LSF Research Working Paper Series

N°. 10-11

Date: 2010

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Keywords: banking; spatial competition; screening; credit risk

JEL Classification: G21; D41; D80

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Market structure, screening activity and bank lending behavior

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Abstract

In this paper we construct a theoretical model of spatial banking competition that considers the differential information among banks and potential borrowers in order to investigate how market structure affects the lending behavior of banks and their incentives to invest in screening technology. Consistent with the prevailing view in the relevant literature, our results reveal that competition reduces lending cost, which, in turn, encourages the entry of new customers in the loan market. Also, that the transportation cost that potential borrowers have to pay in order to reach the bank of their interest is decreased with the degree of competitiveness. Importantly, we demonstrate that market structure exerts a considerable positive effect on banks' incentives to screen their loan applicants since banks are found to invest more in screening as competition in the market becomes higher. This is to say, banks resort to screening that serves as a buffer mechanism against bad credit which entails higher risk and which is more likely under competitive conditions. Overall, our findings provide support to a rather close link between the degree of competition, bank lending activity, and the investment of banks in screening technology.

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Acknowledgements: The author would like to thank Iftekhar Hassan, Robert Krainer and Alexis Direr for their valuable suggestions; also, the participants at the 8th Conference on Research on Economic Theory & Econometrics (CRETE) and the 27th Symposium on Money, Banking and Finance for their comments. The usual disclaimer applies.

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1. Introduction

One of the main tasks of banks is to mitigate the informational asymmetries which characterize credit markets. Indeed, banks have incomplete information regarding the creditworthiness of their loan applicants as they can neither observe their individual characteristics nor view their actions. To alleviate this information problem, banks can engage in an arm's length relation with their creditors and protect their credit with collateral, or enter a control-oriented relationship where they can manage credit by conducting credit evaluations which are based on the gathering and processing of valuable information regarding applicants' characteristics. The initiative of banks to rectify informational asymmetries by acquiring private information about the quality of heterogeneous would-be borrowers is widely known as screening.

Following the profound changes in the competitive structure of the banking industry in recent years due to the deregulation process and technological advances, much attention has been lately paid -both in the theoretical and empirical literature- to the relevance of market conditions in the pre-lending screening function of banks. Consistently, Manove et al. (2001) develop a model where banks make a choice between screening the potential borrowers and asking them to pledge collateral.[1] The posting of collateral by borrowers induces banks to overlook screening even though they receive a very accurate signal regarding applicant's creditworthiness. In high levels of competition, the incentives of borrowers to post collateral increase and this makes banks very reluctant to engage in screening. In the context of creditworthiness tests, Cetorelli and Peretto (2000) demonstrate that, as the number of competitors in the banking market declines, the value added that banks attain from screening becomes larger. Simply stated, competition negatively affects banks' willingness to generate information, a view that is perfectly in line with that of Manove et al. (2001). In a similar vein, Hauswald and Marquez (2006) construct a spatial model of banking competition where the quality of a bank's information-acquisition process decreases as the distance separating the borrower from the bank is getting higher. They find that harsh competition -measured in terms of the bank-borrower distance- erodes bank rents and squeezes the resources that lenders devote to screen their applicants. As a consequence, banks become more vulnerable in taking faulty lending decisions. Lehner and Schnitzer (2008) also rely on a spatial competition model to examine how the entry of foreign banks affects the behavior of their local counterparts in markets that are characterized by different degrees of liberalization. They

[1] In this sense, banks view screening and collateral as substitutes.

show that intensified competition due to *de novo* entry of foreign banks tends to lower the incentives of domestic banks to invest in screening technology.

However, not all studies in the relevant literature report a negative impact of competition on banks' incentives to screen their applicant borrowers. For instance, Hainz et al. (2008) study how competition affects the use of collateral in bank credit markets obtaining results that move to the opposite direction of those of Manove et al. (2001). More concretely, they point out that enhanced competition lowers the presence of collateral by making screening more attractive. Put otherwise, they find that the reduction of loan rates due to higher competition is accompanied by an increase in bank screening activity. Along the same lines, Villas-Boas and Schmidt-Mohr (1999) employ a competition model à la Hotelling to show that competition strengthens the incentives of banks to screen their potential borrowers. As argued in their paper, this can be explained by the fact that banks compete more aggressively for the most profitable applicants.

Interestingly, some other studies are not capable of documenting a robust link between the market structure of the banking sector and the incentives of banks to obtain information about the creditworthiness of their loan applicants through screening. Dell' Arricia (2000), for example, shows that this relationship varies depending on which of the following two opposite effects prevails. On the one hand, fierce competition aggravates the adverse selection problem that banks face pushing them to invest more in screening. On the other hand, more competition is linked to higher incentives for banks to deviate from a screening equilibrium, as the extra market share for a deviating bank becomes larger. It therefore turns out that the sign of the examined relationship is determined by the relative strength of the above two contradictory effects. Likewise, Gehrig (1998) investigates the incentives of banks to produce information by allowing them to choose the level of their screening effort. A rather ambiguous and inconclusive result on the relationship between competition and screening is again highlighted. In particular, Gehrig concludes that the direction of this relationship depends on the decision of banks to detect good or bad investment projects.

In brief, it seems that there is no consensus in the extant literature on the relationship that holds between market structure and banks' willingness to screen loan applicants. It is the aim of this paper to shed more light on this issue. Towards this aim, we consider the differential information among intermediaries and borrowers to investigate how bank market structure affects the lending behavior of banks and their incentives to invest in information acquisition through screening. We follow the recent theoretical literature on banking industry structure and informational asymmetries (see, e.g., Dell'Ariccia, 2001; Hyytinen, 2003; Hauswald and Marquez, 2006; Lehner and Schnitzer, 2008) and consider a spatial model of competition à la Salop (1979), where banks and potential loan customers are located symmetrically around a circle.[2] Under this structure, the two classes of players are differentiated on the basis of their location on the circle. Banks compete in prices for entrepreneurial customers who are endowed with an investment project that requires external funding. Entrepreneurs are of the following two extreme types: either 'good' with high-quality projects, or 'bad' with low-quality projects. The game between the players is essentially static and consists of two stages: in Stage 1 banks employ a costly screening mechanism to distinguish good from bad projects in order to offer credit as appropriate. The amount of investment in screening depends on the level of competition and determines the price of credit. Then, in Stage 2, entrepreneurs view bank offers and travel to the bank that satisfies their type to apply for loan.

Our analysis lends support to the view that, when a bank reduces its lending rates, it succeeds in extending its share in the market. This is made by 'poaching' customers from its rivals that turn out to be relatively more expensive. It is also demonstrated that an increase in competition lowers the equilibrium loan rates rendering credit cheaper for all types of entrepreneurs. In simple terms, more entrepreneurs with either good or bad investment projects enter the loan market due to harsher competition. It is further found that when the market structure of the banking industry resembles perfect competition, the traveling cost of borrowers becomes irrelevant in the setting of the optimal loan rate. Importantly, it is showed in our analysis that competition strengthens the incentives of banks to engage in screening activity. In fact, we argue that screening is the device that banks use to protect their operation against bad credit, which entails higher risk and which is more likely under increased competition. On the whole, we demonstrate that market structure, bank lending behavior, and the willingness of banks to invest in screening technology are strongly interrelated with each other.

The rest of the paper is structured as follows. Section 2 lays out the basic model of interbank competition in the loan market with banks engaged in screening activity. Section 3 characterizes

[2] The role of geographical distance in the bank-borrower relationship has been empirically highlighted by the recent works of Petersen and Rajan (2002) and Degryse and Ongena (2005).

the equilibrium and presents the main results of our analysis. The implications of the results are then discussed in Section 4. Finally, Section 5 concludes.

2. Basic framework of the model

As already mentioned, our analysis relies on a model of spatial competition à la Salop (1979). More particularly, we consider a banking market with two classes of players: banks and entrepreneurs. Both players are risk-neutral and live for one period, which is composed of two stages: Stage 1 and Stage 2. Entrepreneurs are located symmetrically around a circle of length 1, and their total mass is normalized to 1. Each entrepreneur is endowed with an indivisible project that requires an investment of a fixed amount of one unit of money. We assume that entrepreneurs have no initial wealth so that if a project is to be initiated, entrepreneurs must obtain credit from banks (thus, the term 'entrepreneurs' will be used interchangeably with that of 'borrowers' in what follows).

An investment project either succeeds with probability $p_\theta \in (0,1]$ yielding a stochastic return $R(p_\theta)>1$[3] or fails with probability $1-p_\theta$ and returns nothing.[4] The parameter θ describes entrepreneurs' type and takes the following two values: $\{h,l\}$, where h stands for experienced and skilful entrepreneurs with high-quality projects, whereas l represents entrepreneurs who are less qualified and have low-quality projects. Consequently, it holds that $p_h>p_l$ and $R(p_h)>R(p_l)>1$, which imply that good projects have a higher probability of success and produce higher returns if compared with bad projects. We thus obtain that $p_h R(p_h) > p_l R(p_l)$, which shows that the expected returns of a good project are always higher than the expected returns of a bad project.

The fraction of good entrepreneurs is equal to q ($0<q<1$), where q is assumed to be common knowledge. That is, both parties know that in each point of the circle's periphery there is a mass q of h-type entrepreneurs and a mass $(1-q)$ of l-type entrepreneurs. As regards the two-point distribution of θ, we assume that it is public information. However, θ *per se* is observable only to entrepreneurs in the beginning of Stage 1. That is, entrepreneurs are aware of the quality of their own projects, whereas this information is not known to banks. Yet, banks have the expertise to

[3] The return must be higher than 1 (unit of money) in order the entrepreneur to have an incentive to invest in the project.
[4] This is to say, p_θ is the repayment (success) probability of the investment project.

determine entrepreneurs' capabilities and uncover the actual quality of their projects. As mentioned later, this is made through screening in our model. Continuing with entrepreneurs, each of them is required to express his preference for a particular type of loan by travelling along the circumference at a per length transportation cost τ_θ>0 to reach the bank that satisfies his type.[5] The idea behind is that entrepreneurs incur some disutility by conducting business with a bank that is not of their type. The distance d_θ>0 that an entrepreneur covers to get to some particular bank is a measure of his disutility to buy a less-than-ideal product (for more on this point, see Schnitzer, 1999). It has to be mentioned here that τ should not be interpreted in strictly geographical terms. Instead, it should be viewed as some type of transaction cost that each credit applicant needs to pay in order to borrow from the bank of his taste. Subsequently, the total cost of buying one unit of money equals to the sum of the bank lending rate (see below) increased by the total transportation cost ($\tau_\theta d_\theta$) the entrepreneur has to sustain to reach the bank of his preference.

Let us now turn to banks. The whole market consists of $n \geq k$ banks (with k being a positive integer), which -like entrepreneurs- are also symmetrically distributed on the unit circle.[6] Banks are profit maximizers and compete in prices (loan interest rates) to attract heterogeneous entrepreneurs who invest in risky projects.[7] As previously described, banks are faced with an informational problem in their lending decision as they do not know the exact type of their loan applicants and thus the quality of the proposed investment projects. They therefore proceed in screening applicant entrepreneurs to obtain their type. Since screening is a costly activity, a bank is capable of identifying the type of its applicants at a cost equal to $e \in (0,1]$ per unit invested.[8] Following Manove et al. (2001), we assume that screening is non-contractible, so that banks cannot sell it to their customers as service; also, that the signal that banks receive from screening is strictly proprietary in that it is not observable to any of the other banks. In case information spillovers were assumed instead, a free-riding problem would arise, which would curtail the

[5] We thus introduce heterogeineity in preferences in the model. This is to say, preferences are assumed to be sufficiently heterogeneous to allow the relocation of the entrepreneurs on the circle.
[6] The assumption that $n \geq k$ safeguards that the number of banks in the market can increase to infinity, but cannot fall below some threshold value k.
[7] To keep our analysis as simple as possible, we do not model competition on the deposit market assuming that the supply of deposits is perfectly elastic at an interest rate that is normalized to zero.
[8] The screening cost e can be alternatively viewed as bank's effort to screen its loan applicants. Thus, a higher e corresponds to a more extensive screening effort.

incentives of banks to undertake screening. This, in turn, would possibly lead to an inefficient credit allocation.[9] To continue, screening technology is perfect in the sense that the signal each bank receives is not noisy.[10] To be more specific, we assume that banks have access to perfect screening technology only above some threshold value of $e>>0$ that may differ amongst banks, but all have an incentive to pay.[11] Without this assumption, banks would prefer investing the smallest possible amount of money ($i.e., e \cong 0$) to screen their applicants, as they could obtain the entrepreneur's true type with the lowest possible cost. Even more, the level of e is particularly relevant for the better understanding of our findings as it will become clear later in the paper.

After distinguishing good from bad entrepreneurs through screening, banks proceed in price discriminate them by offering them a loan interest rate r_θ chosen from the set $\{r_l,, r_h\}$. The lending rate factor r_θ encompasses two main components: the repayment probability of the loan p_θ that reflects entrepreneurs' creditworthiness, and the administrative cost of lending which is assumed to be constant for all types of entrepreneurs and independent of the distance d_θ that separates banks from potential borrowers. Following Chiappori et al. (1995) and Hyytinen (2003), we assume that banks cannot observe the exact location of the entrepreneurs on the circle, which means that price discrimination is not location-based. Put simply, banks do not engage in spatial pricing. By being offered distinct rates, entrepreneurs learn the type that has been assigned to them and travel to the bank that satisfies their type to apply for credit.

The time structure of the game is as follows. At stage 1, banks screen the applicant entrepreneurs and learn their type. Banks then compete for loan customers by simultaneously making them their price offers as appropriate. At stage 2, entrepreneurs observe the loan rates offered, and travel to the bank that offers the contract with the most favorable terms, *i.e.*, the contract that is compatible with their type, to apply for credit.

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9 See Cetorelli and Peretto (2000) for a thorough analysis of the free-riding problem that emerges when the results of the screening process are observable to the rival banks.

10 For recent studies in banking that use imperfect screening technologies, see Hainz et al. (2008) as well as Lehner and Schnitzer (2008).

11 To make this point clear, think of a bank that-conditional on the screening cost e as well as on the other parameters of the model- decides not to pay e to screen a loan applicant. This bank will learn the entrepreneur's type only after the loan has been granted and invested (see Dell' Arricia, 2001). In such a case, the loan might have been granted to a bad entrepreneur with a low-quality project. In the extreme case where all banks but one are engaged in screening, then that particular bank risks serving all the bad entrepreneurs left in the market. This serious threat provides all banks with a strong incentive to screen their applicants at a cost e.

3. Solution

The game is solved by backward induction: we first solve Stage 2 and then Stage 1. As said before, in Stage 2, the entrepreneur views the interest rate offered by each bank and travels to the bank of his interest. For any given loan interest rate r_θ the expected net return of an entrepreneur of type θ is: [12]

$$p_\theta[R(p_\theta)-r_\vartheta]-\tau_\theta d_\theta \tag{1}$$

We can now formulate entrepreneur θ's participation constraint, which safeguards that every entrepreneur has an interest to participate in the loan market. Indeed, an entrepreneur applies for credit only if his expected net profit is nonnegative:

$$p_\theta[R(p_\theta)-r_\theta]-\tau_\theta d_\theta \geq 0 \Leftrightarrow d_\theta \leq \frac{p_\theta[R(p_\theta)-r_\theta]}{\tau_\theta} \tag{2}$$

Since $d_\theta>0$ by definition, it must hold that $\frac{p_\theta[R(p_\theta)-r_\theta]}{\tau_\theta}>0$. It has been assumed that p_θ and τ_θ are larger than zero, which implies that $R(p_\theta)-r_\theta$ must also be larger than zero, *i.e.*, $R(p_\theta)>r_\theta$. This last relation stands for the project's viability constraint and shows that the return of an investment project must always outweigh the lending cost. In fact, condition $R(p_\theta)>r_\theta$ ensures that relation (2) is not violated.

Assuming that (2) holds with equality and solving for the distance variable d_θ, we obtain:

$$d_\theta = \frac{p_\theta[R(p_\theta)-r_\theta]}{\tau_\theta} \tag{3}$$

Equation (3) shows that it is not profitable for the entrepreneur to apply for a loan beyond d_θ. Since entrepreneurs have learnt the type that has been assigned to them in the beginning of Stage

[12] The lending interest rate r_θ is multiplied by p_θ because there is a possibility (1- p_θ) that the loan will not be repaid.

2 when banks have made them a price offer (either r_h or r_l), we can proceed in extracting the following two equations that are produced by (3) for each type of entrepreneurs:

$$d_h = \frac{p_h[R(p_h) - r_h]}{\tau_\theta} \quad (3a)$$

$$d_l = \frac{p_l[R(p_l) - r_l]}{\tau_\theta} \quad (3b)$$

Let us now turn to characterize the Nash equilibrium in the loan market. Our focus is restricted on symmetric equilibrium in location and interest rates.[13] We mentioned before that each of the n banks makes a price offer to the set of potential borrowers. Without loss of generality, we assume that a typical bank j offers a rate r_θ^j, $j=1,2, \ldots, n$ and that the transportation cost τ_θ is small enough (but not equal to 0) for the banking market to be wholly covered. In this scheme of things, bank j is located equidistantly between banks $j+1$ and $j-1$ that charge r_θ^{j+1} and r_θ^{j-1}, respectively. An entrepreneur of type θ located at a distance $d_\theta \in (0,1/n]$ from bank j is indifferent between borrowing from j and borrowing from its nearest neighbor, say $j+1$, if:

$$p_\theta[R(p_\theta) - r_\theta^j] - \tau_\theta d_\theta = p_\theta[R(p_\vartheta) - r_\theta^{j+1}] - \tau_\theta(\frac{1}{n} - d_\theta) \quad (4)$$

Relation (4) stands for the indifference condition of the game and shows the exact location of the type-θ marginal borrower.[14] Solving (4) for d_θ yields:

$$d_\theta(r_\theta^j, r_\theta^{j+1}) = \frac{1}{2n} + \frac{p_\theta(r_\theta^{j+1} - r_\theta^j)}{2\tau_\theta} \quad (5)$$

[13] Hence, we do not examine collusive equilibria as those sustainable with trigger strategies.
[14] The marginal borrower of type θ is located half-way between bank j and bank $j+1$.

Hence, bank *j* faces the following demand for loans:

$$L_\theta^j(r_\theta^j, r_\theta^{j+1}) = 2d_\theta = \frac{1}{n} + \frac{p_\theta(r_\theta^{j+1} - r_\theta^j)}{\tau_\theta} \qquad (6)$$

From the expression $2\,d_\theta$ in (6), we can infer that there exist two marginal borrowers: one on the left, and one the right. Also notice that for $r_\theta^j = r_\theta^{j+1}$, we get that $d_\theta = \frac{1}{2n}$, which corresponds to the mid-point between the two adjacent banks *j* and *j+1*. Moreover, we obtain that $L_\theta^j = \frac{1}{n}$, which implies that the *n* banks would be equally sharing the borrower population. Like in the Salop's (1979) model, the ratio $\frac{1}{n}$ stands for a measure of bank's market power.

It is obvious from relation (6) that the loan demand function of bank *j* is declining in its own rate r_θ^j and increasing in its rival's rate r_θ^{j+1}. This means that the bank *j* can attract a larger number of customers if it lowers its lending rate. The converse also holds true, *i.e.*, an increase in the lending rate factor is enough to compel borrowers to move away from the relatively more expensive bank. Most importantly, neither the number of banks *n*, nor the level of transferring cost τ_θ vitiates the power of this finding. In other words, borrowers travel to the cheaper bank regardless of the degree of competition and the cost of traveling.

As already said, each bank prices borrowers on the basis of their type. Consequently, for $\theta=h$, the loan demand function (Eq. 6) takes the following form:

$$L_h^j(r_h^j, r_h^{j+1}) = 2d_h = \frac{1}{n} + \frac{p_h(r_h^{j+1} - r_h^j)}{\tau_\theta} \qquad (6a)$$

Correspondingly, for $\theta=l$ we get:

$$L_l^j(r_l^j, r_l^{j+1}) = 2d_l = \frac{1}{n} + \frac{p_l(r_l^{j+1} - r_l^j)}{\tau_\theta} \qquad (6b)$$

We now turn to consider Stage 1. The optimization problem of bank j can be viewed as choosing the optimal lending rates r_h^{*j} and r_l^{*j} by appropriately pricing heterogeneous borrowers through the screening mechanism, given similar choices of the other banks. Bank j's expected net returns per unit of loans granted to h-type and l-type borrowers are:

$$u_h^j(r_h^j) = qp_h r_h^j - (1+e) \tag{7a}$$

and

$$u_l^j(r_l^j) = (1-q)p_l r_l^j - (1+e) \tag{7b}$$

So, bank j solves the following maximization problem:

$$\max_{r_h^j, r_l^j} \pi^j = u_h^j(r_h^h) L_h^j(r_h^j, r_h^{j+1}) + u_l^j(r_l^j) L_l^j(r_l^j, r_l^{j+1}) \tag{8}$$

Substituting (6a), (6b), (7a), and (7b) into (8), we obtain:

$$\max_{r_h^j, r_l^j} \pi^j = [qp_h r_h^j - (1+e)][\frac{1}{n} + \frac{p_h(r_h^{j+1} - r_h^j)}{\tau_\theta}]$$

$$+[(1-q)p_l r_l^j - (1+e)][\frac{1}{n} + \frac{p_l(r_l^{j+1} - r_l^j)}{\tau_\theta}] \tag{9}$$

We now move to differentiate the profit function with respect to r_h^j and r_l^j. The symmetric price equilibrium is obtained by setting $r_h^j = r_h^{j+1}$ and $r_l^j = r_l^{j+1}$ (the proof is relegated to the Appendix):

$$r^{*j}_h = \frac{1}{p_h}[\frac{\tau_h}{n} + \frac{(1+e)}{q}], \text{ when } \theta = h \tag{10a}$$

$$r^{*j}_l = \frac{1}{p_l}[\frac{\tau_l}{n} + \frac{(1+e)}{(1-q)}], \text{ when } \theta = l \tag{10b}$$

Proposition 1 *An increase in competition reduces the equilibrium loan rate no matter the type of the borrower.*

Proof The first order conditions of (10a) and (10b) with respect to *n* are $\frac{\partial r^{*j}_{h}}{\partial n} = -\frac{\tau_h}{p_h n^2} < 0$ and $\frac{\partial r^{*j}_{l}}{\partial n} = -\frac{\tau_l}{p_l n^2} < 0$, respectively. Hence, both r^{*j}_{h} and r^{*j}_{l} decrease with the number of banks *n*, which means that the level of competition is negatively related with the equilibrium lending rates regardless of the entrepreneurs' type. This proposition is in line with the mainstream view that provides support to the negative relationship that holds between the degree of competition and the cost of lending. For instance, Boyd and De Nicolo (2005) and De Nicolo and Loukoianova (2007) find that banks charge lower loan rates when competition is increased and this is a counter-incentive in the borrowers' risk-taking decision. Whereas the effect of market structure on bank credit risk cannot be inferred from the present proposition, it can be argued, however, that competition's impact on the equilibrium rates is uniform across the two types of borrowers, *i.e.*, both good and bad entrepreneurs face lower rates under enhanced competition. In accordance, as competition increases, a larger number of entrepreneurs (of any type) are expected to enter the lending market attracted by the lower interest rates. That is, not only good but also bad projects with lower probability of success and thus higher risk are to be proposed to the banks for potential funding.

Proposition 2 *In high levels of competition transportation cost is irrelevant in the setting of the optimal loan rate*

Proof Again, by looking at the first order conditions of (10a) and (10b) with respect to the number of banks *n*, we can infer that when *n*>>0, we get that $\tau_\theta / n \approx 0$ where $\theta \in \{h, l\}$. This means that in a very competitive loan market where *n* is sufficiently large, the particular type and level of transportation cost τ_θ plays no role in the optimal rate setting. Any additional bank entry that would drive the market further closer to perfect competition ($n \to \infty$) would strengthen the power of this proposition ($\tau_\theta / n \to 0$).

Proposition 3 *Screening serves as a buffer mechanism for banks against credit risk*

Proof Suppose there is the maximum possible heterogeneity between borrowers in the economy, *i.e.*, $q = \frac{1}{2}$. Substituting $q = \frac{1}{2}$ to (10a) and (10b) produces $r_h^{*j} < r_l^{*j}$ since $\frac{1}{p_h}[\frac{\tau_h}{n} + 2(1+e)] < \frac{1}{p_l}[\frac{\tau_l}{n} + 2(1+e)] \Rightarrow p_h > p_l$, which holds by assumption. The inequality $r_h^{*j} < r_l^{*j}$ implies that the bank offers a low loan interest rate r_h^{*j} to good entrepreneurs with high-quality projects and a higher loan rate equal to r_l^{*j} to their bad counterparts. This happens because banks screen would-be borrowers and learn their type and thus the probability of success p_θ of their investment projects. Since p_θ, which is a component of r_θ -together with the administrative cost of lending which, as mentioned above, remains unchanged between the two types of borrowers-, is lower for bad projects (*i.e.*, $p_l < p_h$) , the bank charges bad borrowers with a higher rate in order to be protected against a higher credit risk. This is to say, screening is not only a useful tool for banks to price discriminate investment projects properly, but also an effective device against excessive risk-taking as it provides a buffer against loan losses.

Proposition 4 *Competition induces banks to invest more in screening*

Proof Relation (10a) can be written as follows:

$$r^{*j}_h = \frac{\tau_h}{np_h} + \frac{(1+e)}{qp_h} \Leftrightarrow r^{*j}_h = \frac{\tau_h q + n + ne}{nqp_h} \Leftrightarrow n(1+e) = nqp_h r^{*j}_h - \tau_h q \Leftrightarrow e = qp_h r^{*j}_h - \frac{\tau_h q}{n} - 1$$

If we compute the first derivative of the above equation with respect to n, we get: $\frac{\partial e}{\partial n} = \frac{\tau_h q}{n^2}$, which is positive since $\tau_h q > 0$, (τ_h, q>0, by assumption).[15] Hence, the greater the number of competitors in the banking market, the larger the screening cost that each one incurs. In simple terms, this proposition implies that banks invest more in screening technology when competition increases. Put differently, under mounting competition, banks are willing to pay a

[15] It is straightforward that we obtain the same results if, following the same process, we differentiate (10b) -instead of (10a)- with respect to n.

higher test cost *e* to obtain the true type of their credit applicants. That is, the threshold value of *e* for each bank which ensures the perfect screening outcome increases due to intense competition. The present proposition is in agreement with the results of the studies of Hainz et al. (2008) and Villas-Boas and Schmidt-Mohr (1999), but stands in sharp contrast to those of Manove et al. (2001), Hauswald and Marquez (2006) and Lehner and Schnitzer (2008) who find that intense competition reduces the rents of banks and decreases their overall incentives to screen their credit applicants. The proposition is also in direct conflict with the view of Cetorelli and Peretto (2000), who, though relying upon the assumption that screening information is transferable and not proprietary (like in the current analysis), demonstrate that competition negatively affects banks' willingness to generate information.

4. Discussion

In this section, we synopsize the key results found in the above analysis and discuss their main implications. To begin with, our results provide support to the view that a bank which reduces its lending rate can increase its market share by poaching customers from other banks that turn out to be relatively more expensive.[16] Conversely, the initiative of a bank to raise its loan rate shrinks bank's clientele that seeks to travel to some relatively cheaper bank. Notably, the current implication is independent of the degree of competition in the banking market. In addition, the power of this implication is not restricted in the neighborhood of the cheaper institutions. This is to say, transportation cost plays no role in the decision of entrepreneurs to travel to (move away from) a bank that decreases (increases) its lending rates.

Our findings also suggest that competition has a considerable impact on the cost at which credit is available. In particular, a decreasing relationship between the number of banks and the level of equilibrium lending rates is reported. Hence, a larger number of banks give rise to intensive price competition in the banking market, which ends up lowering credit cost. Interestingly, all borrowers can potentially take advantage of this reduction. To sum up, the interest rate paid by either type of borrower decreases as the market structure of the banking sector becomes more competitive.

[16] The rationale behind borrower poaching can be traced in the study of Bouckaert and Degryse (2006) as well as that of Hauswald and Marquez (2006).

To continue, the importance of transportation cost in the setting of the equilibrium loan rates declines as the number of banks increases. The lowering significance of transportation cost as a result of fierce competition coupled with the previous finding indicates that competition reduces loan interest rates since it shrinks the average distances between all possible combinations of borrowers and neighboring banks. Overall, as the cost of lending declines more entrepreneurs are expected to enter the market, which implies that intensified competition leads to a greater openness in the loan market.

Moreover, we document an increase in banks' screening cost as a result of the increased competition in the lending market.[17] The interpretation to be placed upon this finding is that the level of credit risk that banks are dealing with in a competitive industry tends to be higher. This occurs because banks are more prone to make mistakes in their lending decisions as the number of credit applicants (and thus of bad applicants) increases due to intensified competition (as mentioned in the previous paragraph). If banks are to be protected from taking more credit risk, they have to invest a higher amount in screening technology. This is to say, screening is the device that banks can use to efficiently collect borrower-specific information. Screening acts as a buffer mechanism against credit risk which becomes higher due to the enhanced presence of bad entrepreneurs in the lending market. Our interpretation here is reinforced by the view of Acharya et al. (2006) according to which the informational effectiveness of financial institutions is lower in highly competitive markets. As a consequence, banks become more willing to incur a higher screening cost so as to maintain the quality of information production.

To sum up, our results demonstrate that market structure, bank lending behavior, and the incentives of banks to invest in information acquisition are strongly interrelated. In particular, we document that a competitive banking industry provides cheaper credit to potential borrowers by setting lower loan rates. Regarding the number of would-be borrowers, it is expected to be larger compared to that in less competitive markets. By dealing with a larger number of loan applicants, banks invest more in screening technology to be protected from bad applicants, who entail higher credit risk.

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[17] We acknowledge that several other factors like, for example, the composition of loans, bank size, and ownership status might also have an influence on screening incentives. However, the present analysis focuses on the link between industry structure and the screening activity of banks. An investigation of the relevance of other factors - like those mentioned above- is rather out of the scope of our analysis and is thus left as an exercise for the interested reader.

5. Concluding remarks

One of the not well-defined relations in the banking literature is that between market structure, bank lending behavior and screening activity. In this paper, we make an attempt to partly fill this literature gap by employing a model of spatial competition that incorporates the informational asymmetries which exist between banks and potential borrowers in order to examine the impact of industry structure on the lending behavior of banking institutions as well as on the screening technology that these institutions use to soften the information problem they are faced with.

Several appealing results are delivered which demonstrate that market structure, bank lending behavior, and banks' incentives to invest in screening are largely interlinked. First, we find that a bank can extend its market share by lowering its lending rate. The idea behind this result is rather straightforward: a cheaper bank poaches customers from its competitors thus gaining a substantial share in the market. We further provide support to the mainstream view that greater competition reduces lending cost. Yet, what is more enlightening in this finding is that competition exerts a negative effect on the price of credit for all types of entrepreneurs in our model, that is both good and bad ones. In addition, we document that transportation cost becomes less important in the setting of the equilibrium loan rates as competition increases. By taking a more holistic view of the previous two results, we could argue that our analysis provides support to the view that competition has a downward effect on the equilibrium loan rates whereas at the same time it makes easier for potential borrowers to travel to the banks that satisfy their type as it reduces transaction costs. This fall in the total cost of credit favors the access of an increased number of entrepreneurs to the loan market.

Importantly, we show that banks invest more in screening as a result of higher competition. The explanation we offer is that banks are more easily mistaken in their lending decision as the number of credit applicants increases due to enhanced competition. Therefore, banks resort to screening as they try to get protected against bad entrepreneurs who incur higher credit risk. Overall, in this paper we provide strong theoretical evidence of a clear link that exists between market structure, bank lending, and screening which has a direct influence on the risk-taking behavior of banks and which is very likely to also affect bank performance when measured in terms of loan productivity and profitability.

Appendix

Relation (9) can be written as follows:

$$\max_{r_h^j, r_l^j} \pi^j = \frac{qp_h r_h^j}{n} + \frac{qp_h^2 r_h^j r_h^{j+1} - qp_h^2 (r_h^j)^2}{\tau_h} - \frac{1}{n} - \frac{p_h r_h^{j+1} - p_h r_h^j}{\tau_h} -$$

$$- \frac{e}{n} - \frac{ep_h r_h^{j+1} + ep_h r_h^j}{\tau_h} + \frac{p_l r_l^j}{n} + \frac{p_l^2 r_l^j r_l^{j+1} - p_l^2 (r_l^j)^2}{\tau_l} -$$

$$- \frac{qp_l r_l^j}{n} - \frac{qp_l^2 r_l^j r_l^{j+1} + qp_l^2 (r_l^j)^2}{\tau_l} - \frac{1}{n} - \frac{p_l r_l^{j+1} + p_l r_l^j}{\tau_l} -$$

$$- \frac{e}{n} - \frac{ep_l r_l^{j+1} + ep_l r_l^j}{\tau_l} \tag{I}$$

To obtain bank *j*'s optimal loan interest rate for the *h*-type borrowers, we calculate the first order conditions of (I) with respect to r_h^j:

$$\frac{\partial \pi^j (r^j, r^{j+1})}{\partial r_h^j} = 0 \Rightarrow \frac{qp_h}{n} + \frac{qp_h^2 r_h^{j+1} - 2qp_h^2 r_h^j}{\tau_h} + \frac{p_h}{\tau_h} + \frac{ep_h}{\tau_h} = 0 \Leftrightarrow$$

$$\Leftrightarrow \tau_h q + nqp_h r_h^{j+1} - 2nqp_h r_h^j + n + ne = 0$$

To obtain the symmetric Nash equilibrium we set $r_h^j = r_h^{j+1}$:

$$nqp_h r_h^j = \tau_h q + n(1+e) \Leftrightarrow r_h^j = \frac{\tau_h}{np_h} + \frac{(1+e)}{qp_h} \Leftrightarrow r_h^j = \frac{1}{p_h}[\frac{\tau_h}{n} + \frac{(1+e)}{q}]$$

We work in a similar way to get the optimal loan rate for the *l*-type borrowers:

$$\frac{\partial \pi^j (r^j, r^{j+1})}{\partial r_l^j} = 0 \Rightarrow \frac{p_l}{n} + \frac{p_l^2 r_l^{j+1} - 2p_l^2 r_l^j}{\tau_l} - \frac{qp_l}{n} - \frac{qp_l^2 r_l^{j+1} + 2qp_l^2 r_l^j}{\tau_l} + \frac{p_l}{\tau_l} + \frac{ep_l}{\tau_l} = 0 \Leftrightarrow$$

$$\Leftrightarrow \tau_l + np_l r_l^{j+1} - 2np_l r_l^j - \tau_l q - nqp_l r_l^{j+1} + 2nqp_l r_l^j + n + ne = 0$$

We now set $r_l^j = r_l^{j+1}$:

$$np_l r_l^j - nqp_l r_l^j = \tau_l(1-q) + n(1+e) \Leftrightarrow r_l^j = \frac{t_l}{np_l} + \frac{(1+e)}{p_l(1-q)} \Leftrightarrow r_l^j = \frac{1}{p_l}[\frac{\tau_l}{n} + \frac{(1+e)}{(1-q)}]$$

References

Acharya, V.V., Hasan, I., Saunders, A., 2006. Should banks be diversified? Evidence from individual bank loan portfolios. Journal of Business 79, 1355-1412.

Bouckaert, J., Degryse, H., 2006. Entry and Strategic Information Display in Credit Markets. Economic Journal 116, 702-720.

Boyd, J.H., De Nicolò, G., 2005. The theory of bank risk taking and competition revisited. Journal of Finance 60, 1329-1343.

Cetorelli N.,Peretto, P.F., 2000. Oligopoly banking and capital accumulation. Federal Reserve Bank of Chicago Working Paper Series WP/00/12.

Chiappori, P.A., Perez-Castrillo, D., Verdier, F., 1995. Spatial competition in the banking system, localisation, cross-subsidies and the regulation of interest rates. European Economic Review 39, 889-918.

De Nicolò, G., E. Loukoianova, 2007. Bank ownership, market structure and risk. IMF Working Paper WP/07/215.

Degryse, H., Ongena, S., 2005. Distance, lending relationships and competition. Journal of Finance 60, 231-266.

Dell'Ariccia, G., 2000. Learning by lending, competition, and screening incentives in the banking industry. IMF mimeo

Dell'Ariccia, G., 2001. Asymmetric information and the structure of the banking industry. European Economic Review 45, 1957-1980.

Gehrig, T., 1998. Screening, cross-border banking, and the allocation of credit. Research in Economics 52, 387-407.

Hainz, C., Weill, L., Godlewski, C.J., 2008. Bank competition and collateral: Theory and evidence. Bank of Finland Research Discussion Papers 27.

Hauswald, R., Marquez, R., 2006. Competition and strategic information acquisition in credit markets. The Review of Financial Studies 19, 967-1000.

Hyytinen, A., 2003. Information production and lending market competition. Journal of Economic and Business 55, 233-253.

Lehner, M., Schnitzer, M., 2008. Entry of foreign banks and their impact on host countries. Journal of Comparative Economics 36, 430-452.

Manove, M.A., Padilla, J., Pagano, M., 2001. Collateral versus project screening: A model of lazy banks. Rand Journal of Economics 32, 726-744.

Petersen, M., Rajan, R., 2002. Does distance still matter? The information revolution in small business lending. Journal of Finance 57, 2533–2570.

Salop, S. C., 1979. Monopolistic competition with outside goods. Bell Journal of Economics 10, 141-156.

Schnitzer, M., 1999. Enterprise restructuring and bank competition in transition economies. Economics of Transition 7, 133-155.

Villas-Boas, J.M., Schmidt-Mohr, U., 1999. Oligopoly with asymmetric information: Differentiation in credit markets. The RAND Journal of Economics 30, 375-396.