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Banking Competition, Monitoring Incentives and Financial Stability[*]

VO Thi Quynh Anh[†]

August 2010

Abstract

This paper addresses the desirability of competition in banking industry. In a model where banks compete on both deposit and loan markets and where banks can use monitoring technology to control entrepreneurs' behavior, we investigate three questions: what are the effects of competition on banks' monitoring incentives? Does competition hurt banks' stability? What can be devices to correct potential negative effects of competition vis à vis financial stability? We find that impacts of competition on banks' monitoring incentives can be decomposed into two effects: one on the attractiveness of monitoring and the other on the monitoring efficiency. The first effect operates through the link between competition and loan margin. The second effect comes from the fact that marginal effect of monitoring on entrepreneur's effort depends on loan rate. We characterize the sufficient condition under which competition will increase monitoring incentives as well as banks' stability. For the third question, we focus on the role of capital requirement and claim that with capital requirement, we can attain a weak correction but not strong correction.

JEL Codes: G21, G28, D43, D82.

1   Introduction

"Competition among banks: good or bad?" has been a question raised for a long time. The general argument in favor of competition in any industry resides in its contribution to allocative, productive and dynamic efficiency. However, for banking industry, the answer is much less evident because of delicate relationship between competition and stability.

In public policy, there exists, so far, two different attitudes towards competition in the banking sector. Until quite recently, the prevailing approach, called here the old approach, was that banking competition was bad because it would hurt the stability of

the banking and financial system. In many countries, policy-makers have used different instruments to explicitly limit competition between banks. For instance, in the United States until lately, banks faced different restrictions on activities such as rationing of banking licences, regulatory segmentation between financial activities. Another type of widely used restriction was the geographic segmentation of the markets. In the United States, there were prohibition of interstate banking and branching. In other countries, banks were frequently restricted to lending only limited amount of money outside the area where they had their headquarters. The banking sector has also often been considered exempted from competition policy law or has been subject to special provisions. Moreover, where there was an authority with responsibilities for competition policy in the banking industry, this authority was usually the supervisory authority itself.

This old approach seems to be gradually overcome by a positive view about competition whose existence can be witnessed by the trend towards financial liberalization. Provisions that directly allow or forbid some banks' activities, such as regulation of rate, geographical restrictions, are little by little removed. Supervisors rely more and more on regulatory instruments that are themselves "market friendly"[1] like capital requirement. Concerning competition policy field, competition rules are now taken seriously in the financial sector. All in all, the general trend for public policy today is to introduce competition in banking, checking its potential negative effects with prudential regulation.

In theory, most of the literature on the relationship between competition and stability[2] analyzes the impact that competition has on banks' incentives to take risk. It is well known from banking theory that due to the important weight of debt in banks' capital structure, to the wide dispersion of depositors and to the government safety net, banks have strong incentives to engage in activities which have very high payoffs but low success probabilities. Consistently with the old approach in public policy, early theoretical papers stress how competition worsens this moral hazard problem. The intuition behind the positive relationship between competition and excessive risk taking incentive shown in these papers is that greater competition erodes banks' franchise value and so, the failure is less costly. In consequences, taking excessive risk become more attractive to the banks. This intuition is proved within a framework, called here *franchise-value framework*, where banks compete to collect deposits and then, invest them into a set of financial claims with different levels of risk. The return distribution of these financial claims is taken as given for banks and does not depend on the degree of competition in the banking sector. Very recently, Boyd and DeNicolo (2005) has noted an important missing point of this framework, namely the bank - firm relationship. They argue that when this relationship is explicitly modeled on the asset side, there exists a new channel through that competition have positive effects on the riskiness of banks' asset. They obtain a monotonically increasing link between competition and banks' solvency, which is completely opposite with the conclusion of franchise - value framework. *This contrary shows that some simplifications of banking activities may have substantial effects on the conclusions.*

The above considerations suggest some advantages of constructing a richer setup to

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[1] We learn this expression from Padoa-Schioppa (2001).

[2] For excellent review of this literature, see Carletti (2008), Carletti and Vives (2009).

assess competition and risk - taking incentives. Of course, one cannot expect to incorporate the whole complicated reality into one model. *Our main point is the remark that in Boyd and DeNicolo (2005)'s setup, banks are treated as passive lenders. This treatment is inconsistent with the intermediation theory which always claims the ability of monitoring and processing information as main specificity of bank lending in comparison with security issues in financial market*[3]*. Moreover, being considered as unsophisticated lenders, in Boyd and DeNicolo (2005), banks don't have any possibility to choose risk.*

In this paper, we construct a framework that is able to overcome those weaknesses. Specifically, we consider a model where banks compete à la Cournot on both deposit and loan markets. On deposit market, they compete to attract depositors. On loan market, they compete to extend loans to firms. Both relationship, namely depositors - banks and banks - firms, are subject to a moral hazard problem. Origin of the first moral hazard is the system of deposit insurance with flat premium. The second moral hazard is due to the fact that loan returns depend on hidden effort of borrowers. Differently with depositors who are small households, as sophisticated investors, banks can use costly monitoring to alleviate information problem they face. In order to model monitoring, we adopt a continuous version of the formulation proposed by Holmstrom and Tirole (1997). We assume that banks can choose a monitoring intensity and that higher monitoring intensity will induce a more appropriate behavior of borrowers because it reduces the marginal cost of their effort. In our model, higher risk-taking incentives of banks are materialized by choosing a lower monitoring intensity.

Within such a setup, we investigate three questions: what are the effects of competition on banks' monitoring incentives? Does competition hurt banks' stability? What can be devices to correct potential negative effects of competition vis à vis financial stability? We find that impacts of competition on banks' monitoring incentives can be decomposed into two effects. On the one hand, greater competition reduces loan margin and so, makes monitoring less attractive to banks - *attractiveness effect*. This effect is bad for monitoring incentives. On the other hand, since how much monitoring may improve loan return distribution depends on loan rate, competition also has impacts on monitoring efficiency - *efficiency effect*. The direction of efficiency effect is uncertain but there exists situations where it is good and stronger than attractiveness effect. *Hence, our analysis shows that the common presumption that market power increases banks' incentives to exert monitoring effort is careless.* The main ingredient allowing us to get positive relationship between competition and monitoring incentives is that we don't assume an exogenous level of monitoring efficiency but endogenize it. *The efficiency effect found in this paper allows us to point out the connection between welfare effect and stability effect of competition in banking industry, which is so far ignored in the literature.*

Regarding the second question, in this paper, risk exposure of banks is jointly determined by banks and borrowers behaviors. When competition increases, loan rate will decrease and that induces the borrowers to exert more effort. However, this effect may be overweighted by the effect of competition on banks' monitoring incentives. So, greater competition reduces banks' probability of failure if it raises monitoring incentives of banks.

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[3]See Freixas and Rochet (1997).

With our setup, we are able to produce basic results in the literature as special cases.

Concerning the third question, we focus on the role of capital requirement. We find that apart from a positive direct effect on financial stability, capital requirement has also indirect effects which operate through its impacts on interest rates. We claim that with capital requirement, we can attain a weak correction but not strong correction.

The paper proceeds as follows. After reviewing the related literature in section 2, we present our model setup in section 3. Section 4 is devoted to the characterization of symmetric equilibrium. In section 5 we examine the role of capital requirement in correcting negative effects of competition vis à vis financial stability. In section 6, we discuss the benefits of financial liberalization. Finally, section 7 concludes with some remarks about future research directions.

2   Relation to the Literature

Our paper belongs to the theoretical literature analyzing the ties between competition and banks' risk-taking incentives. As we have seen in the introduction, there exists two strands within this literature.

The first and earliest strand is pioneered by Keeley (1990) and then successively followed by, among others, Allen and Gale (2000), Hellman, Murdock and Stiglitz (2000), Matutes and Vives (2000), Cordella and Yeyati (2002), Repullo (2004). The common feature of these papers is that all of them use franchise-value framework to address the effects of competition on risk - taking incentives of banks. This framework is characterized by the fact that banking competition is explicitly modeled only on the liability side; that on the asset side, banks' asset allocation decisions are modeled as a "portfolio allocation problem" and then, banks' asset return does not depend on the degree of competition. With this setup, greater competition implies an increase of deposit rate and thus, reduces banks' charter values. Keeping in mind that charter values represent the cost of failure for banks, these papers obtain that more competition results in higher incentives for banks to take risks. Some of the above papers also investigate the efficiency of different regulatory tools in limiting perverse impacts of competition on risk - taking. For instance, Matutes and Vives (2000) consider the role of deposit regulation (rate regulation or deposit limits). They find that this instrument is sufficient to implement welfare - optimal policy when deposit insurance scheme is risk-sensitive. However, with flat-premium deposit insurance, to improve welfare, deposit regulation may need to be combined with direct asset restrictions. Cordella and Yeyati (2002) focus on the effects of information disclosure and deposit insurance scheme. They obtain that both are likely to mitigate bad effects of competition.

The second strand includes two papers: Boyd and DeNicolo (2005); Martinez-Miera and Repullo (2008). These papers differentiate themselves from the first strand by the fact that they explicitly take into consideration the lenders - borrowers relationship on the asset side of banks' balance sheet. This feature has two implications. First, banks' asset returns will depend on the competitiveness of banking industry through loan rate. Second, the riskiness of banks' assets also depends on borrowers' behaviors. Boyd and DeNicolo (2005) find that the risk level of banks' assets is monotonically decreasing with the number

of banks. The intuition of their result is as follows: when competition increases, loan rate will decrease, which induces the borrowers to choose safer investments. Martinez and Repullo (2008) deviate from Boyd and DeNicolo (2005) by assuming that loan returns are imperfectly correlated. In that case, a decrease of loan rate will reduce performances of non-defaulting loans, that provide a buffer to cover loan losses. They show that when that effect of competition, called there margin effect, is taken into account, a U-shaped relationship between competition and the risk of bank failure generally obtains.

Our paper introduces the role as monitors of banks into the second strand. Thus, we get a more complete and appropriate description of bank lending. To the best of our knowledge, before, only Caminal and Matutes (2002) study how market power affects banks' solvency through its impacts on banks' incentives to invest in reducing information problem. Their analysis is done within a very specific setting where monitoring is perfect and where project choices are independent of market structure. In their analysis, banks only fail due to macroeconomic shocks, not because of project choices. They get the conclusion that market power enhances monitoring incentives, which will not be necessarily the case if we endogenize the efficiency of monitoring technology, as shown in this paper. Moreover, Caminal and Matutes (2002)'s results are very sensitive to the assumption about decreasing return to scale of investment[4]. Our results are obtained within a framework of constant return to scale.

Empirical literature about the relationship between competition and stability in banking has produced until now mixed findings. The main distinction of different empirical papers resides in the choice of measures for competitiveness and for banks' riskiness. Measures of market power used in the literature include measures of concentration (e.g. HHI index or n-firm concentration ratios), Lerner index or the Panzar and Rosse H-statistic. Proxy indicators for risk employed contain Z-index, non-performing loan ratio. For example, measuring market structure by concentration indicators, Boyd, DeNicolo and Jalal (2006) conclude that the probability of failure increases with more concentration in banking. Another work by Schaeck, Cihak and Wolfe (2006) uses Panzar and Rosse H-statistic as measure of competitiveness and finds that more competitive banking system is more stable than monopolistic system because of a lower likelihood of bank failure and a longer time to crisis. Contrasting with these results, in the context of Spanish banks, Jiménez, Lopez and Saurina (2007) show that nonperforming loans decrease with the rise in the degree of market power which is measured by Lerner index.

3   Model

We consider an economy with two dates $(t = 0, 1)$ and a banking industry composed of N commercial banks indexed by $i = 1, 2...N$. These banks compete à la Cournot to collect deposits from depositors and to extend loans to entrepreneurs.

A. *Deposit Market*

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[4]In fact, without the assumption of decreasing return to scale, all conclusions of the paper do not hold any more.

Banks have no capital[5] and are funded by deposits at date 0. They face an upward sloping supply of deposits which is represented by an inverse supply curve $r_D(.)$. Denote by D_i the amount of deposits collected by bank i. We assume that deposits are fully insured and that the deposit insurance premium is flat. These two assumptions imply that the deposit supply does not depend on risk and so, the deposit interest rate is function of only total deposits $\sum_{i=1}^{N} D_i$. In our judgment, the assumption of deposit insurance best reflects reality. In most countries of the world, there exists either explicitly or implicitly a system of deposit insurance. Moreover, the existence of fixed premium deposit insurance is the origin usually claimed of moral hazard in banking. For expositional purposes, in this paper, we take the flat premium to be zero[6].

Assumption 1 *Inverse deposit supply function $r_D(.)$ satisfies*

$$r_D(0) > 0, r_D'(0) > 0, r_D''(.) \geq 0$$

B. *Loan Market*

On the loan market, there is a population of risk-neutral and penniless entrepreneurs. Each entrepreneur has access to a project that requires one unit of investment at date 0 and yields at date 1 a stochastic cashflows $\tilde{R}$. We assume that $\tilde{R}$ can take two values

$$\tilde{R} = \begin{cases} R & \text{with probability} \quad p \\ 0 & \text{with probability} \quad 1-p \end{cases}$$

The distribution of cashflows depends on the effort of the entrepreneur, i.e. how diligently the project is managed. We measure this level of effort by the probability of success $p \in [0, 1]$ of the project. Therefore, by carefully running the project, the entrepreneur can improve the likelihood of getting a high return. The costs of being diligent correspond to the sacrifice of some private benefit, which can be thought of as a quiet life, managerial perks or diversion of corporate revenues for private use.

To fund their projects, entrepreneurs must borrow from banks. This borrowing relationship is subject to a moral hazard problem because banks can not directly observe entrepreneurs' effort. However, banks can use monitoring activities to induce appropriate behavior of their borrowers. In practice, banks' monitoring amounts to verifying whether borrowers comply with restrictive covenants and to enforcing the covenants if they do not. Hence, as noted by Holmström and Tirole (1997), monitoring may reduce borrowers' opportunity costs of being diligent. In order to formalize this idea, we here assume that the level of private benefit the entrepreneur can enjoy depends on how intensively banks monitor the project's running. Let $m \in [0, 1]$ denote the monitoring intensity exerted by a bank for each unit of loan (m_i will then denote the monitoring intensity chosen by bank i). Therefore, in this model, the entrepreneur's private benefit will be a function of two variables, namely p and m. Denote it by $B(p, m)$. We make following assumptions on the

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[5] We will relax this assumption later.

[6] All our results are still valid if the flat premium is strictly positive.

function $B(.,.)$. From now on, for convenience of notation, we use subscripts to refer to partial derivatives.

Assumption 2 *Entrepreneur's private benefit function $B(.,.)$ satisfies*

(i) $B_{pp}(p, m) < 0$

(ii) $B_{pm}(p, m) > 0$

(iii) $B_p(0, m) = 0; \; B_p(1, m) = -\infty$

So, private benefit is decreasing and concave function of effort. Since in our model, the cost of effort for the entrepreneur is modeled by some reduction in his private benefit, the negative of $B_p(p, m)$ can be interpreted as marginal cost of effort. Thus, positive sign of cross-partial derivative B_{pm} means that a higher monitoring intensity makes effort less costly marginally. Part (iii) of this assumption serves to rule out corner solutions. In this paper, we will pay special attention to the case where $B(p, m)$ takes the following form

$$B(p, m) = h(p)g(m) \tag{1}$$

The above assumptions can be then translated into the assumptions that the function $h(.)$ is decreasing and concave with $h'(0) = 0$ and $h'(1) = -\infty$ and that the function $g(.)$ is decreasing.

Monitoring is costly for banks, which introduces another moral hazard problem concerning banks-depositors relationship. We represent the monitoring cost corresponding to the monitoring intensity m by a twice differentiable function $C(m)$[7]. We assume that monitoring cost function is increasing, convex and, to insure interior solutions, satisfies Inada's conditions.

Assumption 3 *Monitoring cost function $C(.)$ satisfies*

(i) $C(0) = 0; \; C''(.) \geq 0$

(ii) $C'(0) = 0; \; C'(1) = +\infty$

Regarding competition between banks to grant loans, similarly to the deposit market, we adopt a Cournot formulation. Hence, given the loan supply L_i of each bank i, the interest rate charged for each unit of loan will be determined by a downward sloping demand function $r_L(\sum_{i=1}^{N} L_i)$[8]. Note that because deposits are the only source of funds for banks, balance sheet identity implies that $D_i = L_i$ for all i.

Assumption 4 *Inverse loan demand function*

$$r_L(0) > 0, r_L'(0) < 0, r_L''(.) \leq 0$$

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[7] We here assume that all banks have access to the same monitoring technology. Therefore, we write both private benefit function and cost function without i - label on the functional symbol.

[8] In this paper, the loan competition is modeled in reduced - form by some decreasing and concave demand function. This demand function can be generated by a population of potential entrepreneurs whose reservation utility differs.

To insure that all parties get a positive surplus when the investment project succeeds, we impose an additional assumption

Assumption 5

$$R > r_L(0) > r_D(0)$$

The timing of the model is as follows. At the beginning of date 0, all banks simultaneously determine the amount of deposits collected and the volume of loans extended to entrepreneurs. Then, each bank i chooses monitoring intensity m_i and each entrepreneur chooses effort level p. At date 1, project returns are realized and payments are settled. The following figure summarizes this timing.
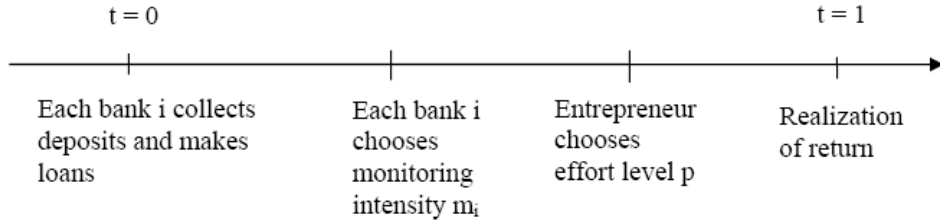
Timing of the model

Before going to the characterization of equilibrium, some more remarks are useful. First, in this model, by monitoring, banks can reduce the extent of moral hazard problem but they can not completely eliminate it. In other words, our monitoring technology is imperfect and its efficiency is determined, as we will see below, endogenously. Second, in our setting, quality of loan portfolios - banks' assets - depends on behaviors of both parties in the borrowing relationship and neither banks nor entrepreneurs can have complete control over it. We believe that this feature reflects the best the actual complex financial environment where unceasing innovation not only provides to participants numerous means to better manage their investment but also expose them to more risk of control loss. In theoretical aspect, this remark makes sense when we notice that two existing frameworks in the literature assume full control either of banks or of entrepreneurs over the riskiness of banks' asset.

4   Symmetric Equilibrium

To solve for the equilibrium, we first determine the effort level the entrepreneur will choose if facing a loan rate r_L and monitoring intensity m. Then, we analyze the banks' choice of monitoring intensity. The characterization of equilibrium will be complete by finding the equilibrium deposit and loan rates.

4.1   Entrepreneur's effort level p

Given a loan rate r_L and monitoring intensity m, the entrepreneur will choose p to maximize his expected profit including private benefit

$$\underset{p \in [0,1]}{Max} \ \Pi^E = p\left(R - r_L\right) + B\left(p, m\right) \tag{2}$$

8

Note that because of the assumption 2, the entrepreneur's profit function Π^E is concave function of p and no corner solutions exist. So, the solution is characterized by the following FOC:

$$R - r_L + B_p(p, m) = 0 \tag{3}$$

Denote such a solution by $p^*(r_L, m)$. Using implicit differentiation, we get

$$\frac{\partial p^*}{\partial r_L} = \frac{1}{B_{pp}(p^*, m)} < 0 \tag{4}$$

$$\frac{\partial p^*}{\partial m} = -\frac{B_{pm}(p^*, m)}{B_{pp}(p^*, m)} > 0 \tag{5}$$

Hence, similarly with Boyd and DeNicolo (2005), a decrease in the interest rate on loans increases the level of effort exerted by entrepreneurs. Another method for banks to incentivize the entrepreneur arised in our model is monitoring because increasing monitoring intensity could have the same effects. Intuition for this effort - enhancing effect of monitoring comes from the fact that higher monitoring intensity reduces marginal cost of effort.

4.2 Bank's monitoring intensity m

We now turn to the monitoring incentives of banks. For given D_i and D_{-i}, each bank i will choose m_i such that[9]

$$\underset{m_i \in [0,1]}{Max} \ \Pi_i^B = \{p^*(r_L, m_i) [r_L - r_D] - C(m_i)\} D_i$$

When writing bank's profit function, we make an implicit assumption that loans' returns are perfectly correlated. As noted by Allen and Gale (2000), perfect correlation of loans is equivalent to assuming that the risk associated with each loan can be decomposed into systemic and idiosyncratic components, and that with a large number of entrepreneurs, the idiosyncratic component can be perfectly diversified away. Moreover, although perfect correlation is an extreme case[10], some degree of correlation is necessary to provide role for monitoring in our setup.

Since Π_i^B is a continuous function and the feasible set $[0; 1]$ is compact, the Weierstrass theorem applies and so, a maximizer exists. In addition, due to the assumption that monitoring cost function $C(m)$ satisfies Inada's conditions, corner solutions are excluded. Therefore, the solution to the above optimization problem satisfies:

$$p_{m_i}^*(r_L, m_i) [r_L - r_D] - C'(m_i) = 0 \tag{6}$$

and

$$p_{m_i m_i}^*(r_L, m_i) [r_L - r_D] - C''(m_i) \leq 0 \tag{7}$$

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[9]For notational simplicity, in situations where there is no risk of confusion, we will write loan and deposit rates simply as r_L and r_D suppressing the fact that they depend on respectively total loans and total deposits.

[10]Martinez - Miera and Repullo (2008) study the case of imperfect correlation in a setting without monitoring.

Equation (6) clarifies the trade-off banks face when raising monitoring intensity. That is the trade-off between higher costs of monitoring and higher probability that loans pay off.

Let m_i^* be the optimal monitoring intensity chosen by bank i. It is obvious from equation (6) that monitoring intensity depends on interest rates of both deposit and loan markets $m_i^* (r_L, r_D)$. To analyze effects of these interest rates on banks' monitoring incentives, we perform some comparative statics. First, by applying implicit differentiation to equation (6) and assuming that the inequality in (7) is strict, we obtain

$$\frac{\partial m_i^*}{\partial r_D} = \frac{p_{m_i}^* (r_L, m_i^*)}{p_{m_i m_i}^* (r_L, m_i^*) [r_L - r_D] - C'' (m_i^*)} \tag{8}$$

Because of (5) and the second order condition (7), we see that partial derivative of m_i^* with respect to r_D is negative. Hence, an increase in the deposit rate reduces monitoring incentives of banks, which is exactly the standard effect of deposit competition found in the literature. Concerning the effects of loan rate, we have

$$\frac{\partial m_i^*}{\partial r_L} = - \frac{p_{m_i}^* (r_L, m_i^*) + p_{m_i r_L}^* (r_L, m_i^*) [r_L - r_D]}{p_{m_i m_i}^* (r_L, m_i^*) [r_L - r_D] - C'' (m_i^*)} \tag{9}$$

Hence, apart from a similar effect as deposit rate, loan rate has another effect on monitoring intensity represented by the cross-partial derivative $p_{m_i r_L}^*$ which can be negative or positive, depending on the properties of the private benefit function $B(p, m)$. We will discuss this in more detail in the next subsection. *Our main message here is that while increasing competition on the deposit market can only have a negative effect on monitoring incentives, increasing competition on the loan market may have some potentially positive effect.* This suggests that competition on deposit market and on loan market should be treated in different ways by policy makers.

4.3 Equilibrium interest rates

We are now in a position to determine the equilibrium deposit and loan rates. Given D_{-i} chosen by other banks, each bank i chooses D_i such that

$$\underset{D_i \geq 0}{Max} \ \Pi_i^B = \{p^* (r_L, m_i^*) [r_L (D_i + D_{-i}) - r_D (D_i + D_{-i})] - C (m_i^*)\} D_i \tag{10}$$

Denote total deposits by $Z = \sum_{i=1}^{N} D_i$ and define a function $f(Z)$ by

$$f(Z) = p^* (r_L, m_i^*) [r_L(Z) - r_D(Z)] - C (m_i^*)$$

$f(Z)$ then represents the expected return of individual loan. The maximization program (10) becomes

$$\underset{D_i \geq 0}{Max} \ \Pi_i^B = f(Z)D_i$$

In what follows, we are going to assume that functional forms and parameter values

are such that $f'(0) < 0$ and $f''(.) \leq 0$. Therefore, the symmetric equilibrium, where all banks choose the same amount of deposits D^* and so the total deposits $Z^* = ND^*$, is characterized by the following equation

$$f'(Z^*)Z^* + Nf(Z^*) = 0 \qquad (11)$$

Lemma 1 *In equilibrium, the total amount of deposits (and so of loans) is increasing with the number of banks.*

Proof. By totally differentiating (11), we have

$$\frac{dZ^*}{dN} = -\frac{f(Z^*)}{f''(Z^*)Z^* + (N+1)f'(Z^*)}$$

which is positive since $f'(.) < 0$ and $f''(.) < 0$. Q.E.D. ∎

Lemma 1 states a standard result of increasing competition in a Cournot paradigm. It implies that higher competition increases deposit rate and decreases loan rate.

We are now equipped to explore how the competitiveness of banking industry affects banks' monitoring incentives and banks' failure probability. We measure the intensity of competition by the number of banks. In the symmetric equilibrium, all banks choose the same monitoring intensity equal to $m^*(r_L(Z^*), r_D(Z^*))$. We have

$$\frac{dm^*}{dN} = \frac{dm^*}{dZ^*}\frac{dZ^*}{dN}$$

Since Z^* is an increasing function of N, $\frac{dm^*}{dN}$ has the same sign as $\frac{dm^*}{dZ^*}$. Using (8) and (9), we obtain the following proposition

Proposition 1 *The effect of competition on the optimal monitoring intensity of banks is given by*

$$\frac{dm^*}{dZ^*} = -\frac{p^*_{mr_L}(r_L, m^*)\, r'_L(Z^*)\,(r_L - r_D) + p^*_m(r_L, m^*)\left(r'_L(Z^*) - r'_D(Z^*)\right)}{p^*_{mm}(r_L, m^*)\,(r_L - r_D) - C''(m^*)} \qquad (12)$$

Hence, competition impacts banks' monitoring incentives through two channels:

First, more competition leads to a lower loan margin. Keeping in mind that, for banks, monitoring serves to decrease the probability of loans defaults, this first effect makes monitoring less attractive to banks and thus, unambiguously reduces their incentives - the *attractiveness effect*. In (12), this effect corresponds to the second component of the numerator. Clearly, its sign is negative and, since the denominator is negative, this term will tend to induce a decreasing relationship between N and m^*.

However, competition still has another effect on monitoring intensity, which is represented by the first term in the numerator of (12). This effect comes from the link between the marginal impact of monitoring on entrepreneurs' effort (i.e. p^*_m) and the loan rate - the *efficiency effect*. What is the intuition for the dependence of monitoring

efficiency on competition? As noted in subsection 4.1, monitoring has effort - enhancing value because a higher monitoring intensity reduces marginal cost of effort. In addition, choice of effort results from a trade - off between its benefits and costs. In consequence, how efficient monitoring is will depend on effort benefit level, which in turn depends on the intensity of competition through the loan rate.

Whether competition increases or decreases monitoring efficiency depends on properties of the private benefit function $B(p, m)$. In the case where $B(p, m)$ has a separately multiplicative form as (1), the efficiency effect is good for monitoring incentives if the following condition holds

$$h'''(p)h'(p) < \left[h''(p)\right]^2 \tag{A}$$

This condition is equivalent to the property that the function $\ln\left(\left|h'(p)\right|\right)$ is concave[11]. When (A) does not hold, the efficiency effect is bad and so, higher competition will hurt banks' monitoring incentives. When condition (A) is satisfied, the two effects of competition on monitoring intensity go in opposite directions. The sufficient condition for a positive relationship between competition and monitoring incentives is the following[12]

$$-\frac{\ln\left(\left|h'(p)\right|\right)''}{\ln\left(\left|h'(p)\right|\right)'} > h''(p)g(m)\frac{r'_D - r'_L}{r'_L(r_L - r_D)} \tag{B}$$

Regarding banks' failure, the equilibrium solvency probability for banks is $p^*(r_L(Z^*), m^*(Z^*))$:

$$\frac{dp^*}{dN} = \left(\frac{\partial p^*}{\partial r_L}r'_L(Z^*) + \frac{\partial p^*}{\partial m}m^{*'}(Z^*)\right)\frac{dZ^*}{dN} \tag{13}$$

The first term in the parenthesis of (13) is positive while the sign of the second term depends on the relationship between equilibrium monitoring intensity and competition. When banks' monitoring incentives are increasing with competition, a more competitive banking industry is more stable. In other case, competition has ambiguous effect on banks' stability.

Summing up, we have the following proposition

Proposition 2 *Assuming that the private benefit function has a separately multiplicative form as (1), then in a symmetric Nash equilibrium*

(i) *If condition (A) does not hold, the intensity of monitoring by banks decreases with the number of banks (N). In that case, increasing competition has an ambiguous effect on banks' probability of failure.*

(ii) *If condition (B) holds, the intensity of monitoring by banks increases with the number of banks (N) and so, more competition will make banks safer.*

Proof. See appendix. ∎

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[11] $\left|h'(p)\right|$ is then said to be logarithmically concave function.

[12] Compared to (A), this condition means that the function $\ln\left(\left|h'(p)\right|\right)$ must be sufficiently concave.

An interesting point is worth noting here. *It relates to the connection between welfare effect and stability effect of competition in banking industry.* So far, these two effects are usually considered separately, no studies point out their probable relationship. The new effect of competition on banks' monitoring incentive found in this paper - *efficiency effect* - sheds some light on this problem. In the banking industry, as in any other industry[13], competitive pressure is believed to push firms to look for the most efficient way to organize their operations. This is the productive efficiency benefit, one of three welfare benefits frequently claimed of competition. In this sense, increasing competition is expected to be accompanied with a more efficient monitoring technology, which is beneficial to stability. This argument illustrate the view that if banks are strengthened by the forces of competition, the banking system will be stronger and more resilient.

All in all, both effects on monitoring found in our paper are likely to be present in practice. When the banking sector is highly concentrated, efficiency - improving effect of increasing competitive pressure is likely to be greater than the opposite effect of loan margin reduction. When in the banking market, there is already a great deal of competition, all options to improve efficiency are exhausted, increasing competition would result more in a reduction of loan margin than in an advance of efficiency. Therefore, part (ii) of the proposition (2) is more likely to occur when N is small whereas part (i) is more probable when N is already high. This suggests that the relationship between competition and fragility may be in U-shape.

4.4 Special Cases

In this subsection, we highlight how basic results of the literature can be obtained in our setup and whereby, shed some light on the role of alternative assumptions.

First of all, let us see what happen if we assume, as in the franchise-value framework, that return of banks' assets is independent of the degree of competition. Our setup can be then restated shortly as follows: N banks compete to collect funds from depositors and invest the proceeds in loans. Each unit of loans pays some *exogenous* return r_L in case of success and 0 in case of failure. The loans' probability of success depends on the monitoring intensity chosen privately by banks. With the independence of loans' return, competition affects banks' asset quality only through deposit rate: in (12), by replacing $r'_L(Z^*) = 0$, we get $\frac{dm^*}{dN} < 0$. So, greater competition unambiguously induces worse behaviors of banks. This in turn implies in (13) that banks' solvency probability is lower higher competition is. That is exactly the famous trade - off between competition and stability.

Now, we turn to Boyd and DeNicolo's setup. As we have noted in the introduction, in that setup, banks are treated as passive lenders. They don't have any instruments to mitigate the moral hazard problem arised in their relationship with borrowers. One way to get rid of monitoring in our model is to assume that cross - partial derivative of the private benefit function B_{pm} is negative. Such an assumption implies, as seen in (5), that monitoring does not have any discipline effect. In other words, monitoring technology

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[13]For empirical evidence that individual firms' productivity is higher in more competitive market in manufacturing industry, see Nickell (1996).

becomes useless and thus, in the equilibrium, banks choose a null monitoring intensity (see (6)). Without monitoring, banks' solvency probability is monotonically increasing with the number of banks, as (13) indicated. Thus, with passive banks and a Cournot competition paradigm as Boyd and DeNicolo (2005), all effects of deposit competition on banks' asset quality are ignored.

In summary, two existing frameworks of the literature can be seen as two extreme cases of our setting. In each of those cases, there are always some effects found in this paper that are missing.

5 Capital Requirement as Corrective Device

As the analysis in previous section has shown, the view that competition is unambiguously good or bad for the stability of banking system is too simplistic. The impact of competition on financial fragility can be very complex. Therefore, a more balanced policy approach with respect to banking competition, we believe, would be to find different methods to correct negative effects and promote the positive ones. We distinguish two kinds of corrective effects. *Weak correction* refers to compensation for perverse consequences of competition. *Strong correction* corresponds to change of the sign of the relationship between competition and stability.

Consistently with the growing role of capital requirement in prudential supervision, we examine in this section the effectiveness of this regulation to remedy perverse impacts of competition. In order to do that, we introduce capital regulation into the model of the section 3. We assume that banks must invest some of their own capital to support deposits they mobilize. Let k_i denote the capital invested by bank i, expressed as a fraction of deposits mobilized. By regulation, k_i must be greater or equal to some minimum capital requirement k. The opportunity cost of capital is ρ. We assume that ρ is high enough so that banks will not hold any excess capital (i.e. $k_i = k$)[14]. The view that opportunity cost of banks'capital is high is relevant because otherwise, moral hazard problem in banking could be solved easily. Regulator would simply require banks to hold sufficient capital and banks would willingly comply.

Since the behavior of entrepreneurs when facing a loan rate r_L and a monitoring intensity m is the same as in initial model, the solvency probability of each bank i still equals $p^*(r_L, m_i)$. Its total loans L_i equal $(1 + k)D_i$ and its profit can be written as follows[15]

$$\Pi_i^{CB} = [p^*(r_L, m_i)((1 + k)r_L - r_D) - \rho k - C(m_i)(1 + k)] D_i$$

The optimal monitoring intensity chosen by bank i is now solution to the following condition[16]

$$p^*_{m_i}(r_L, m_i)[(1 + k)r_L - r_D] - C'(m_i)(1 + k) = 0 \tag{14}$$

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[14]This is equivalent to the assumption that ρ is sufficiently higher than $r_L(0)$. The same assumption is made in Hellmann, Murdock and Stiglitz (2000).

[15]The superscript "CB" means capitalized banks.

[16]The associated second order condition is $p^*_{m_i m_i}(r_L, m_i)[(1 + k)r_L - r_D] - C''(m_i)(1 + k) < 0$

Hence, besides the two interest rates, optimal monitoring intensity, denoted now by m_i^C, is also *directly* influenced by the level of capital requirement. This direct effect of capital requirement on monitoring incentives can be determined as follows:

$$\frac{\partial m_i^C}{\partial k} = - \frac{p_{m_i}^*(r_L, m_i^C) r_L - C'(m_i^C)}{p_{m_i m_i}^*(r_L, m_i^C)\left[(1+k)r_L - r_D\right] - C''(m_i^C)(1+k)}$$

From (14), we get

$$\frac{\partial m_i^C}{\partial k} = - \frac{\frac{1}{1+k} p_{m_i}^* r_D}{p_{m_i m_i}^*(r_L, m_i^C)\left[(1+k)r_L - r_D\right] - C''(m_i^C)(1+k)} > 0$$

which means that a higher capital requirement has a positive direct effect on monitoring. The intuition for this positive effect is that banks' capital acts as buffers against risk. When banks invest more their own capital, they have to bear more downside risk, which incites them to behave more appropriately.

However, this is not the whole story yet. Variation of the capital requirement also brings about changes of equilibrium interest rates[17]. Overall effects of the capital requirement on monitoring then depend on the relationship between loan and deposit rates and monitoring incentives. Note that imposing a capital requirement can be seen as imposing an additional cost for deposits[18]. Consequently, when banks' capital is scarce, an increase in the capital requirement may reduce the available amount of deposits and loans in the banking sector, which leads deposit rate to decrease and loan rate to increase. If such a scenario happens, increasing the capital requirement may act as a countervailing force to an increase of competition. It lessens the decrease of loan margins caused by greater competition. Using the terminology proposed above, by increasing the capital requirement, we can obtain a weak correction effect.

Is a strong correction also accessible through an increase in the capital requirement? The answer is provided by the following proposition.

Proposition 3 *In the presence of a capital requirement, the effect of competition on the optimal monitoring intensity of banks is given by:*

$$\frac{\partial m^C}{\partial N} = - \frac{\left((1+k)r_L - r_D\right)(1+k) \, p_{m r_L}^*\left(r_L, m^C\right) r_L' + p_m^*\left(r_L, m^C\right)\left((1+k)^2 r_L' - r_D'\right)}{p_{mm}^*(r_L, m^C)\left((1+k)r_L - r_D\right) - C''(m^C)(1+k)} \frac{\partial Z^C}{\partial N}$$
$$\tag{15}$$

Proof. Implicitly differentiating (14) with respect to N, keeping in mind that r_L and r_D are function of Z^C, immediately yields (15). ∎

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[17]Indeed, with capital requirement, the total deposits Z^C in the symmetric equilibrium are determined by

$$f_Z^C\left(Z^C, k\right) Z^C + N f^C\left(Z^C, k\right) = 0$$

where

$$f^C\left(Z, k\right) = p^*\left(r_L, m_i^C\right)\left[(1+k)r_L\left((1+k)Z\right) - r_D(Z)\right] - \rho k - C(m_i^C)(1+k)$$

Therefore, Z^C is function of both N and k, which implies that r_L and r_D also depend on k.

[18]Without capital requirement, expected cost for one unit of deposit is $p r_D$. With capital requirement k, this expected cost becomes $p r_D + k\left(\rho - p r_L\right) > p r_D$ when $\rho > r_L(0)$.

In proposition 2, we see that when condition (A) does not hold (i.e. $p^*_{mr_L}(.,.) > 0$), there is a negative link between monitoring intensity and the degree of competition in the banking market. In that case, the sign of (15) is also negative whatever the value of k. Hence, increasing capital requirement can not reverse the relationship between competition and monitoring.

Corollary 1 *Increasing the capital requirement can have a weak correction effect but not a strong correction effect*

6   Benefits of Financial Liberalization

Since the last two decades, banking systems all over the world are experiencing a wave of financial liberalization. Its expression can be observed in different ways. Deposit - rate ceilings are lifted. Barriers to entry are reduced, entry of foreign banks is allowed. The wall between banking and non-banking activities is broken down. Restrictions on real estate lending are eliminated. In developing countries, publicly owned banks are privatized; directed credit declines and requirements for special credit allocations to priority sectors are removed. In the European Union, numerous measures are adopted to promote the integration of banking and financial markets.

An immediate consequence of financial liberalization is the erosion of banks' profits. Based on this phenomenon, different papers in the literature (e.g. Hellmann, Murdock and Stiglitz (2000)) claim that financial liberalization might aggravate moral hazard in banking. However this argument ignores two other realities also often associated with the process of financial liberalization.

First, financial liberalization may lead to significant gains in productivity and efficiency, especially in countries where banking system is not very well developed yet. The magnitude of these efficiency gains is empirically established in numerous papers. For instance, Isik and Hassan (2003) examine productivity growth and efficiency change in Turkish commercial banks during the deregulation of financial market in Turkey. They find that all types of Turkish banks have recorded significant productivity gains, driven mostly by efficiency increases. Efficiency increases in turn are mostly owing to the improvement of resource management practices. This last conclusion is very encouraging with respect to the efficiency effect found in our paper. The same upgrade of efficiency is reported in Shyu (1998) for Taiwanese banking system as well as in Bhattacharya et al. (1997) for liberalization process in India.

Second, a market enlargement typically accompanies financial liberalization. As Vives (2001) notes, this market extension comes either from the possibilities of access to international financial markets and market integration, or from an increase in internal demand for financial services once "financial repression" is eliminated. Vives (2001) focuses on larger diversification possibilities implied by market expansion. Here, we want to attract attention to its consequences for the elasticity of deposits supply and loans demand which appear in our condition (B) that we proved to be sufficient for a positive relationship between competition and stability.

7   Concluding Remarks

This paper offers an analysis about the desirability of competition in the banking industry. The main distinction point of our study consists in bringing up the monitoring function of banks in lending relationship with borrowers and then investigating impacts of competition on banks' stability through its impacts on monitoring incentives. We reveal two possible effects of competition on monitoring: attractiveness and efficiency effects. We also identify sufficient condition under which competition will increase monitoring incentives as well as banks' stability. For policy matter, we consider the role of capital requirement as corrective device and show that with such a capital requirement, one can obtain a weak correction but not strong correction.

To keep our analysis tractable, we have made some simplistic assumptions. We here wish to have some more detailed discussion about them. First, in our setup, we choose Cournot paradigm to model the competition between banks. The appropriateness of this paradigm in modeling the competitive behaviors of banks seems to be questioned by the literature examining banking competition under asymmetric information. The main objective of this literature is to study how informational asymmetries among banks affect competitive outcome. More specifically, papers belonging to this literature are interested in characterizing the equilibria emerging in a loan market where banks can use imperfect screening test to assess the ability of potential borrowers to repay and compete to fix interest rate. Broecker (1990) shows that within such a setup, even in the limit, there is always some degree of oligopolistic competition, which contrasts with the findings of classical competition settings. Gehrig (1998) finds that market integration does not necessarily leads to more competition outcome in loan market. More surprisingly, Marquez (2002) obtains the result that increasing the number of banks may push loan rate up as it leads to less efficient screening by banks. Hauswald and Marquez (2005) shows that this result will be reversed if information acquisition is endogenous. *These considerations suggest that trying to construct a more adequate framework to model banking competition may be an interesting agenda for future research. However, we also would like to note that as long as more competition leads to lower loan rate and higher deposit rate - a likely outcome observed in practice, all our qualitative conclusions will hold.*

Another remark concerns the fact that in this paper as well as in all other papers in the literature, the focus is made on the analysis of symmetric equilibria where heterogeneity of banks' size can not be taken into account. However, it seems that the role of size in banking industry is an important issue for two reasons. First, the moral hazard problem is more severe in big banks than in small banks because of "too big to fail" effects. Second, it is much more difficult to supervise a big bank with very complex organization and where the risk of regulatory capture is more likely to be present. These two reasons can lead to criticizing the view that market power could promote financial stability. We leave this question to future research.

A Appendix

To prove the proposition 2, we have to establish two results

  (i) When condition (A) does not hold, the cross - partial derivative $p^*_{mr_L}$ has positive sign

  (ii) When condition (B) is satisfied, the numerator of (12) is positive

Indeed, using (5) and the multiplicative form of the private benefit function $B(p,m)$, we get

$$p^*_m = -\frac{h'(p^*)g'(m)}{h''(p^*)g(m)} \tag{16}$$

Then,

$$p^*_{mr_L} = -\frac{[h''(p^*)h''(p^*) - h'(p^*)h'''(p^*)]\ p^*_{r_L}\ g'(m)\ g(m)}{[h''(p^*)g(m)]^2}$$

Replacing $p^*_{r_L} = \frac{1}{h''(p^*)g(m)}$ (see (4)), we have

$$p^*_{mr_L} = \frac{[h'(p^*)h'''(p^*) - h''(p^*)h''(p^*)]\ g'(m)}{h''(p^*)[h''(p^*)g(m)]^2} \tag{17}$$

Clearly, if $h'''(p)h'(p) > \left[h''(p)\right]^2$ for all p (i.e. (A) does not hold), $p^*_{mr_L}$ will be positive.

  Now return to (ii): the fact that the numerator of (12) is positive is equivalent to

$$p^*_{mr_L}(r_L, m^*)\, r'_L\,(r_L - r_D) > p^*_m(r_L, m^*)\left(r'_D - r'_L\right) \tag{18}$$

Applying (16) and (17), we obtain the equivalence of condition (18) as follows

$$-\frac{h'(p^*)h'''(p^*) - h''(p^*)h''(p^*)}{h'(p^*)\ h''(p^*)} > h''(p^*)g(m^*)\frac{r'_D - r'_L}{r'_L\,(r_L - r_D)} \tag{19}$$

The left - hand side of (19) is exactly $-\dfrac{\ln\left(\left|h'(p^*)\right|\right)''}{\ln\left(\left|h'(p^*)\right|\right)'}$.

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