by (15), s_i^* are given by (16), and Q^* is the firm decision rule as described before.

Notice that the equilibrium screening level s_i^* cannot be zero. For suppose $s_i^* = 0$ for bank i . Given the other bank's screening level s_j , bank i can charge a loan rate

$$p_i = \frac{2mn_j(2l_{g,j} - 1)z + 4ml_{g,j}r + rn_j}{4ml_{g,j}(n_j + m) - mn_j} \quad (1.17)$$

At this price, bank i 's profit Π_i is an increasing function of s_i at $s_i = 0$. Thus $s_i = 0$ is not an optimal screening level in equilibrium.

Given the feature of the cost function $c(s)$, it is easy to see that $s = 1$ cannot be an optimal screening level either. Therefore, (16) must have interior solutions which are given by their first order conditions:

$$l'_{g,i}(\pi_g p_i^* - r) + l_{g,i}\pi_g p_i^{*'} + l'_{b,i}(\pi_b p_i^* - r) + l_{b,i}\pi_b p_i^{*'} = 2c'_i \quad (1.18)$$

where

$$\begin{aligned} p_i^{*'} = & \frac{(mz - r)[n_j + 2l_{g,j}(n_i + m)]}{[4l_{g,i}l_{g,j}(n_i + m)(n_j + m) - n_i n_j]^2} \{4l_{g,j}(n_j + m)[l'_{g,i}(n_i + m) + \\ & + l_{g,i}n'_i] - n'_i n_j\} - \frac{2l_{g,j}(mz - r)n'_i}{4l_{g,i}l_{g,j}(n_i + m)(n_j + m) - n_i n_j}. \end{aligned} \quad (1.19)$$

Because of the symmetry in terms of s_i and s_j , we can simplify (18) as follows by imposing $p_i^* = p_j^*$:

$$l'_g(\pi_g p^* - r) + l_{g,g}p^{*'} + l'_b(\pi_b p^* - r) + l_{b,b}p^{*'} = 2c', \quad (1.20)$$

where

$$p^{*'} = (mz - r) \frac{4l'_g l_g (n + m)^2 + n'n(2l_g - 1)}{[2l_g(n + m) - n]^2 [2l_g(n + m) + n]}, \quad (1.21)$$

and

$$p^* = z - \frac{\frac{1}{2}(\pi_g + \pi_b)z - r}{(l_g \pi_g + l_b \pi_b)(2l_g - 1) + l_g(\pi_g + \pi_b)}. \quad (1.22)$$

Notice that at $s = 0$,

$$p^* = \frac{2r}{\pi_g + \pi_b}, \quad (1.23)$$

$$p^{*'} = \frac{8l'_g(mz - r)}{3m} > 0, \quad (1.24)$$

and the L.H.S. of (20) is positive:

$$(l'_g - l'_b) \frac{(\pi_g - \pi_b)r}{\pi_g + \pi_b} + (l_g \pi_g + l_b \pi_b) p^{*'} > 0 \quad (1.25)$$

In addition, at $s = 1$, the L.H.S. is finite since p^* and $p^{*'}$ are both finite. Thus, by continuity, an interior solution to (20) exists. It follows that a symmetric equilibrium with the screening level s^* , determined by (20), and the loan rate p^* exists.

Proposition: *In a symmetric equilibrium, the optimal screening level of each bank in a duopoly banking market is higher than that of a monopoly bank.*

proof. As one can see, s^* is determined by solving equation (20). Comparing equation (20) with the F.O.C. of the monopoly bank's profit function, i.e., equation (5), one would notice that their R.H.S. are the same, but the L.H.S. in equation (20) is larger than that in equation (5) everywhere. Namely, subtracting the L.H.S. of (5) from that of (20) yields:

$$\begin{aligned} M &\equiv (l_g \pi_g + l_b \pi_b) p^{*'} + (l'_g \pi_g + l'_b \pi_b) (p^* - z) \\ &= (mz - r) \frac{n[4l'_g l_g (n + m)^2 + n'n(2l_g - 1)]}{[2l_g(n + m) - n]^2 [2l_g(n + m) + n]} - \frac{n'(mz - r)}{2l_g(n + m) - n} \\ &= (mz - r) \frac{2l'_g l_g [2l_b \pi_b (n + m)^2 + \pi_g n^2] - 2l_g l'_b \pi_b [2l_g(n + m)^2 - n^2]}{[2l_g(n + m) - n]^2 [2l_g(n + m) + n]} \end{aligned}$$

Since $l'_g > 0$, $l'_b < 0$, and $2l_g(n + m)^2 - n^2 > 0$, $M > 0$. Therefore, the solution (or the smallest solution, if multiple solutions exist) to (20) must

be higher than the solution to (5). As a result, the optimal screening level s^* of a duopoly bank, determined by (20), must be higher than the monopoly bank's screening level s_m^* , determined by (5). **Q.E.D.**

Note that if $p_i^* < p_m^*$ were taken as a parameter independent of the screening levels, then bank i 's optimal screening level which is obtained by (16) could be less than s_m^* , as asserted by the earlier literature. That level would be necessarily less than s_m^* , if $\pi_g l'_g(s_m^*) + \pi_b l'_b(s_m^*) > 0$, that is if at the monopolist's optimal screening level, the benefits from identifying good projects exceed the benefits from avoiding bad projects. Essentially the same observation has been made earlier by Thomas Gehrig [see Gehrig (1998; Corollary 3.3)].

Further note that because of the firm decision rule Q^* , the traditional affiliation of a firm with a bank perpetuates itself in the symmetric equilibrium: the firm stays with its original bank. Thus informational advantages cement lasting bank-firm relationships — which is quite plausible. To our knowledge, this important aspect has not been considered in the emerging literature on relationship banking [see, e.g., Peterson and Rajan (1995), Yafeh and Yosha (2000)].

1.3 Ramifications and Conclusions

In our setting, screening can potentially benefit both banks and good-type firms. In the monopoly case, however, all rent is extracted by the bank and the sole value of screening for the bank lies in identifying profitable projects and eliminating potential losses. In contrast, competition causes banks to give up part of their loan profits to firms, especially to good-type firms. Moreover, a higher screening level makes it harder for competitors to lure good firms away and, consequently, screening serves an additional purpose: to help alleviate competitive pressure. This additional function of screening has not been observed before. It gives rise to a two-way interaction between the banks' loan rate and screening expenditure decisions. Because of the two-way interaction, we obtain higher screening levels under banking duopoly than under banking monopoly.

Our findings are in stark contrast with the prior theoretical literature which has concluded that more competition leads to less screening. In quite a different context, Santos and Scheinkman (2000) also challenge the widely held view that competition among financial intermediaries necessarily lowers standards (margin requirements in their case). They consider competition between exchanges rather than banks. In that context, competition is thought to lead to a "race to the bottom" in which financial intermediaries settle for excessively low levels of contractual guarantees in an attempt to increase volume. In their model, exchanges design contracts to attract trading volume, but also take into consideration that potential customers differ in credit quality and may choose to default. They find that when credit quality is observable, then competing exchanges would require more guarantees than a monopolist. They also present examples where private information is present and competition produces higher standards than monopoly.

The empirical evidence regarding the impact of fiercer competition on the handling of risk by financial institutions is mixed. For lack of data, one cannot directly test any relationship between the degree of competition and screening intensity in the credit market. However, loan loss provisions can serve as a proxy for the actual or anticipated volume of bad loans. Then an increase of loan loss provisions indicates an actual or perceived decline of the quality of the banks' loan portfolio. By that measure, de Boissieu (1993)

and Gehrig (1996) suggest a worsening of average loan quality in France and Switzerland, respectively, during a period of more intensely contested financial markets.

Some studies, e.g. Demirgüç-Kunt and Detragiache (1998) and Gruben et al. (1999) suggest a positive link between financial liberalization and financial crises. However, it is worth pointing out that it is not necessarily the competitive pressure brought about by financial liberalization that causes previously protected domestic lenders to assume greater risks. It may rather be their easier access to international funding sources combined with a persistent weak budget constraint — based on a concrete or perceived bailout guarantee by their governments — that renders those traditional domestic lenders more prone to excessive risk taking. Honohan (1997) offers the additional reason that régime changes per se might cause riskier behavior simply because they alter the pattern of economic and financial shocks and introduce inexperienced players. In any event, it has been the suggested positive link between financial liberalization and financial crises that motivated some of the theoretical literature.

But there is also some evidence that financial liberalization might actually reduce risk. According to Jayaratne and Strahan (1996), lifting intrastate restrictions has contributed to the substantial improvement in loan quality of the U.S. banking sector. It also seems to be the case that those European countries in economic transition who have greatly reduced their entry restrictions, are the ones with the better performing banking sectors.

Our model treats the two competing banks symmetrically. It allows a direct comparison between a monopolistic and an imperfectly competitive credit market. It is well suited to address consequences of less competition, more concentration, mergers and acquisitions in the banking sector. Financial liberalization, however, typically gives rise to an asymmetric scenario, with domestic or in-state incumbent banks and potential foreign or out-of-state entrants. For that reason, Chen (2000) compares the case of a monopoly bank with the asymmetric situation of an incumbent bank and a potential entrant. The incumbent is assumed to have an advantage in screening relative to the potential entrant — which is plausible when the potential entrant is a foreign bank. For simplicity, this advantage manifests itself in the assumption that the entrant never screens. In all other respects, her assumptions and approach are similar to ours. It turns out that in equilibrium, entry does not occur, but that under the threat of entry the

incumbent charges a lower interest rate and screens more than the otherwise identical monopolist. This conforms with the fact that after financial liberalization, foreign entrants often gain only moderate market shares. Like in our model, competitive pressure increases rather than reduces screening intensity. Screening serves as a device to counter the downward pressure on loan rates.

Chen (2000) analyzes a second model with only a rudimentary, binary screening technology, but with collateral as an additional or alternative sorting device. She shows that whenever the monopolist resorts to screening, an incumbent facing potential entry will also screen. She further demonstrates the possibility that the monopolist requires collateral without screening, whereas the threat of entry induces the incumbent to forego collateral and to screen instead. Once again, competitive pressure does not reduce screening. Rather, as observed before, increased screening may help dampen price competition. This improves loan quality. To the extent that screening replaces collateral and the future value of collateral is uncertain, collateral risk is eliminated — an added benefit.

The fact that our key argument has been successfully employed in three different models demonstrates a certain robustness of our results. The model could be further refined in several ways which would complicate the analysis without fundamentally affecting the main result. To begin with, most of the convenient assumptions on screening costs can be relaxed. Instead of simply assuming that screening the other bank’s prior clients is not worthwhile, the advantage in screening one’s former customers could be made explicit. The population of firms could be further stratified by means of the reputation acquired during the previous banking relationship. We assume that realized project returns are verifiable and rule out voluntary default. If there was the possibility of voluntary default and renegotiation of contract terms, the posted loan rates would have to be replaced by the effective renegotiated rates. We assume that the bank receives nothing, if a project fails. Chen (2000) shows that in principle, collateral can be introduced into the model to guarantee some repayment in the case of default. Like Gehrig (1998) and others we opt for a simple description of projects which makes it easy to distinguish between “good” and “bad” ones. Otherwise, risk-return trade-offs would render the screening criteria of banks more complex.

Our findings appear sensitive with regard to two specific assumptions, though. Namely, first of all, our argument rests on a specific order of moves: deter-

mination of screening levels prior to loan rates. If screening levels happen to be more difficult to adjust than loan rates, this order is quite plausible, albeit in stark contrast to the sequencing of moves assumed in the literature. Comparison of our findings with the literature shows that the order of decisions proves crucial, confirming a well known insight from models of spatial competition where market participants also compete in two dimensions, location and price. Secondly, our argument is based on the assumption that a bank charges the same loan rate to all its borrowers — who all have been classified as “good” according to the screening outcome. The alternative would be to charge a higher rate to existing customers. We have argued earlier that the latter practice is not to be expected in the commercial loan market.

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Chapter 2

Financial Liberalization, Competition and Sound Banking

Xiaofen Chen¹

Abstract

This paper shows that financial liberalization – removing entry restrictions specifically – does not necessarily cause riskier banking behavior. The first model demonstrates that a bank facing an entry threat has a higher marginal value of screening than a monopoly bank and thus has greater incentive to screen loan applicants. Consequently, loan quality can be improved due to competition. The second model finds that a bank facing competition is more likely to rely on screening instead of collateral requirements, and therefore, may be less vulnerable to asset price shocks.

2.1 Introduction

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In the past two decades, the world has witnessed waves of financial liberalization² as well as frequent outbreaks of banking distress and crises. Researchers seem to agree that financial liberalization contributed to the past experience of financial instability and that intensified competition fostered riskier banking behavior. Despite such a consensus, the empirical findings regarding the effects of increased competition on bank risk taking are mixed. On the one hand, there is evidence of a positive link between financial liberalization and financial crises³. On the other hand, there also exists evidence supporting a different argument. According to Jayaratne and Strahan (1996), branch deregulation of the US banking sector has contributed substantially to loan quality improvement and the long lasting economic boom. Among the emerging economies of Europe, the countries with better performing banking sectors are also those who greatly reduced their entry restrictions.

In this paper, we question the view that competition should necessarily make banks prone to take more risk. Specifically, we show that removing entry restrictions may increase banks' incentives to screen loan applicants and thus promote safer banking practices. Moreover, competition may prompt banks to rely more on information processing instead of collateral requirements to deal with information asymmetry. It follows that a competitive banking system may be less vulnerable to asset price shocks.

The paper first uses a simple model to study the impact of financial liberalization on banks' risk taking behavior. It considers a credit market where an incumbent bank faces the threat of losing market share to a new entrant. The model has two distinctive features. First, it takes into account the asymmetric positions of an incumbent bank and a new entrant in a local credit market. An incumbent bank is considered to have an advantage of lower screening costs. This advantage is modeled by allowing only the incumbent bank to possess the screening technology. The second feature is to allow for interactions between banks' loan rate decision and screening decision, especially the feedback of a bank's screening activities on its loan rate decision. This formulation leads to the conclusion that raising the screening level can reduce competitive pressure, especially, the pressure of cutting loan rates. The simple intuition is that if loan applicants know their status, a good applicant is more willing to have its status revealed while a bad applicant prefers to hide its status. Thus, adopting a higher

²See Williamson and Mahar (1998) for a detailed account.

³See, e.g., Demirgüç-Kunt and Detragiache (1998) and Gruben et. al (1999).

screening level benefits high quality applicants and in turn benefits the bank. For a monopoly bank, its market power regarding the loan rate limits the effect of screening activities on the loan rate decision. When the bank faces competition, screening has the additional effect of reducing the pressure of cutting loan rates in order to compete for good applicants. Thus, the marginal benefit of screening increases when there is competition. As a result, a bank with an entry threat has greater incentive to screen loan applicants than a monopoly bank.

The paper then extends the model by allowing both banks to have the option of using collateral as a risk sorting device. To some extent the use of collateral is a substitute for screening activities in that it can reduce moral hazard and adverse selection problems caused by information asymmetry in the credit market, as addressed in abundant literature. However, there is ample evidence showing that banks tend to be overly optimistic about collateralized loans and to ignore their potential risk⁴. It has been widely recognized that relying excessively on collateral exposes banks to asset price shocks and causes inefficiency. In fact, asset prices have been fluctuating substantially in the past several decades and their sharp falls have often been associated with banking distress. The channels through which this flaw arises are discussed in a growing body of literature⁵.

The second model focuses on the effects of market structure on banks' incentives for adopting screening versus collateral requirements. We find that a bank facing an entry threat resorts to screening for a wider range of parameter values than a monopoly bank. That is, whenever it is optimal for a monopoly bank to screen, screening is also optimal for a bank facing an entry threat. In some cases, a monopoly bank does not screen, while a bank facing competition screens. As in the first model, the reason behind these findings is that competitive pressure enhances the benefit of screening in comparison with the case where the bank has monopoly power. More

⁴For example, during the bubble years, most Japanese banks made excessive and reckless collateralized loans. These loans have been turning bad quickly. But banks only have loan loss reserves against a fifth of problem loans since they typically do not make provisions for loans secured against property. See The Economist (2000) and Schaede (1995).

⁵See, for example, ECB report (2000) and IMF report (2000). A popular explanation is that when asset prices are inflated, borrowers' borrowing ability increases with collateral values, and banks' lending standards tend to be loosened. Hence, excessive credit is extended. When the trend of asset prices reverses, banks' performances will be affected negatively as borrowers' insolvency increases and their collateral value falls.

specifically, competition drives down the monopoly bank's opportunity cost of screening, which is its profit when it requires collateral. As a result, a competitive banking system is more likely to rely on information processing instead of collateral requirements, and competition may prevent excessively collateralized loans.

The paper is related to the literature studying the link between competition and banks' risk taking behavior. The literature is generally in favor of the view that competition causes riskier banking. Chan et al. (1986) use loan rates to parameterize competition and show that the marginal benefit of screening will be reduced when loan rates decrease. Gehrig (1998) argues that competition may reduce screening efforts when the benefits from identifying profitable projects exceed the benefits of avoiding unprofitable projects. In Schnitzer (1999), one of the banks in a duopoly banking market may have the same screening level as a monopoly bank, but the overall loan quality still declines. Dell'Ariccia (2000) focuses on the relationship between the informational structure of loan markets and banks' screening incentives. He shows that, under certain conditions, competition may lead to reduced screening. Hellmann et al. (2000) consider deposit competition with assets of observable risk and conclude that increased competition lowers banks' franchise values and thus encourages risky behavior. The paper is also related to Manove et al. (2000), who are in favor of a monopolistic banking structure in terms of the inefficiency arising from banks' lazy attitude towards screening when they can use collateral.

The paper is organized as follows: Section 2 introduces the simple model and demonstrates that a bank's screening incentive is greater after removing entry restrictions. Section 3 presents the model with collateral as a risk sorting option and finds that it is more likely for a bank threatened by entry to screen loan applicants. This finding leads to the conclusion that removing entry restrictions may encourage screening activities. Section 4 contains final remarks.

2.2 The Simple Model

The simple model has a basic set-up similar to that of Gehrig (1998). Consider a credit market where banks face two types of firms with the total measure normalized to one. The portions of the good type firms (g) and the bad type firms (b) are one half each. Each firm is endowed with a project

which needs 1 unit of investment and can only be funded by borrowing from a bank. A good firm's project generates a return z with probability π_g and a return 0 with probability $1 - \pi_g$; a bad firm's project has the same return z with a lower probability π_b and a return 0 with probability $1 - \pi_b$. Firms know about their own types while banks do not. However, banks can observe the results of projects and enforce repayments from borrowers of successful projects. If a project fails, the firm pays nothing to the bank.

Banks have unlimited funding with a fixed gross rate 1. Assume $\pi_g z - 1 > 0$, and $\pi_b z - 1 < 0$, so that funding a good project is beneficial for the economy, while funding a bad project is inefficient. Also assume

$$\frac{1}{2}(\pi_g z - 1) + \frac{1}{2}(\pi_b z - 1) = \frac{1}{2}(\pi_g + \pi_b)z - 1 > 0, \quad (2.1)$$

that is, overall the projects are worth funding.

A monopoly bank can acquire information about a firm's status by screening the firm. In the duopoly banking market, the model assumes that only one bank, bank 1, has the screening technology. This assumption is based on the following consideration. When a bank is new in a market, it is more costly for it to collect information than for an incumbent bank simply because of the lack of local knowledge. This information disadvantage is an important reason why foreign banks are generally not much involved in local or retail business in their host countries. The above assumption is for the purpose of capturing the information advantage of domestic banks in a simple form. One may interpret bank 1 in the model as a domestic bank, and bank 2 as a foreign bank. This assumption may also be generalized to apply to credit markets with incumbent banks and new entrants that are not familiar with the local market.

The screening technology has the following features. Screening a firm costs $c(s)$, where $s \in [0, 1]$ represents the screening level. Assume $c(0) = 0$, $c'(0) = 0$, $c'(s) > 0$ for $s > 0$, $c''(s) > 0$, and $c(1) > \frac{1}{2}(\pi_g z - 1)$, so that it is never optimal for banks to screen at the level $s = 1$. Based on the screening result, the bank assigns applicants to two categories: good (G) and bad (B). Only those in category G can get a loan. The probability of a good firm and a bad firm being assigned to category G depends on the screening level s and is denoted as $p(G|g) = l_g(s)$ and $p(G|b) = l_b(s)$, respectively. Assume $l'_g > 0$, $l''_g \leq 0$, $l'_b < 0$, $l''_b > 0$; and $l_g(0) = l_b(0) = \frac{1}{2}$, $l_g(1) = 1$, $l_b(1) = 0$.

Let r_i be the loan rate that bank i charges when there are two banks. For the bank without screening technology, bank 2, the expected profit of giving a loan at rate r_2 is given by: $\Psi_2(r_2) = \frac{1}{2}(\pi_g r_2 - 1) + \frac{1}{2}(\pi_b r_2 - 1) = \frac{1}{2}(\pi_g + \pi_b)r_2 - 1$, provided that it expects the pool of its applicants to contain the same portion of both types of firms as the entire pool of firms. In some cases (as we will see later), bank 2 can infer for certain a loan applicant's type based on both banks' offers. In order to allow bank 2 to utilize this information, assume that bank 2 can reject applicants if it infers that only bad firms apply. A similar modelling approach has been taken by Hellwig (1987).

The timing of the borrowing procedure in the duopoly banking market is as follows:

- First, the bank with the screening technology announces screening levels and then both banks announce loan rates. Screening levels and loan rates are observable but screening results are not revealed to the other bank.
- Second, firms make choices of going to bank 1 or bank 2, or staying out of the credit market based on their expected payoffs from dealing with the banks. Assume they go to bank 1 if they are indifferent.
- Third, the bank with the screening technology screens applicants.
- Finally, both banks issue loans to those who are considered worthy of lending to, that is: bank 1 gives loans to those assigned to category G ; bank 2 either gives loans to every applicant or rejects all applicants depending on the offers of both banks. The same procedure applies to the monopoly bank case, except that bank 2 is not present.

2.2.1 The Monopoly Case

A monopoly bank maximizes its profit with respect to the loan rate r it charges and the screening level s it chooses:

$$\Psi_m(r, s) = \frac{1}{2}l_g(s)(\pi_g r - 1) + \frac{1}{2}l_b(s)(\pi_b r - 1) - c(s) \quad (2.2)$$

Notice that the loan rate r must not exceed z : when $r \leq z$, all firms that qualify will take a loan, otherwise no firm will take a loan. Obviously, a monopoly bank will choose the highest possible loan rate:

$$r_m^* = z$$

Since $\Psi_m(z, s)$ is strictly concave, the optimal screening level s^* is given by the first order condition:

$$l'_g(\pi_g z - 1) + l'_b(\pi_b z - 1) = 2c' \quad (2.3)$$

Notice that at zero screening level, the monopoly bank earns a positive expected profit by simply giving a loan to every applicant. In order for the bank to apply a positive screening level, the screening technology should be efficient so that there exist $s > 0$, at which $\Psi_m(s)$ is greater than the profit the bank earns without screening. For this purpose, assume the set $S^0 = \{s \in (0, 1) | \Psi_m(z, s) = \frac{1}{2}(\pi_g + \pi_b)z - 1\}$ is non-empty, and there exists $\hat{s} \in S^0$ such that $\Psi'_m(\hat{s}) > 0$ ⁶. With this condition, $\Psi_m(s^*) > \frac{1}{2}(\pi_g + \pi_b)z - 1$, and s^* is indeed its optimal screening level.

2.2.2 The Case with an Entrant

As specified before, bank 1 is endowed with the screening technology, while bank 2 is not. Since no firm will take a loan if $r > z$, only the case $r_i \leq z$ is considered.

A good and a bad firm's expected profits from bank 1 are $l_g(s)\pi_g(z - r_1)$, and $l_b(s)\pi_b(z - r_1)$, respectively. If bank 2 accepts applicants at the final stage, a good firm will come to bank 2 when

$$\pi_g(z - r_2) > l_g(s)\pi_g(z - r_1), \quad (2.4)$$

i.e.,

$$r_2 < z - l_g(s)(z - r_1) \equiv \tilde{r}_2.$$

Let $\tilde{r}_2 \equiv z - l_g(s)(z - r_1)$.

⁶The following is a numerical example where there is s such that $\Psi_m(z, s) > \frac{1}{2}(\pi_g + \pi_b)z - 1$. Given $\pi_g = \frac{1}{2}$, $\pi_b = \frac{1}{8}$, $z = 4$, $l_g(s) = \frac{1}{2} + \frac{s}{1+s}$, $l_b(s) = \frac{1}{2} - \frac{s}{1+s}$ and $c(s) = s^4$, $\Psi_m(z, \frac{1}{2}) = \frac{5}{16} > \frac{1}{2}(\pi_g + \pi_b)z - 1 = \frac{1}{4}$.

A bad firm will come to bank 2 when

$$\pi_b(z - r_2) > l_b(s)\pi_b(z - r_1), \quad (2.5)$$

i.e.,

$$r_2 < z - l_b(s)(z - r_1).$$

Notice that good firms require a lower loan rate from bank 2 than bad firms for them to choose bank 2 if bank 1's screening level is positive. The reason is that when bank 1 screens, a good firm is easier to get a loan from bank 1 than a bad firm. This makes it more difficult for bank 2 to attract good firms than to attract bad firms. When it undercuts bank 1 by setting r_2 lower than the threshold for good firms to come, i.e., when (2.4) and (2.5) are both satisfied, bank 2's expected profit for accepting applicants is: $\Psi_2(r_2) = \frac{1}{2}(\pi_g + \pi_b)r_2 - 1$. When (2.4) is satisfied but (2.5) is not, only bad firms will come if bank 2 accepts applicants. In this situation, bank 2 should reject applicants at the final stage.

Next let us specify bank 2's belief about an applicant's status that determines its optimal strategy at the final stage. There could be three situations depending on s , r_1 , and r_2 :

1) $l_g(z - r_1) < (z - r_2)$, which implies $l_b(z - r_1) < (z - r_2)$. In this case, both types of firms prefer bank 2 if bank 2 accepts applicants. Accordingly, bank 2 would have the belief that the probability of an applicant's type being good is 1/2;

2) $l_b(z - r_1) > (z - r_2)$, which implies $l_g(z - r_1) > (z - r_2)$. In this case, both types of firms prefer to go to bank 1 whatever bank 2 does at the final stage. Bank 2's belief about the probability of an applicant being good could be anything between 0 and 1, and would be irrelevant in equilibrium. Let us assume it is 1/2;

3) $l_g(z - r_1) > (z - r_2)$, but $l_b(z - r_1) < (z - r_2)$. In this case, going to bank 2 is a strictly dominated strategy for good firms (recall the assumption that good firms prefer bank 1 when the payoffs from both banks are the same), but bad firms would strictly prefer to go to bank 2 if it accepts applicants. Thus, bank 2 would not hold a belief that an applicant's type is good with a

positive probability. In other words, bank 2 would believe that an applicant belongs to the bad type with probability 1.

Based on these beliefs, bank 2's optimal strategy at the final stage is to accept in cases (1) or (2), provided $\Psi_2(r_2) > 0$, and to reject otherwise.

Given s and r_1 , if $\Psi_2(\tilde{r}_2) > 0$, bank 2 can always undercut bank 1 by setting $r_2 = \tilde{r}_2 - \varepsilon$ and attract all firms, and bank 1 should either cut its loan rate or raise its screening level to keep the market share. Thus, an equilibrium would occur only when bank 1 drives bank 2's profit to be non-positive at $\tilde{r}_2$. In this case, s and r_1 are determined by

$$\left. \begin{aligned} \underset{s, r_1}{Max} \Psi_1 &= \frac{1}{2}l_g(s)(\pi_g r_1 - 1) + \frac{1}{2}l_b(s)(\pi_b r_1 - 1) - c(s) \\ s.t., \Psi_2(\tilde{r}_2) &= \frac{1}{2}(\pi_g + \pi_b)\tilde{r}_2 - 1 \leq 0 \end{aligned} \right\} \quad (2.6)$$

where $\tilde{r}_2 \equiv z - l_g(s)(z - r_1)$.

After simplifying the constraint to

$$r_1 \leq z - \frac{1}{l_g(s)}\left(z - \frac{2}{\pi_g + \pi_b}\right),$$

one can easily see that the constraint is always binding since otherwise bank 1 can raise r_1 to improve its profit. Thus, (2.6) is equivalent to

$$\left. \begin{aligned} \underset{s \in [0,1]}{Max} \Psi_1 &= \frac{1}{2}(l_g(s)\pi_g + l_b(s)\pi_b)r_1 - \frac{1}{2}(l_g(s) + l_b(s)) - c(s) \\ &= \frac{1}{2}(l_g(s)\pi_g + l_b(s)\pi_b)\left[z - \frac{1}{l_g(s)}\left(z - \frac{2}{\pi_g + \pi_b}\right)\right] \\ &\quad - \frac{1}{2}(l_g(s) + l_b(s)) - c(s) \end{aligned} \right\} \quad (2.7)$$

Lemma 1 *In the banking market described above, a pure strategy (perfect Bayesian)*

equilibrium has the following features:

- Bank 1 announces s^* that solves (2.7) and sets

$$r_1^* = z - \frac{1}{l_g(s^*)}\left(z - \frac{2}{\pi_g + \pi_b}\right);$$

- Bank 2 announces $r_2^* = \tilde{r}_2^* \equiv z - l_g(s^*)(z - r_1^*) = \frac{2}{\pi_g + \pi_b}$, and rejects applicants at the final stage;
- Firms go to bank 1.

Proof.

As specified earlier, bank 2's optimal strategy at the final stage is to accept in case (1) or (2), provided $\Psi_2(r_2) > 0$, and to reject otherwise. Given bank 2's strategy r_2^* and this rejection rule, the following shows that bank 1 has no incentive to deviate from (s^*, r_1^*) . If bank 1 has (s', r_1') such that $\tilde{r}_2(s', r_1') > \tilde{r}_2^*$, it implies (4) holds (case (1)), and both types of firms would prefer to go to bank 2. Bank 2 will accept applicants at the final stage and earns a profit $\Psi_2(\tilde{r}_2^*) = 0$. Bank 1 would then lose all firms if this is the case. If bank 1 announces (s'', r_1'') such that $\tilde{r}_2(s'', r_1'') \leq \tilde{r}_2^*$, case (2) or (3) holds. In either case both firms would come to bank 1. Among all possible combinations (s'', r_1'') , bank 1 always prefers those at which the equality holds, because otherwise it can raise r_1 and obtain a higher profit. Given this condition, it is straightforward to see that (s^*, r_1^*) gives a maximum profit.

Given bank 1's optimal strategy (s^*, r_1^*) , bank 2 has no incentive to deviate from its equilibrium strategy r_2^* either. If $r_2 > \tilde{r}_2^*$, bank 2 cannot attract any good firm whatever it does at the final stage. If $r_2 < \tilde{r}_2^*$, all firms would come to bank 2 if bank 2 accepts them, but then bank 2 would make a loss since $\Psi_2(\tilde{r}_2^*) = 0$ and $\Psi_2' > 0$. At r_2^* , bank 2 would incur a loss if it accepts applicants since it would attract only bad firms. Thus, the response (r_2^*, reject) , which yields a zero profit, is bank 2's best response. ■

Because $s \in [0, 1]$, a solution to (2.7) exists. As in the monopoly case, assume the screening technology is efficient enough so that at r_1^* , the set $S_1^0 = \{s \in (0, 1) | \Psi_1(s) = 0\}$ is non-empty, and there exists $\hat{s} \in S_1^0$, such that $\Psi_1'(\hat{s}) > 0$. With this assumption, an equilibrium with the features stated in lemma 1 exists⁷.

At equilibrium, the effective loan rate in the market is bank 1's loan rate: $r_1^* = z - \frac{1}{l_g(s^*)}(z - \frac{2}{\pi_g + \pi_b})$, which is lower than the monopoly loan rate

⁷In the numerical example shown in footnote 5, there also exists s such that bank 1 earns positive profit: $r_1^*(\frac{1}{2}) = \frac{76}{5}$ and $\Psi_1(r_1^*(\frac{1}{2}), \frac{1}{2}) = \frac{41}{400} > 0$.

z since $z > \frac{2}{\pi_g + \pi_b}$ by (2.1). Also notice that $r_1^*(s)$ is an increasing function of s . That is, a higher screening level eases the pressure of cutting loan rate for bank 1.

Proposition 2 *The optimal screening level of bank 1, the bank facing an entry threat, is higher than that of a monopoly bank.*

Proof. Since

$$\frac{\partial \Psi_m}{\partial s} = \frac{1}{2}(l'_g \pi_g + l'_b \pi_b)z - \frac{1}{2}(l'_g + l'_b) - c'$$

and

$$\frac{\partial \Psi_1}{\partial s} = \frac{1}{2}(l'_g \pi_g + l'_b \pi_b)[z - \frac{1}{l_g}(z - \frac{2}{\pi_g + \pi_b})] + \frac{1}{2}(l_g + l_b)\frac{l'_g}{l_g^2}(z - \frac{2}{\pi_g + \pi_b}) - \frac{1}{2}(l'_g + l'_b) - c',$$

subtracting $\frac{\partial \Psi_m}{\partial s}$ from $\frac{\partial \Psi_1}{\partial s}$ yields:

$$\frac{\partial \Psi_1}{\partial s} - \frac{\partial \Psi_m}{\partial s} = \frac{\pi_b}{l_g^2}(z - \frac{2}{\pi_g + \pi_b})(l'_g l_b - l'_b l_g) > 0,$$

since $z - \frac{2}{\pi_g + \pi_b} > 0$ from (2.1), and $l'_g > 0$, $l'_b < 0$.

Thus, $\frac{\partial \Psi_1}{\partial s}$ is greater than $\frac{\partial \Psi_m}{\partial s}$ for all $s \in [0, 1]$.

Notice that Ψ_m is strictly concave. Particularly, it first increases, then decreases with s . Hence, $\Psi'_m(s) > 0$ for $s < s_m^*$ and $\Psi'_m(s) = 0$ at $s = s_m^*$. Thus, $\Psi'_1(s) > \Psi'_m(s) > 0$ for $s \leq s_m^*$. Therefore, there exists $\hat{s} > s_m^*$, such that $\Psi_1(\hat{s}) > \Psi_1(s)$ for all $s \leq s_m^*$. In other words, $s^* > s_m^*$. That is, bank 1's optimal screening level s^* in the duopoly case is higher than that of a monopoly bank, s_m^* . ■

In the proof, it is shown that the derivative of the profit function with respect to the screening level is higher for bank 1 when it is threatened by entry than that when it is a monopolist. The interpretation is apparent: the marginal value of information increases when competition is introduced. The reason is that increasing screening level reduces the incumbent's need of cutting loan rates and hence contributes to the increase in profit. This is a result of competition under asymmetric conditions. Consequently, a bank

facing an entry threat adopts a higher screening level than a monopoly bank.⁸

In the equilibrium, bank 2 (the new entrant) has zero market share. This is not surprising considering its disadvantageous position. However, its stand-by presence creates a non-negligible threat to bank 1 (the incumbent bank). This result is consistent with observations regarding foreign bank entry. The removal of entry restrictions may induce a number of foreign entrants, but foreign banks usually do not hold significant market share. However, as shown in Claessens, Demirgüç-Kunt and Huizinga (1998), the number of foreign entrants, regardless of their market share, may have significant impact on domestic banks.

2.3 A Model with Collateral

This section considers a model with both banks having the option of using collateral as a risk sorting device. For the purpose of simplicity, assume there is no differentiation in terms of screening levels. Once a bank screens a firm, it knows perfectly the status of the firm. Under this assumption, screening and using collateral are substitutes in that a bank has no need to use collateral as a sorting device once it decides to screen. Thus, the following analysis considers a bank's incentive for adopting screening versus collateral requirements. Further assume screening each firm costs a bank a fixed amount of resources C .⁹

Following Bester (1985), assume that all banks discount the value of a collateral by the same rate δ , which accounts for the liquidation cost and, more importantly, the expected future change of its value. Let K denote the amount of collateral measured by its current market value. The expected value of the collateral when it is liquidated is then $(1 - \delta)K$. Due to reasons such as lack of supply flexibility in the short run¹⁰, asset prices can fluctuate wildly. With uncertainty and subjectivity in forming expectations,

⁸The reason of this effect differs from that in a limit pricing model, where the incumbent charges a lower price than the monopolistic price in order to convey low cost information to a potential entrant in a separating equilibrium.

⁹A model with both banks having the collateral option but with imperfect screening technology and variable screening cost for bank 1 can also be solved using specific functional forms. The result is similar to that in section 1.

¹⁰See IMF World Economy Outlook (2000) for comprehensive analysis.

the expected collateral value could be well above its fundamental value, inducing a potential risk of bank insolvency when asset prices fall sharply.

Further assume that a good firm has a higher opportunity cost of conducting its project than a bad firm. That is, a good firm's reservation payoff is $A > 0$, and a bad firm's is 0.

The timing of the game is as follows:

- Bank 1 decides to use collateral or screening;
- Bank 1 announces its collateral or screening level, and bank 2 announces its collateral requirement at the same time;
- Both banks announce their loan rates.
- Each firm picks a bank and applies for a loan;
- Bank 1 screens applicants in case it makes this choice at the first stage.
- Both banks grant loans.

The procedure for a monopoly bank is similar but without the presence of bank 2.

2.3.1 The Monopoly Case

We first consider the case of using collateral. Denote a good firm's and a bad firm's expected payoffs from a loan with loan rate r and collateral K by φ_g and φ_b , respectively. Thus,

$$\begin{aligned}\varphi_g &= \pi_g(z - r) - (1 - \pi_g)K; \\ \varphi_b &= \pi_b(z - r) - (1 - \pi_b)K.\end{aligned}$$

Figure 1 shows the isopayoff lines of both types of firms corresponding to their reservation payoffs. The line $\varphi_g = A$ is flatter than the line $\varphi_b = 0$ because $\pi_g > \pi_b$. A firm applies for a loan if the bank's offer is located below its isopayoff line. In the case where the bank's offer is the same as a firm's reservation payoff, assume that a good firm applies for a loan but a bad firm does not.

Figure 2.1: The monopoly case.

As in Bester (1985), the bank can choose the loan rate and collateral level in the shaded area W shown in figure 1 such that only good firms are interested in applying for a loan. The bank's optimal choice for this strategy is then point Q , the intersection of the two isopayoff lines. To see this, rearrange the bank's profit $\Psi(K, r)$ as

$$\begin{aligned}\Psi(K, r) &= \frac{1}{2}[\pi_g r + (1 - \pi_g)(1 - \delta)K - 1] \\ &= \frac{1}{2}[(\pi_g r - \pi_g z + (1 - \pi_g)K) + \pi_g z - \delta(1 - \pi_g)K] \\ &= \frac{1}{2}[\pi_g z - \delta(1 - \pi_g)K - \varphi_g(K, r)],\end{aligned}\tag{2.8}$$

where $\varphi_g(K, r)$ is a good firm's payoff for borrowing from the bank. Holding φ_g constant, the bank's profit $\Psi(K, r)$ decreases with K .

Alternatively, the bank can choose a point below both reservation payoff lines such that both types of firms will demand a loan. For this kind of strategy, point P is the best choice. For simplicity, from here on, assume equation (2.1) does not hold. In this case, the bank would only make a

loss when extending loans to both types of firms. Hence, P is no longer a desirable choice. The bank's optimal choice is then point Q , at which only good firms apply for loans.

Notice that at Q ,

$$\pi_g(z - r) - (1 - \pi_g)K = A$$

and

$$\pi_b(z - r) - (1 - \pi_b)K = 0.$$

Solving these two equations yields a monopoly bank's optimal collateral level K_m and loan rate r_m^K :

$$K_m = \frac{\pi_b}{\pi_g - \pi_b} A$$

$$r_m^K = z - \frac{1 - \pi_b}{\pi_g - \pi_b} A$$

Correspondingly, its expected profit at (K_m, r_m^K) is:

$$\begin{aligned} \Psi_m^K &= \frac{1}{2}[\pi_g r_m^K + (1 - \pi_g)(1 - \delta)K_m - 1] \\ &= \frac{1}{2}(\pi_g z - A - 1) - \frac{1}{2}(1 - \pi_g)\delta K_m \\ &\equiv \frac{1}{2}(\pi_g z - A - 1) - D_m \end{aligned} \tag{2.9}$$

The last term $D_m \equiv \frac{1}{2}(1 - \pi_g)\delta K_m = \frac{1}{2} \frac{(1 - \pi_g)\pi_b \delta}{\pi_g - \pi_b} A$ stands for the expected cost of using collateral. In order for Ψ_m^K to be positive, assume:

$$A < (\pi_g z - 1) \frac{\pi_g - \pi_b}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta} . \tag{2.10}$$

Note that when asset prices plunge unexpectedly, the true value of a collateral can be much less than expected when it is liquidated. In other

words, the true δ , and hence the actual cost of using collateral, can be much higher than expected. If this is the case, the actual profit will be lowered, greatly increasing the bank's risk of insolvency.

When the monopoly bank conducts screening, a loan applicant's status will be recognized for sure. In order for a good firm to demand a loan, the monopoly bank must ensure that its expected payoff is no less than its reservation payoff. Thus, the loan rate should satisfy the following condition:

$$\pi_g(z - r) > A.$$

Hence, the bank would choose the loan rate

$$r_m^S = z - \frac{A}{\pi_g},$$

at which its expected profit is

$$\begin{aligned}\Psi_m^S &= \frac{1}{2}(\pi_g r_m^S - 1) - C \\ &= \frac{1}{2}(\pi_g z - A - 1) - C\end{aligned}$$

As we can see, the difference between the expected profits of using collateral and conducting screening lies in their costs. The monopoly bank will select to screen if screening returns a higher profit, i.e., if the cost of screening is lower than the expected cost of using collateral:

$$C \leq D_m \equiv \frac{1}{2} \frac{(1 - \pi_g)\pi_b \delta}{\pi_g - \pi_b} A; \quad (2.11)$$

otherwise it will choose to use collateral.

2.3.2 The Case with an Entrant

Now let us consider an incumbent bank, bank 1, facing the threat of losing market share to bank 2 after removing entry restrictions. Bank 1 has the choice of either using collateral or adopting the screening technology, while bank 2 may only use collateral. We proceed by analyzing the two subgames with bank 1 adopting screening technology and using collateral separately.

Figure 2.2: The case with an entrant – bank 1 screens loan applicants.

Suppose bank 1 chooses to screen and charges a loan rate r_1 . Bank 2 competes with bank 1 through collateral requirement K_2 and loan rate r_2 . In this case, bank 1 would know a firm's status for sure. Thus, a good firm and a bad firm's expected payoffs from bank 1 are $\pi_g(z - r_1)$ and 0, respectively.

Let $\varphi_{g,i}$ and $\varphi_{b,i}$ denote a good and a bad firm's expected payoffs from bank i , for $i = 1, 2$. Figure 2 shows both types of firms' isopayoff lines when borrowing from bank 2 at their reservation payoff level and the isoprofit line for bank 2 at the break even level. At Q , where $\varphi_{g,2} = A$ and $\varphi_{b,2} = 0$, bank 2's profit would be the same as a monopoly bank's if it can keep the good firms: $\Psi_2(K_2, r_2) = \frac{1}{2}[\pi_g r_2 + (1 - \pi_g)(1 - \delta)K_2 - 1] > 0$. Thus, the line $\Psi_2(K_2, r_2) = 0$ is located below Q . Denote its intersection with the line $\varphi_{b,2} = 0$ as point E , and a good firm's expected payoff from bank 2 at E as φ_g^o .

As we will see, the equilibrium outcome with bank 1 screening loan applicants depends on the screening technology. There are two cases. Case 1, bank 1's screening technology is sufficiently efficient such that it can earn a positive profit if it offers $\varphi_{g,1} = \varphi_g^o$.

Definition 3 *The screening technology is sufficiently efficient if $\Psi_1(r_1^*) = \frac{1}{2}(\pi_g r_1^* - 1) - C > 0$, where r_1^* satisfies $\varphi_{g,1}(r_1^*) = \varphi_g^o$.*

To find r_1^* , we first find bank 2's corresponding loan rate and collateral level (K_E, r_E) at E . Since

$$\Psi_2(K_E, r_E) = \frac{1}{2}[\pi_g r_E + (1 - \pi_g)(1 - \delta)K_E - 1] = 0,$$

and

$$\pi_b(z - r_E) - (1 - \pi_b)K_E = 0,$$

solving them obtains

$$K_E = \frac{\pi_b(\pi_g z - 1)}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta},$$

and

$$r_E = z - \frac{(1 - \pi_b)(\pi_g z - 1)}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta}.$$

Thus,

$$\begin{aligned} \varphi_g^o &= \varphi_{g,2}(K_E, r_E) \\ &= \pi_g(z - r_E) - (1 - \pi_g)K_E \\ &= \frac{(\pi_g - \pi_b)(\pi_g z - 1)}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta}. \end{aligned}$$

From $\varphi_{g,1}^* = \pi_g(z - r_1^*) = \varphi_g^o$, we obtain

$$r_1^* = z - \frac{(\pi_g - \pi_b)(\pi_g z - 1)}{\pi_g[\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta]}. \quad (2.12)$$

Thus, an alternative way to define sufficient efficiency of the screening technology is that the screening cost satisfies:

$$C \leq \frac{1}{2}(\pi_g z - 1) \frac{(1 - \pi_g)\pi_b \delta}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta} \equiv D_c \quad (2.13)$$

Lemma 4 *In the case where bank 1's screening technology is sufficiently efficient, an equilibrium at which bank 1 screens loan applicants has the following features:*

- Bank 1 announces r_1^* as specified in (2.12);
- Bank 2 offers (K_2^*, r_2^*) such that $\varphi_{g,2}^*(K_2^*, r_2^*) = \varphi_g^o$ and $\varphi_{b,2}^*(K_2^*, r_2^*) \leq 0$.

Proof. We first show a good firm's expected payoff from bank 1 is φ_g^o at equilibrium.

Suppose bank 1 offers r_1 at which $\varphi_{g,1} < \varphi_g^o$. If bank 2 offers (K_2, r_2) such that $\varphi_{g,2} = \varphi_{g,1}$ and $\varphi_{b,2} = 0$, $\Psi_2(K_2, r_2) > 0$ by definition of φ_g^o . To see that, notice in figure 2, the line $\varphi_{g,2} = \varphi_{g,1}$ is located above E where $\Psi_2(K_2, r_2) = 0$. Thus, at F , where $\varphi_{g,2} = \varphi_{g,1}$ and $\varphi_{b,2} = 0$, bank 2's potential expected profit $\Psi_2(K_2, r_2) > 0$ if it can keep good firms. If bank 2 sets (K_2, r_2) such that $\varphi_{g,2} = \varphi_{g,1} + \varepsilon$, and $\varphi_{b,2} = 0$, where ε is a small positive number, it can attract all good firms and earn a positive profit (e.g., at G). In turn, bank 1 should lower its loan rate and offer an equally high $\varphi_{g,1}$ to good firms. Hence, the initial loan rate r_1 such that $\varphi_{g,1} < \varphi_g^o$ is not an equilibrium offer.

Suppose $\varphi_{g,1} > \varphi_g^o$. In Figure 2, F would be located below the line $\Psi_2(K_2, r_2) = 0$. Bank 2's best response is to stay out of the market since it would make a loss if it tried to attract good firms. Bank 1 should then raise its loan rate and lower $\varphi_{g,1}$ to improve its profit. Thus, the loan rate r_1 such that $\varphi_{g,1} > \varphi_g^o$ is not an equilibrium offer either.

Since bank 1's loan rate must satisfy $\varphi_{g,1} = \varphi_g^o$ at equilibrium, its equilibrium loan rate is r_1^* .

Given bank 1's offer r_1^* , $\varphi_{g,1}^*(r_1^*) = \varphi_g^o$, $\varphi_{b,1}^* = 0$. If bank 2 tries to attract good firms, (K_2, r_2) must satisfy $\varphi_{g,2} > \varphi_g^o$ and $\varphi_{b,2} \leq 0$, but then bank 2 would make a loss. Thus, (K_2^*, r_2^*) such that $\varphi_{g,2}^*(K_2^*, r_2^*) = \varphi_{g,1}^*(r_1^*)$ and $\varphi_{b,2}^*(K_2^*, r_2^*) \leq 0$ is bank 2's best response, at which no firm applies for a loan from bank 2.

Given bank 2's offer (K_2^*, r_2^*) , $\varphi_{g,2}^*(K_2^*, r_2^*) = \varphi_g^o$. To attract good firms, bank 1 must offer r_1 such that $\varphi_{g,1} > \varphi_g^o$. Thus, the loan rate r_1^* , at which the equality holds, is a best response in that Ψ_1 decreases with $\varphi_{g,1}$. To see that, rearrange $\Psi_1(r_1) = \frac{1}{2}(\pi_g r_1 - 1) - C = \frac{1}{2}(\pi_g z - 1 - \varphi_{g,1}) - C$. ■

At r_1^* , $\Psi_1(r_1^*) > 0$ by the condition of sufficient efficiency of the screening technology. Also notice that when assumption (2.10) holds, $r_1^* < z - \frac{A}{\pi_g}$.

Therefore, r_1^* must be lower than the interest rate a monopoly bank would charge when it screens.

In the case where bank 1's screening technology is inefficient, i.e., $\Psi_1(r_1^*) < 0$ when $\varphi_{g,1}(r_1^*) = \varphi_g^o$, bank 2 can drive bank 1 out of the market if it sets (K_2, r_2) such that $\varphi_{b,2} = 0$, and $\varphi_{g,2} = \overline{\varphi_{g,1}} + \varepsilon$, where $\overline{\varphi_{g,1}}$ is a good firm's expected payoff from bank 1 at bank 1's break-even loan rate, and ε is a small positive number.

Next we consider the case where bank 1 selects to use collateral. Since $\varphi_{g,i} = \pi_g(z - r_i) - (1 - \pi_g)K_i$, and $\varphi_{b,i} = \pi_b(z - r_i) - (1 - \pi_b)K_i$,

$$\pi_b(\varphi_{g,1} - \varphi_{g,2}) - \pi_g(\varphi_{b,1} - \varphi_{b,2}) = (\pi_g - \pi_b)(K_1 - K_2). \quad (2.14)$$

To attract good firms only, a bank would tend to set its collateral requirement higher than the other bank. To see this, suppose $\varphi_{g,1} > \varphi_{g,2}$ and $\varphi_{b,1} < \varphi_{b,2}$. From (2.14), K_1 must be greater than K_2 .

By lowering the loan rate and raising the collateral requirement to attract good firms only, banks' expected profits would be eroded from both directions (see (2.8)). Intuition suggests that both banks would end up earning zero profits as a result of competition.

Lemma 5 *Each bank has a zero profit at an equilibrium where bank 1 uses collateral.*

Proof. Suppose $\Psi_i(\tilde{K}_i, \tilde{r}_i) > 0$. Bank j can set its collateral requirement as $K_j = \tilde{K}_i + \epsilon$, and its loan rate r_j as $r_j = \tilde{r}_i - \epsilon$ such that $\varphi_g^j > \varphi_g^i$ and $\varphi_b^i < \varphi_b^j$, and attract all good firms. When ϵ and ε are sufficiently small, bank j earns a positive profit. In turn bank i should use the same strategy, implying $(\tilde{K}_i, \tilde{r}_i)$ is not an equilibrium offer. Thus, at equilibrium, $\Psi_i(\tilde{K}_i, \tilde{r}_i) \leq 0$. In Figure 3, clearly, if bank i offers F , which is located above the isoprofit line $\Psi(K, r) = 0$, bank j can offer G to attract all good firms and leave all bad firms to bank i .

Next we show both banks' offers are on the line $\varphi_g = \varphi_g^o$ at equilibrium. Suppose bank i 's offer satisfies $\varphi_g > \varphi_g^o$, say, at P . Notice at N , φ_g is the

Figure 2.3: The case with an entrant - bank 1 requires collateral.

same as at P , and $\varphi_b = 0$. Hence a bank can earn a positive profit at N if it can keep the good firms. Therefore, the other bank, bank j , can attract good firms and have a positive profit with an offer located a little bit below N on the line $\varphi_b = 0$. On the other hand, if bank i 's offer is below the line $\varphi_g = \varphi_g^o$, good firms will apply for a loan and the bank who extends loans must make a loss. Thus, an equilibrium offer must be located on the line $\varphi_g = \varphi_g^o$.

Given bank 1's offer that is on the line $\varphi_g = \varphi_g^o$, bank 2 would stay out of the market since otherwise it would make a loss. This implies bank 1's offer should be at E in order not to make a loss. If bank 1 offers E , bank 2's best response is E or anywhere on the line $\varphi_g = \varphi_g^o$ below E , say M . On the other hand, if bank 2 offers E or M , bank 1's best response is E . Therefore, bank 1 offering E and bank 2 offering E or M constitute equilibria, at which firms go to bank 1 and both banks make zero profits. Thus, at equilibrium, both banks earn zero profits. ■

Since bank 1 can only obtain zero profit by using collateral, the condition for the equilibrium with bank 1 screening loan applicants to be achieved is that the screening technology is sufficiently efficient, i.e., (2.13) holds. When

this condition is satisfied, the equilibrium described in lemma 3 is a subgame perfect equilibrium.

Comparing this condition with the condition for a monopoly bank to screen (equation (2.11)), one observes that bank 1, the bank threatened by entry, is more likely to screen than the monopoly bank.

Lemma 6 *Whenever it is optimal for a monopoly bank to screen, it is also optimal for a bank facing an entry threat (bank 1) to do so. Moreover, when the screening cost lies in the interval $(D_m, D_c]$, bank 1 screens, but a monopoly bank does not.*

Proof. From (2.10), we know $(\pi_g z - 1) \frac{\pi_g - \pi_b}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta} > A$, thus,

$$\begin{aligned} D_c &\equiv \frac{1}{2}(\pi_g z - 1) \frac{(1 - \pi_g)\pi_b \delta}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta} \\ &= \frac{1}{2} \frac{(1 - \pi_g)\pi_b \delta}{\pi_g - \pi_b} * (\pi_g z - 1) \frac{\pi_g - \pi_b}{\pi_g - \pi_b + (1 - \pi_g)\pi_b \delta} \\ &> \frac{1}{2} \frac{(1 - \pi_g)\pi_b \delta}{\pi_g - \pi_b} A \\ &= D_m \end{aligned}$$

It follows that whenever (2.11) holds, (2.13) also holds, i.e., whenever a monopoly bank screens, bank 1 would also screen. However, when $C \in (D_m, D_c]$, the condition for a competitive bank to screen (2.13) holds, but the one for a monopoly bank to screen (2.11) does not. In this situation, bank 1 chooses to screen, but a monopoly bank does not. ■

It follows that a competitive banking system has a wider range of parameters where screening prevails, and a monopoly bank is more likely to rely on the use of collateral. For a monopoly bank, the opportunity cost of screening is positive, which is its profit when it imposes a collateral requirement. When there is competition from bank 2, the incumbent bank's profit of using collateral is driven down to zero. Thus, the opportunity cost of using collateral is lower under competition. Therefore, as explained earlier, a competitive banking system may be less vulnerable to asset price shocks.

Not surprisingly, the impact of market structure on screening activities hinges on the efficiency of the screening technology. When the screening

cost is low ($C < D_m$), i.e., when the screening technology is highly efficient, a monopoly bank and a bank facing competition both screen. When the screening cost C reaches a threshold level D_m , a monopoly bank gives up screening while a bank facing competition would still opt to screen. When the screening technology is inefficient ($C > D_c$), a competitive bank eventually gives up screening. In this case, the information advantage of being an incumbent bank disappears.

2.4 Final Remarks

This paper studies the effect of financial liberalization, characterized by removing entry restrictions on the banking sector, on banks' prudent behavior. Its first model shows that when the feedback of screening activities to loan rates is taken into account, the marginal benefit of screening increases when there is competition. Thus, a bank's screening incentive is higher when there is an entry threat even if loan rates are driven lower. The second model incorporates an option of collateral requirement. It shows that a bank facing competition has a lower opportunity cost of screening and thus is more likely to screen loan applicants. Consequently, a more competitive banking system may rely more on information collecting instead of collateral requirements, and thus may be less vulnerable to asset price shocks.

As a conclusion, increased competition may strengthen banks' ability to cope with both default risk and market risk by increasing banks' incentives for screening. It may be true that financial liberalization has contributed to past financial crises in some ways. However, the causes and effects of these events need to be better understood. Incomplete reforms such as retaining soft budget constraints, imperfect legal systems¹¹ and shocks of regime changes that introduce inexperienced and unskilled players¹² can all contribute to the weakness of the banking sector. These issues are addressed in a host of literature and not discussed here.

The models adopt a simple one-period formulation. A dynamic modelling approach should not produce fundamental differences. In fact, in a dynamic setting, when possible changes of a firm's status from period to period are taken into account, there is a need for banks to conduct screening in every period. In this sense, each period can be taken independently,

¹¹The Second Best Theory can be used as a relevant argument here.

¹²See Lindgren, et al. (1996), pp. 100, and Honohan (1997).

and the incumbent bank's information advantage may be viewed partly as a benefit of the previous lending relationship with the firms.

The effects of market structure on screening activities depend on the efficiency of screening technology, as mentioned in section 3. When the screening technology is inefficient, neither the monopoly bank nor the bank facing competition would screen. It is not obvious what effects competition may have in this situation. This case can be studied with a richer model. If it turns out that competition renders banks less prudent, the timing of financial liberalization might become an issue. In any case, the efficiency of screening technology matters in terms of the effects of competition, and financial liberalization may have better results when the banking system is relatively efficient in handling risk.

Another concern is that incumbent banks and new entrants may have different collateral costs. For example, it may be more inconvenient and more costly for foreign banks to liquidate a collateral. This might weaken the robustness of the results. A possible extension of the second model should take this into account.

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Chapter 3

Banking Competition and Risk-Taking: Evidence from the EU

Xiaofen Chen¹

Abstract

This paper studies the effect of financial deregulation on bank loan quality using bank-level balance sheet data and macroeconomic data for the European Union. Contrary to the popular claim that intensified competition due to financial deregulation results in riskier lending behavior, the data shows evidence of loan quality improvement after removing cross-border banking restrictions in the EU, indicated by the decline of loan loss provisions. The analyses using non-performing loans as an indicator for loan quality with a smaller sample size do not find support for a positive relationship between risky behavior and financial deregulation either. The data also shows evidence that lending behavior in different sized banks across all EU countries has converged.

¹I would like to thank Anya McGuirk, Russ Murphy and Hans Haller for there generous help.

3.1 Introduction

It is often argued that increased competition causes riskier banking behavior, and therefore, financial deregulation is a potential source of financial crises. While the majority of the theoretical work on this issue supports this argument², there also exist opposite opinions arguing that increased competition should foster safer banking practices³. This paper tests whether competition induced by financial deregulation causes riskier banking behavior, using banking industry data from European Union countries. The study finds evidence of loan quality improvement after the removal of cross-border bank entry restrictions, suggesting that banks have become more cautious in lending when competition is intensified.

How to empirically examine the link between deregulation and bank behavior is not a trivial issue. As pointed out in Lindgren, et al. (1996, p. 100) and Honohan (1997), imperfect legal systems and regime shocks that introduce inexperienced players can all contribute to the weakness of banking sectors. In order to concentrate on the effects of market structure on banks' risk taking and to separate the factors that are inherent and permanent from those that are avoidable and temporary, it is better to study countries where regime changes have been smoother and shocks to the financial systems are less abrupt. Based on this consideration, reliable analysis of the link between increased competition and banks' risk-taking behavior would be more difficult for emerging markets. Moreover, lacking international accounting standards for bank-level data of these countries poses additional difficulties.

Another possible approach is to perform a cross-sectional analysis of all available banking markets which compares the quality of bank assets versus the degree of competition. The problem is that there is no accurate measure of degree of competition. It is common to use bank asset concentration ratios like the Herfindahl Index as an indicator of competition degree. A market with a lower concentration ratio is generally considered more competitive. Despite its popularity, such an index is not appropriate as a lower concentration ratio does not necessarily mean that a banking market is more competitive. For example, the unusually large number of banks in the United States is a direct result of a high degree of regulation. Therefore, using a

²Examples include Chan et al. (1986), Riordan (1993), Gehrig (1998), etc.

³See for example, Chen and Haller (2001) and Chen (2001).

concentration ratio as an indicator for the degree of banking competition and performing cross-sectional analysis seems also inappropriate.

In contrast, the banking market in the European Union during the 1990s provides a potentially promising arena for examining the link between deregulation and bank behavior. The European Union removed cross-border bank entry restrictions by implementing the Second Banking Directive in the mid-1990s. Competition is reported to be intensified as a result of this deregulation according to a report by the European Commission (1997). The relatively smooth deregulation process and the existence of high quality data around this period makes it a good candidate for our purpose. Another appealing feature for cross-country analysis is that the European Union countries are relatively homogeneous because of historical reasons and their long term effort of building a common market.

Using bank balance sheet information from Bankscope and macroeconomic information from IFS, we conduct statistical analysis of the effects of removing cross-border restrictions on bank asset quality. The data shows evidence of loan quality improvement after the removal of entry restrictions. This result echoes Jayaratne and Strahan's (1996) analysis that shows evidence of improvement in bank asset quality after the removal of intrastate geographical restrictions of the US banking sector.

Gropp and Vesala (2001) use the same banking database in their analysis of the relationship between deposit insurance and banks' risk taking. They conclude that financial liberalization tends to lower bank asset quality, characterized by the share of problem loans in total assets. However, their analysis is constrained to only 128 large commercial banks out of the available 4997 European Union banks in Bankscope. Further, they provide no evidence regarding the statistical validity of their regression model. Our findings, which are from an extended version of their data set, suggest their model may be misspecified, rendering their finding tenuous.

Other empirical work studying the link between financial liberalization and banks' risk taking includes Demirgüç-Kunt and Detragiache (1998), and Gruben et. al (1999). They both find evidence of a positive connection between the two. However, their sample selection approaches are not suitable to address the question considered here. Gruben et. al (1999) chose data in periods when financial crises occurred; Demirgüç-Kunt and Detragiache

(1998) use a cross-section comparison approach for a large number of developed and developing countries, which is difficult to identify market structure effect from many other factors.

The paper is organized as follows. Section 2 reviews the process of the European Union's financial liberalization. Section 3 carries out the statistical analysis. Section 4 contains the conclusion. Quantitative results are reported in the appendix.

3.2 Financial Deregulation in the EU

The purpose of banking deregulation in European Union countries was to transform the highly segmented national markets into a common single market. In 1977, the First Banking Coordination Directive was introduced. It initiated measures to harmonize regulatory framework and enhance cooperation and supervision. However, the banking systems continued to be highly regulated. Specifically, cross-border operations were restricted by law and subject to restrictions on capital flows. Government intervention was extensive in many countries, such as France, Greece, Italy, Portugal and Spain.

It was the adoption of the Second Banking Co-ordination Directive that marked the removal of cross-border banking restrictions in the European Union. All formal restrictions regarding cross-border banking operations were lifted. Banks were authorized to set up branches and provide financial services across all European Union countries with a single license. The requirements for branches to maintain a minimum level of endowment capital that was an obstacle to free establishment of branches in other countries were abolished. In principle, foreign banks are only subject to regulatory control of their home countries after the deregulation.

All European Union countries completed the implementation of the Second Directive between 1991-1994. Germany finished the process in 1991, Luxemburg and United Kingdom in 1995; Belgium, Spain, Austria, Finland and Sweden in 1995; all other countries completed at the end of 1992. It is generally considered that the implementation of the Second Directive would greatly intensify competition in the banking industry. According to a report of the European Commission (1997), competition in both retail and corporate markets of all European Union countries has increased to a large

degree. With a measure scale 0-50, where 25 indicates a small increase of competition and 0 indicates no change, a survey reports that the increase of competition is above 35 in most countries (pp. 71).

Table 1. Average Non-performing Loan Ratio and Real GDP Growth Rates
(Source: Bankscope and IFS)

Year	Non-performing Loan Ratio	Real GDP Growth
1990	8.43	2.42
1991	5.56	1.28
1992	7.60	0.98
1993	10.09	-0.45
1994	9.86	2.84
1995	8.37	2.56
1996	8.79	1.78
1997	8.04	2.64
1998	7.56	2.89
1999	4.46	2.96

Table 1 shows the average real GDP growth rates and average non-performing loan ratios. The average non-performing loan ratio reaches its peak in 1993, when the European Union countries experienced the lowest average real economic growth. After the completion of the Second Banking Directive (between 1993 and 1994 for most of the countries), the non-performing loan ratio began to decline and reaching the lowest point in 1999. We analyze the potential effects of deregulation on banks' loan quality in the next section.

3.3 Empirical Analysis

The data used are bank-level balance sheet data and country-level economic data. The bank-level data is from Fitch IBCA and Bureau van Dijk's Bankscope database. It includes yearly balance sheet data for 4997 banks in 15 European Union countries from 1990 to 1999. For most countries, the database covers most of the existing financial institutions. We exclude

Specialized Governmental Credit Institution from the analysis. Data with apparent problems, such as negative loan quantity, negative loan loss provision, a dubious high level of loan loss provision or non-performing loans greater than the loan size, are also dropped. All country-level data are from the International Financial Statistics provided by the International Monetary Fund.

3.3.1 Model Specification

In practice, banks face various types of risks. The following analysis focuses on default risk. As banks' risk taking directly affect their loan quality, we use non-performing loans to indicate default risk. Under equal conditions, if banks act more prudently, their loan quality should improve, and their non-performing loans should decline.

Factors affecting banks' loan quality include competition effect, which is to be tested, and several other factors. For obvious reasons, the whole economic situation should affect banks' loan quality (see table 1). The level of lending rates is another important factor because of the following reasons. First, higher lending rates affect borrowers' repayment ability. Second, higher rates tend to squeeze out good borrowers and induce borrowers to engage in risky behavior because of adverse selection problem and risk shifting effects⁴. Banks' business orientation may also affect their loan quality. As many banks move away from their traditional loan business to off-balance sheet business, loan quality could be adversely affected as less attention is paid to it. We use the ratio of non-interest income to total assets to indicate this effect. Finally, loan size should also be included to account for the size effect. Thus, the model is specified as

$$\begin{aligned} bad_{t,i} = & \alpha_0 + \alpha_1 * loan_{t,i} + \alpha_2 * rothast_{t,i} + \alpha_3 * econ_{t,j} + \\ & + \alpha_4 * lendrate_{t,j} + \alpha_5 * comp + u_{t,i} , \end{aligned}$$

where t , i and j are indices for year, bank and country separately; the α 's are coefficients to be estimated; *bad*, *loan*, *rothast*, *econ*, *lendrate* and *comp* indicate the sizes of non-performing loans, loan size, non-interest income to asset ratio, real GDP growth rate, lending rate and the indicator for competition intensity separately. Among them, *econ* (real GDP growth rate)

⁴See Sounders (1999), pp. 8-9 for a summary.

and *lendrate* (lending rates) are yearly country-level data; *bad*, *loan*, and *rothast* are yearly bank-level data. Because the distributions of both non-performing loans and loan sizes are highly skewed, a log transformation is used.

For the degree of competition, we argued that the market concentration ratio is not an appropriate measure in the introduction. We also believe existing measures such as market share or number of foreign banks are not good indicators of competitiveness. First, these measures only account for a part of foreign bank activities. Very often, a foreign bank enters a market taking an organization form of an agency office or a representative office initially. These forms are not qualified as banks that engage in regular deposit and loan businesses. As a result, data for these initial attempts of foreign bank entry are not included in existing bank databases. Moreover, foreign bank entry is often through merger and acquisition activities. To study this would require information of ownership history that is also hard to find.

Second, new bank establishment and merger and acquisition activities have not been intense among European Union countries since the implementation of the Second Directive, causing doubts about the effects of deregulation and about the contestability of the banking market. However, the rareness of these activities does not necessarily mean that deregulation has little effect on fostering competition. According to Chen (2001), potential entry into the banking market could produce competition pressure great enough to change incumbents' behavior. In fact, as reported in European Commission (1997), competition has intensified to a large degree since the completion of the Second Directive. Given the dramatic improvement in entry conditions in the European Union after the deregulation and to avoid an insufficient measure of competition degree, a dummy, d , will be used to indicate the effects of deregulation.

If we view loan quality as partly a result of banks' screening investment decision jointly decided with the loan rate, then there could be a simultaneity problem between default risk and loan rates. Since the part of the loan rate that accounts for the risk of the loan is the risk premium, excluding this part from the lending rate should take care of the simultaneity problem. As overnight loans between banks involve little credit risk, we use the money market rate, denoted by *mmr*, to indicate the level of interest rates for now. In section 3.4, we use as an alternative a two-stage least squares method to deal with this issue. Thus, the model becomes:

$$\begin{aligned}
bad_{t,i} = & \alpha_0 + \alpha_1 * loan_{t,i} + \alpha_2 * rothast_{t,i} + \alpha_3 * econ_{t,j} + \\
& + \alpha_4 * mmr_{t,j} + \alpha_5 * d + u_{t,i}
\end{aligned} \tag{3.1}$$

where d takes the value of one after deregulation and is zero otherwise

Equation (3.1) is estimated using OLS. The results are reported in table 2. With a p -value close to one, the estimated effect of the deregulation is insignificant. Thus, it appears that deregulation which has reportedly increased competition has not significantly affected the riskiness of bank behavior. These results are counter to those of Gropp and Vesala (2001). However, before drawing any conclusion, we need to ensure that the statistical assumptions underlying (3.1) are satisfied.

3.3.2 Misspecification Tests and Model Respecification

The misspecification testing and respecification methodology follows Spanos (1986, 1999) and McGuirk et al. (1993, 1995). The assumptions to be tested include normality, functional form, homoskedasticity, independence, and mean and variance shifts.

Although the European Union has long been seeking to harmonize regulations and to build a common market, it is still likely that banks in different countries practice differently because of the differences in their business habits and cultures, and the previous level of government intervention, etc. In addition, bankers' behavior is probably different across different types of financial institutions. For example, a cooperative bank by nature should have better loan quality than a regular bank if it mainly lends to its members who know each other. Thus, the forms of mean shifts to be tested include country effects and the effect of financial institution types.

Individual misspecification tests show problems for all assumptions for model (3.1) except for the functional form test. We proceed with a joint conditional mean test in order to identify the source of misspecification. As pointed out by McGuirk et al. (1993), "the joint conditional mean test simultaneously assesses stability of β (the coefficients), functional form and independence", and can help "pinpoint the correct source of misspecification".

The joint conditional mean test has a result that all p -values for the joint misspecification tests are less than 0.0002, except the functional form test with a p -value of 0.092. The test for the assumption of independence has a lowest p -value, close to 0, suggesting this is the most likely source of misspecification.

A series of temporal dependence tests and joint conditional mean tests using auxiliary regressions indicate that the model should be dynamic, where the lagged dependent variable *bad* has significant effects. Both forms of mean shift (country effects and the effect of financial institution types) seem to exist. Thus, the respecified model finally becomes a dynamic linear model with country and financial institution type dummies (*country_j* and *type_k*) and a structural change dummy (*d*):

$$\begin{aligned} bad_{t,i} = & \alpha_0 + \alpha_1 * loan_{t,i} + \alpha_2 * rothast_{t,i} + \alpha_3 * econ_{t,j} + \alpha_4 * mmr_{t,j} + \\ & + \alpha_5 * d + \sum_j \alpha_{6j} * country_j + \sum_k \alpha_{7k} * type_k + \alpha_8 * bad_{t-1,i} + \\ & + u_{t,i} . \end{aligned} \quad (3.2)$$

where k is bank type index.

To avoid perfect collinearity, Italy is excluded from the country dummies and commercial banks is excluded from the bank type dummies. The rest of the financial institution types include commercial banks, cooperative banks, investment banks, medium & long term credit banks, non-banking credit institutions, real estate or mortgage banks and savings banks.

This model is again subject to another joint conditional mean test, which indicates both functional form and independence assumptions can be accepted. The results are reported in table 4. A joint variance test is also conducted and the results are reported in table 5. The results of individual misspecification tests are in table 6. All test results are satisfactory except the tests for normality. The t-plot of the residuals shows that the rejection of the normality test is likely due to the existence of the outliers. However, the data does not reveal obvious sources of outliers. For this reason, the test results of the estimates should be interpreted asymptotically.

The regression results are listed in table 2. The signs of real GDP growth rate and money market rate are as expected. The coefficient for loan size is

positive but less than one, suggesting the size of non-performing loans grows with the loan size but its ratio to loans is declining with the loan size. The ratio of non-interest income has also a positive coefficient, indicating shifting away from traditional loan business has negative effects on loan quality. The deregulation effect is still insignificant with a negative sign. Thus, there is again no evidence supporting the claim that competition intensification due to financial deregulation causes riskier behavior in lending activities.

Table 2 also reports the regression results estimating the interaction effects between deregulation and country effects and between deregulation and bank type effects. Since some countries and bank types have low frequencies, countries are grouped when considering their interactions with deregulation effects. Specifically, three country group dummies, *scand* (including 3 Nordic countries), *poor* (including 3 relatively poor countries: Greece, Spain and Portugal), and *competitive* (including the countries with relatively competitive banking markets before deregulation: UK, Belgium, Germany, Ireland, Luxemburg and Netherlands) are created and their interactions with the deregulation dummy, *d*, are considered. From the estimates of the main country effects, it seems that the two previously less competitive countries, France and Italy, as the base group, have the largest level of non-performing loan ratio, followed by the poor country group. After deregulation, non-performing loans declined by the largest percentage rate in these two groups of countries. The previously more competitive countries and the 3 Nordic countries have a much smaller non-performing loan ratio before deregulation and deregulation also has a smaller effect on them. As a result, the gaps between non-performing loan ratio in these countries have narrowed.

The regression results with two additional size dummies, *large* for banks with over 1 billion US\$ assets, and *small* for banks with less than 2 million US\$ assets, and their interactions with deregulation effect are also reported. The large positive estimate for the dummy *small* indicates that before deregulation, smaller banks have much higher levels of non-performing loan ratio. However, after deregulation, non-performing loans in small banks declined to the largest degree. Thus, similar to decreasing country differences after deregulation, loan quality of different sized banks has also converged.

3.3.3 Using Loan Loss Provision to Indicate Loan Quality

The above regressions with non-performing loans as dependent variable has only 74 observations before deregulation, which are probably too few to

assess the deregulation effect. To solve this problem, we resort to loan loss provision, an indicator closely related to non-performing loans. When loans go bad and are written off, banks should provide loan loss provisions to maintain sufficient loan loss reserves corresponding to the quantity and risk degree of problem loans. Undoubtedly, loan loss provisions and non-performing loans should be highly correlated. The data shows a correlation coefficient of 0.88 between them.

The results of the regression similar to model (3.1) without misspecification tests but with loan loss provision as the dependent variable are reported in table 3. It appears that deregulation would significantly worsen loan quality. However, this model is also subject to misspecification test and we will later see that the results of a misspecified model could be very misleading.

Using similar misspecification testing and respecification approaches (results are reported in table 4-6), it turns out that, again, both forms of mean shifts are significant, and the model should be in a linear dynamic form as follows.

$$\begin{aligned}
prov_{t,i} = & \beta_0 + \sum_{m=0}^1 \beta_{1m} * loan_{t-m,i} + \sum_{m=0}^1 \beta_{2m} * rothast_{t-m,i} + \\
& + \sum_{m=0}^2 \beta_{3m} * econ_{t-m,j} + \sum_{m=0}^1 \beta_{4m} * mmr_{t-m,j} + \beta_5 * d + \\
& + \sum_j \beta_{6j} * country_j + \sum_k \beta_{7k} * type_k + \\
& + \sum_{m=1}^2 \beta_{8m} * prov_{t-m,i} + u_{t,i} ,
\end{aligned} \tag{3.3}$$

where *prov* indicates log transformed loan loss provision. As before, Italy is excluded from the country dummies and commercial banks is excluded from the bank type dummies.

Regression results for the above model are reported in table 3. As both static and dynamic homoskedasticity tests are rejected, White's heteroskedasticity-consistent variances are used and the corresponding *p*-values are reported for valid inferences. The coefficient for loan size is again positive but less than one, suggesting the size of loan loss provision grows with loan size but the ratio of loan loss provision to loan is declining with the loan size. Coefficients for previous periods' loan loss provision are also positive, which is not surprising. Problem loans at a lower risk class could upgrade to a higher risk class over time. By the classification method of risk degree

of problem loans, the longer it is defaulted, the higher the risk of the loan. Correspondingly, a higher portion of loan loss reserve should be allocated to the loans that are categorized to a higher risk class in evaluating the sufficiency of the loss reserve, possibly resulting in the need of providing additional loan loss provision. As a result, there is a positive relationship between current and lagged loan loss provisions.

Money market rate has a positive effect on the level of loan loss provision, as predicted by the theories of the relationship between the level of interest rates and credit risk. Current economic condition (real GDP growth rate) has a negative coefficient, indicating when real economic growth is high, there is less need to set aside loan loss provision, i.e., loan repayment rate is high. The coefficients' signs for previous economic growth rates do not agree with each other, which is a little puzzling. One possible reason is that good economic conditions may induce bankers' reckless lending and the problem may not show up in the balance sheet until there is a downturn later on.

The coefficient for the deregulation dummy is -0.217 with a p -value 0.000, showing loan loss provision declined by roughly 20 percent after implementing the Second Banking Directive. Given that supervision has been continuously strengthened since the beginning of financial deregulation in the 1980s, the decline should not be a result of lower standards of loan loss reserves. Thus, we may conclude that the data is not supportive of the popular claim that competition intensification due to financial deregulation causes riskier lending behavior.

As before, results for regressions estimating different interaction effects are also reported. Small banks seem to have lower provision ratio before deregulation although they have higher non-performing loan ratio. After implementing the Second Banking Directive, loan loss provision ratios among different sized banks again appear to converge. Deregulation seem to have largest effect on the poor countries, and there seems to exist convergence among the competitive and non competitive countries (excluding the Nordic countries and the three poor countries).

3.3.4 Two-Stage Least Squares Estimating Results

This section reports the estimating results using a two-stage least squares method to account for the simultaneity problem between loan quality and

lending rates. According to interest rate theories, the level of lending rates are affected by central banks' monetary policy, inflation rates, exchange rates, and riskiness and liquidity of the loans. As before, we use loan quality (non-performing loans or loan loss provision) to indicate the riskiness of loans and money market rates to account for effects of exchange rates and other factors. Liquidity effects are explained by the constant. The model for the lending rate is then

$$lendrate_{t,i} = \gamma_0 + \gamma_1 * mmr_{t,i} + \gamma_2 * risk_{t,i} + \gamma_3 * if_{t,i} + \epsilon_{t,i} , \quad (3.4)$$

where *risk* and *if* stand for average yearly loan quality (non-performing loans or loan loss provision) and inflation rates for each country separately.

Applying a two-stage least squares method, we first conduct a regression with the left hand side as *lendrate*, and the right hand side including all independent variables of model (3.4) and model (3.2) (or model (3.3)). Loan size and non-interest income ratio are yearly averages for each country. Misspecification tests indicate that the regression should be dynamic and the lagged *lendrate* and *mmr* should be included. The misspecification test results for this respecified model are reported in tables 4-6. The misspecification test results for the model with the fitted value of *lendrate* as an independent variable are also reported in these tables. Regression results of the respecified models are reported in tables 2-3. As we can see, the results are not very different from those using money market rate as a substitute of lending rate.

3.4 Concluding Remarks

This paper studies the effect of financial deregulation on bank loan quality using bank-level balance sheet data and macroeconomic data for the European Union. Applying dynamic linear regressions after comprehensive misspecification tests, the data reveals that loan loss provision declined after the removal of cross-border restrictions. Given the continuous improvement in banking supervision, the results suggest that loan quality improved as a result of intensified competition. Thus, contrary to the popular claim, there is evidence that competition intensification due to financial deregulation could actually foster more cautious behavior in banks' lending activities. The analysis directly using non-performing loans with a smaller sample size

dose not find evidence of a positive relationship between risky behavior and financial deregulation either. In addition, there is evidence that lending behavior in different sized banks across all EU countries has converged, indicated by the decreased differences in non-performing loan ratio and loan loss provision ratio.

The analyses using loan loss provision may be improved if adopting a more appropriate distribution form of the sample. From the t-plots of the regression residuals, it seems that its distribution is relatively symmetric but with fat tails, likely a Student's t distribution. However, analysis taking this into account will not be conducted here.

It is also worth mentioning that the process of misspecification tests and respecification verified that the violations of assumptions are related to each other and that the joint misspecification tests are helpful in isolating the sources of misspecification problems, as pointed out by McGuirk et al. (1993, 1995).

Finally, the results of an incorrectly specified model could be misleading. The estimated deregulation effect without misspecification testing (using loan loss provision as the dependent variable) is exactly the opposite of the estimate in the better specified model, model (3.3). The lesson is that misspecification checking in empirical work is important.

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Appendix A

Tables

Table 2. Regression Results with Non-performing Loans as Dependent Variable
(p-values in parentheses)

	Model (1-1)	Model (2)	Model (2-1)	Model (2-2)	Model (2-3)	Model (5-1)
constant	-2.697 (0.000)	-0.534 (0.000)	0.043 (0.877)	-0.584 (0.000)	-0.647 (0.000)	-0.708 (0.000)
d	-0.010 (0.923)	-0.061 (0.414)	-0.595 (0.023)	-0.009 (0.919)	-0.063 (0.501)	-0.030 (0.702)
loan	0.988 (0.000)	0.156 (0.000)	0.160 (0.000)	0.156 (0.000)	0.168 (0.000)	0.156 (0.000)
rothast	0.043 (0.000)	0.013 (0.064)	0.013 (0.052)	0.013 (0.062)	0.013 (0.057)	0.012 (0.066)
econ	-0.122 (0.000)	-0.020 (0.132)	-0.021 (0.126)	-0.020 (0.138)	-0.021 (0.131)	-0.025 (0.071)
mmr*	0.002 (0.834)	0.037 (0.000)	0.029 (0.000)	0.036 (0.000)	0.036 (0.000)	0.041 (0.000)
bad _{t-1}	-	0.838 (0.000)	0.843 (0.010)	0.837 (0.000)	0.837 (0.000)	0.837 (0.000)
Denmark	-	-0.325 (0.004)	-	-0.330 (0.003)	-0.324 (0.004)	-0.355 (0.001)
Spain	-	-0.210 (0.000)	-	-0.213 (0.000)	-0.204 (0.001)	-0.148 (0.015)
Finland	-	-0.263 (0.017)	-	-0.257 (0.021)	-0.242 (0.030)	-0.208 (0.065)
France	-	0.124 (0.019)	-	0.122 (0.022)	0.123 (0.026)	0.156 (0.006)
UK	-	-0.024 (0.851)	-	-0.024 (0.847)	-0.028 (0.827)	0.065 (0.609)
Greece	-	-0.239 (0.231)	-	-0.237 (0.235)	-0.217 (0.277)	-0.473 (0.030)
Netherlands	-	0.451 (0.221)	-	0.446 (0.227)	0.438 (0.235)	0.459 (0.214)
Portugal	-	-0.104 (0.128)	-	-0.102 (0.136)	-0.095 (0.180)	-0.131 (0.025)
Sweden	-	0.368 (0.000)	-	-0.369 (0.000)	-0.353 (0.000)	-0.329 (0.000)

* Estimated lending rate for model (5-1).

Table 2. (continued)

	Model (1-1)	Model (2)	Model (2-1)	Model (2-2)	Model (2-3)	Model (5-1)
Bnk hld com	-	-0.110 (0.332)	-0.139 (0.206)	0.066 (0.902)	-0.113 (0.309)	-0.116 (0.297)
Cooperative	-	-0.034 (0.322)	-0.048 (0.152)	0.020 (0.957)	-0.033 (0.335)	-0.037 (0.282)
Investment	-	-0.203 (0.025)	-0.163 (0.063)	0.294 (0.435)	-0.175 (0.057)	-0.202 (0.026)
Medium & long term	-	-0.158 (0.033)	-0.167 (0.024)	-0.220 (0.422)	-0.159 (0.032)	-0.163 (0.028)
Non-bank credit	-	-0.082 (0.055)	-0.066 (0.111)	0.038 (0.858)	-0.095 (0.028)	-0.086 (0.045)
Real estate/Mortgage	-	-0.054 (0.465)	-0.064 (0.379)	-0.011 (0.956)	-0.066 (0.382)	-0.056 (0.454)
Savings	-	-0.060 (0.116)	-0.091 (0.013)	0.069 (0.697)	-0.067 (0.085)	-0.060 (0.118)
d * Bnk hld com	-	-	-	-0.184 (0.733)	-	-
d * Cooperative	-	-	-	-0.056 (0.882)	-	-
d * Investment	-	-	-	-0.525 (0.174)	-	-
d * Medium & long term	-	-	-	0.070 (0.807)	-	-
d * Non-bank credit	-	-	-	-0.124 (0.568)	-	-
d * Real estate/Mortgage	-	-	-	-0.046 (0.825)	-	-
d * Savings	-	-	-	-0.134 (0.459)	-	-

Table 2. (continued)

	Model (1-1)	Model (2)	Model (2-1)	Model (2-2)	Model (2-3)	Model (5-1)
competitive	-	-	-0.640 (0.155)	-	-	-
scand	-	-	-0.429 (0.261)	-	-	-
poor	-	-	-0.104 (0.785)	-	-	-
d * competitive	-	-	0.468 (0.307)	-	-	-
d * scand	-	-	0.166 (0.671)	-	-	-
d * poor	-	-	0.051 (0.895)	-	-	-
large	-	-	-	-	-0.111 (0.410)	-
small	-	-	-	-	0.470 (0.132)	-
d * large	-	-	-	-	0.038 (0.774)	-
d * small	-	-	-	-	-0.404 (0.198)	-

Model (1-1): Original model.

Model (2): Respecified model.

Model (2-1) to (2-3): With interaction effects.

Model (5-1): Two-stage least squares estimates.

Table 3. Regression Results with Loan Loss Provision as Dependent Variable (p-values in parentheses)

	Model (1-2)	Model (3)	Model (3-1)	Model (3-2)	Model (3-3)	Model (5-2)
constant	-4.678 (0.000)	-1.046 (0.000)	-1.151 (0.000)	-1.115 (0.000)	-1.113 (0.000)	-1.270 (0.000)
d	0.109 (0.003)	-0.217 (0.000)	-0.115 (0.367)	-0.185 (0.023)	-0.192 (0.010)	-0.212 (0.001)
loan	0.967 (0.000)	0.169 (0.092)	0.186 (0.060)	0.169 (0.091)	0.174 (0.083)	0.172 (0.078)
loan _{t-1}	-	0.094 (0.357)	0.083 (0.415)	0.093 (0.363)	0.094 (0.360)	0.088 (0.376)
rothast	0.049 (0.000)	0.051 (0.018)	0.052 (0.019)	0.050 (0.020)	0.051 (0.018)	0.052 (0.017)
rothast _{t-1}	-	-0.039 (0.038)	-0.036 (0.058)	-0.038 (0.040)	-0.039 (0.040)	-0.041 (0.032)
econ	-0.123 (0.000)	-0.105 (0.000)	-0.092 (0.000)	-0.101 (0.000)	-0.103 (0.000)	-0.097 (0.000)
econ _{t-1}	-	0.052 (0.000)	0.059 (0.000)	0.053 (0.000)	0.053 (0.000)	0.059 (0.000)
econ _{t-2}	-	-0.038 (0.000)	-0.033 (0.000)	-0.032 (0.001)	-0.035 (0.000)	-0.042 (0.000)
mmr*	0.042 (0.000)	0.033 (0.000)	0.025 (0.012)	0.037 (0.000)	0.036 (0.000)	0.035 (0.019)
mmr* _{t-1}	-	0.002 (0.832)	0.005 (0.585)	0.002 (0.852)	0.001 (0.890)	0.011 (0.577)
prov _{t-1}	-	0.505 (0.000)	0.521 (0.000)	0.501 (0.000)	0.503 (0.000)	0.506 (0.000)
prov _{t-2}	-	0.198 (0.000)	0.197 (0.000)	0.201 (0.000)	0.199 (0.000)	0.198 (0.000)
Austria	-	0.328 (0.011)	-	0.353 (0.006)	0.361 (0.006)	-
Belgium	-	0.118 (0.103)	-	0.144 (0.050)	0.099 (0.183)	0.115 (0.120)
Germany	-	0.218 (0.038)	-	0.250 (0.019)	0.240 (0.020)	0.134 (0.187)

* Estimated lending rate for model (5-2)

Table 3. (continued)

	Model (1-2)	Model (3)	Model (3-1)	Model (3-2)	Model (3-3)	Model (5-2)
Denmark	-	0.272 (0.000)	-	0.278 (0.000)	0.243 (0.000)	0.262 (0.000)
Spain	-	-0.119 (0.015)	-	-0.103 (0.038)	-0.139 (0.007)	-0.075 (0.133)
Finland	-	0.099 (0.675)	-	0.112 (0.636)	0.065 (0.781)	0.124 (0.598)
France	-	0.234 (0.000)	-	0.256 (0.000)	0.213 (0.000)	0.295 (0.000)
Greece	-	0.256 (0.003)	-	0.260 (0.002)	0.237 (0.005)	0.349 (0.000)
UK	-	0.191 (0.075)	-	0.178 (0.098)	0.170 (0.111)	-0.143 (0.405)
Ireland	-	0.441 (0.029)	-	0.403 (0.044)	0.421 (0.035)	0.471 (0.016)
Luxemburg	-	-1.380 (0.043)	-	-1.361 (0.047)	-1.400 (0.040)	-1.232 (0.071)
Netherlands	-	0.280 (0.004)	-	0.291 (0.003)	0.258 (0.007)	0.283 (0.004)
Portugal	-	0.266 (0.001)	-	0.265 (0.001)	0.235 (0.004)	0.179 (0.065)
Sweden	-	-0.128 (0.348)	-	-0.124 (0.330)	-0.133 (0.324)	-0.089 (0.510)
Bank holding com	-	-0.056 (0.613)	-0.084 (0.443)	-0.035 (0.876)	-0.046 (0.681)	-0.040 (0.722)
Cooperative	-	-0.089 (0.001)	-0.096 (0.000)	-0.061 (0.687)	-0.088 (0.001)	-0.090 (0.001)
Investment	-	0.083 (0.518)	0.116 (0.369)	-0.296 (0.274)	0.087 (0.498)	0.084 (0.512)
Medium & long term	-	-0.232 (0.004)	-0.233 (0.004)	-0.621 (0.038)	-0.231 (0.004)	-0.240 (0.003)
Non-bank credit	-	0.036 (0.603)	0.048 (0.489)	-0.192 (0.532)	0.041 (0.555)	0.032 (0.639)
Real estate/Mortgage	-	-0.395 (0.000)	-0.401 (0.000)	0.049 (0.760)	-0.406 (0.000)	-0.393 (0.000)
Savings	-	-0.073 (0.010)	-0.099 (0.001)	-0.117 (0.382)	-0.075 (0.009)	-0.076 (0.008)

Table 3. (continued)

	Model (1-2)	Model (3)	Model (3-1)	Model (3-2)	Model (3-3)	Model (5-2)
d * Bank holding com	-	-	-	-0.018 (0.942)	-	-
d * Cooperative	-	-	-	-0.029 (0.848)	-	-
d * Investment	-	-	-	0.414 (0.170)	-	-
d * Medium & long term	-	-	-	0.399 (0.196)	-	-
d * Non-bank credit	-	-	-	0.239 (0.446)	-	-
d * Real estate/Mortgage	-	-	-	-0.496 (0.002)	-	-
d * Savings	-	-	-	0.044 (0.747)	-	-
competitive	-	-	0.018 (0.912)	-	-	-
scand	-	-	-0.026 (0.938)	-	-	-
poor	-	-	-0.078 (0.527)	-	-	-
d * competitive	-	-	-0.021 (0.901)	-	-	-
d * scand	-	-	0.055 (0.871)	-	-	-
d * poor	-	-	-0.089 (0.486)	-	-	-
large	-	-	-	-	0.144 (0.295)	-
small	-	-	-	-	-0.150 (0.306)	-
d * large	-	-	-	-	-0.222 (0.098)	-
d * small	-	-	-	-	0.136 (0.357)	-

Model (1-2): Original model; Model (3): Respecified model;
Model (3-1-3): With interaction effects; Model (5-2): 2SLS estimates.

Table 4. Joint Conditional Mean Tests
(p-values in parentheses)

	Model (2)	Model (3)	Model (4)	Model (5-1)	Model (5-2)
Overall	0.413	0.503	0.198	0.433	0.997
Functional Form	0.184	0.502	0.118	0.196	0.718
Independence	0.980	0.325	0.228	0.951	0.289
Mean Shift:					
Country Effect	-	-	-	-	-
Type Effect	-	-	-	-	-
Deregulation Effect	-	-	0.306	-	-

Model (2): Dependent Variable: Non-performing Loans

Model (3): Dependent Variable: Loan Loss Provision

Model (4): The model of lending rate

Model (5-1): 2SLS (Dependent Variable: Non-performing Loans)

Model (5-2): 2SLS (Dependent Variable: Loan Loss Provision)

Table 5. Joint Variance Tests
(p-values in parentheses)

	Model (2)	Model (3)	Model (4)	Model (5-1)	Model (5-2)
Overall	0.428	0.000	0.000	0.430	0.000
Shift	0.768	0.103	0.126	0.783	0.120
Static homoskedasticity:					
White	0.530	0.016	0.000	0.549	0.008
Dynamic homoskedasticity:					
Arch	0.132	0.000	0.057	0.130	0.000

Model (2): Dependent Variable: Non-performing Loans

Model (3): Dependent Variable: Loan Loss Provision

Model (4): The model of lending rate

Model (5-1): 2SLS (Dependent Variable: Non-performing Loans)

Model (5-2): 2SLS (Dependent Variable: Loan Loss Provision)

Table 6. Individual Misspecification Tests
(p-values in parentheses)

		Model (2)	Model (3)	Model (4)	Model (5-1)	Model (5-2)
Normality	Shapiro- Francia	0.000	0.000	0.000	0.000	0.000
	Skewness	0.000	0.000	0.030	0.000	0.000
	Kurtosis	0.000	0.000	0.000	0.000	0.000
Functional Form	Reset2	0.075	0.209	0.174	0.074	0.208
	Reset3	0.018	0.134	0.189	0.015	0.135
	KG2	0.675	0.009	0.652	0.789	0.000
Static Homosk.	Reset2	0.585	0.488	0.010	0.587	0.418
	White	0.261	0.000	0.000	0.282	0.000
Dynamic Homosk.	ARCH1	0.091	0.000	0.003	0.082	0.000
Independence	AC1	0.940	0.337	0.671	0.991	0.305

Model (2): Dependent Variable: Non-performing Loans

Model (3): Dependent Variable: Loan Loss Provision

Model (4): The model of lending rate

Model (5-1): 2SLS (Dependent Variable: Non-performing Loans)

Model (5-2): 2SLS (Dependent Variable: Loan Loss Provision)

Vita

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