Market structure, screening activity and the lending behaviour of banks

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Abstract

In this paper, we use a spatial model of industrial organization that considers the differential information among banks and potential borrowers to investigate how competition affects the lending behavior of banks and their incentives to invest in screening technology. Our analysis suggests that by lowering its lending rate a bank can extend its market share by 'poaching' customers from the rival banks that turn out to be relatively more expensive. Moreover, that enhanced competition has a negative effect on the demand for loans of individual banks. Consistent with the prevailing view, our results further show that a larger number of banks reduces lending cost, which, in turn, encourages the entry of new customers in the loan market. Also, that market structure has an important impact on banks' incentives to screen loan applicants. In particular, we find that banks invest more in screening as a result of higher competition. This is largely explained by the fact that banks are more easily mistaken in their lending decisions when the number of credit applicants increases due to intensified competition. Consequently, banks resort to screening in order to efficiently protect themselves against excessive credit risk. Overall, our results provide support to a rather close relationship between the industry structure, the lending activity of banks, and bank investment in screening technology.

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1. Introduction

One of the main tasks of banks is to mitigate informational asymmetries which characterize credit markets. Indeed, banks have incomplete information regarding the creditworthiness of their loan applicants as they can observe neither their special features nor their actions. To alleviate this information problem, banks either 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 known as screening.

Following the profound changes in the structure of the banking industry in recent years, much attention has been paid in the theoretical and empirical literature to the pre-lending screening function of banks. Manove et al. (2001) develop a model where banks have to 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, borrowers are more willing to post collateral rendering banks more 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 from screening increases for banks. Hence, competition negatively affects banks' willingness to generate information, which is in line with the view of Manove et al. (2001). Similarly, 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 that separates the borrower from the bank becomes larger. They find that harsher 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. Further, 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 characterized by different levels 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 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. Their results move to the opposite direction of those of Manove et al. (2001). Specifically, they point out that enhanced competition lowers the presence of collateral by making screening more attractive. In other words, the reduction of loan rates due to higher competition is accompanied by an increase in bank screening activity. In a similar vein, Villas-Boas and Schmidt-Mohr (1999) employ a Hotelling model to show that competition increases the incentives of banks to screen their potential borrowers. As they argue, this can be explained by the fact that banks compete more aggressively for the most profitable applicants.

Still, other studies are not capable of documenting a robust relationship 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, fiercer competition aggravates the adverse selection problem that banks face making them to invest more in screening. On the other hand, more competition is related to higher incentives for banks to deviate from a screening equilibrium, as the extra market share for a deviating bank is larger. It turns out that the sign of the examined relationship depends on 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 relationship between competition and screening is highlighted. In particular, he finds that the sign of this relationship depends on whether banks are mainly concerned with detecting good or bad investment projects.

In short, 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 relationship. In particular, we take into account the differential information among intermediaries and borrowers to investigate how the industry structure affects the lending behavior of banks and their incentives to invest in information acquisition through screening. To this aim, we follow the recent theoretical literature on bank competition (see, e.g., Dell'Ariccia, 2001; Hyytinen, 2003; Hauswald and Marquez, 2006; Lehner and Schnitzer, 2008) and consider a spatial model of industrial organization a la Salop (1979), where banks and customers are located symmetrically around a circle.[2] This is to say, 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. Regarding entrepreneurs, these are of the following two extreme types: either 'good' with high-quality projects, or 'bad' with low-quality projects. The game is essentially static and consists of two stages: In Stage 1, banks employ a costly screening mechanism to distinguish good from bad entrepreneurs in order to offer credit as appropriate. Then, in Stage 2, entrepreneurs view bank offers and travel to the bank that maximizes their utility.

Our analysis suggests that intensified competition lowers the demand for loans of individual banks. This happens because in a more competitive environment the total loan demand is distributed among a larger number of participants. Moreover, results lend support to the view that, when a bank reduces its lending rates, it extends its market share by 'poaching' customers from its rivals that turn out to be relatively more expensive. We further find that an increase in competition lowers the equilibrium loan rates rendering credit cheaper for all types of entrepreneurs. As a result, more entrepreneurs enter the loan market due to harsher competition. Another finding of our analysis is that, when the market structure of the banking industry gets closer to perfect competition, the traveling cost of borrowers becomes irrelevant in the setting of the optimal loan rate. This reveals the decline of the average distances between banks and borrowers under competitive market conditions. Importantly, we show that screening comprise the device that banks choose to use in order to efficiently protect themselves against bad entrepreneurs who are found to be less capable of sustaining credit cost compared to the good ones. 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 proceeds 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 the equilibrium and presents the main results of our analysis.

[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 implications of the results are then discussed in Section 4. Finally, Section 5 draws the conclusions of the paper paving the way for further research.

2. Basic framework of the model

As already mentioned, our analysis relies on a model of spatial competition a la Salop (1979). More particularly, we consider a banking market with two classes of players: banks and entrepreneurs. Both are risk-neutral profit maximizers 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 $R(p_\theta)>0$, or fails with probability $1-p_\theta$ and returns nothing.[3] The return function is assumed to be increasing in p_θ, i.e., $R'(p_\theta)>0$. The parameter $\theta>0$ describes entrepreneurs' type and takes the following two values: $\{l,h\}$, where h stands for experienced and skilful entrepreneurs with high-quality projects, while l represents entrepreneurs who are less qualified and have low-quality projects. It is thus straightforward that $l<h$. As a consequence: $p_l<p_h$, and $R(p_l)<R(p_h)$, i.e., good projects have a higher probability of success and also produce higher returns. It therefore holds that $p_l R(p_l) < p_h R(p_h)$, 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, this is assumed to be public information. However, θ *per se* is observable only to entrepreneurs in the beginning of Stage 1. That is, applicants can observe their own type, whereas this information is

[3] p_θ is the repayment probability of the investment project.

unknown to banks. Yet, banks have the expertise to determine entrepreneurs' capabilities and discover the actual quality of their projects. In other words, banks can uncover such information and, in turn, assign entrepreneurs their type θ.

Continuing with entrepreneurs, each of them has preferences over a particular type of loan and travels along the circumference at a per length transportation cost $\tau>0$ to reach the bank that satisfies his type. The idea here is that entrepreneurs incur some disutility by conducting business with a bank that is not of their type. The distance $d \geq 0$ that an entrepreneur covers to get to some particular bank is a measure of his disutility to buy a less-than-ideal product (see Schnitzer, 1999). It has to be mentioned at this point that τ should not be interpreted in strictly geographical terms. Instead, τ should be viewed as a 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 increased by the unit transportation cost the entrepreneur has to sustain to reach the bank of his preference.

Let us now turn to banks. The whole market consists of $n\geq 2$ banks which -like entrepreneurs- are also symmetrically distributed on the unit circle and compete in prices (loan interest rates) to attract heterogeneous entrepreneurs who invest in risky projects. As previously mentioned, 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 their investment projects. Banks therefore proceed in screening applicant entrepreneurs to obtain their type.[4] Since screening is a costly activity, a bank can identify the type of its potential borrowers at a cost equal to $e \in (0,1]$ per unit invested.[5] Following Manove et al. (2001), we assume that screening is non-observable and non-contractible, so that banks cannot sell it to their customers as service. Moreover, screening technology is assumed to be perfect in the sense that the signal each bank receives is not noisy.[6] In fact, banks have access to perfect screening technology only above some threshold value of e that may differ amongst banks, but

[4] Recall that entrepreneurs are penniless. If this would not be the case, then banks could ask entrepreneurs to post collateral and this would reduce the incentives of banks to screen, as they would be partly protected from the consequences of funding a low-quality project.
[5] 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.
[6] For recent studies in banking that use imperfect screening technologies, see: Hainz et al. (2008) and Lehner and Schnitzer (2008).

that all banks have an incentive to pay. [7] Without this last assumption, all banks would prefer investing the smallest possible amount of money (i.e., $e \approx 0$) to screen their applicants, as all of them could obtain the entrepreneur's true type with the lowest possible cost. Even more, the magnitude of e is relevant for the better understanding of our findings as it will become clear later. This signal that banks receive is strictly proprietary; that is, it is not observable to any of the other banks. In case information spillovers were assumed, a free-riding problem would arise, which would curtail the incentives of banks to undertake screening. This, in turn, would possibly lead to an inefficient credit allocation.[8]

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 physical distance that separates banks from potential borrowers. It is thus clear that banks cannot determine the exact location of the entrepreneurs, which means that price discrimination is not location-based. In other words, banks do not engage in spatial pricing (see Chiappori et al., 1995; Hyytinen, 2003). 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 game has the following time structure. At stage 1, banks screen the applicant entrepreneurs and learn their type. Banks then compete for customers by simultaneously make 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 and maximizes their utility. Apparently, in case two banks make the same offer, entrepreneurs choose the one which is nearer. Moreover, an entrepreneur is indifferent

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[7] Assume that a bank decides not to pay *e* to screen a loan applicant; this means that it will learn his 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 that returns nothing. 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. Under this fear, all banks have incentives to screen their applicants at a cost equal to *e*.

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

between two banks in case he has to pay the same total cost (recall that total cost is the sum of the loan rate paid to the bank plus the transferring cost).

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.

3. Solution

The game is solved by backward induction. Thus, consider first Stage 2 and the entrepreneur's optimization problem. As said before, in Stage 2, the entrepreneur maximizes his utility from the investment project. To ensure that we will obtain an interior solution to this problem, we assume that the return function is concave, i.e., $R''(p_\theta) \leq 0$, and also that $R(0) < R'(0)$. Accordingly, the problem that the entrepreneur solves reads as follows:[9]

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

Relation (1) describes the maximum expected net profit that an entrepreneur of type θ can get for any given loan interest rate r_θ. By differentiating (1) with respect to p_ϑ, we get the following first order condition:

$$R(p_\theta) - p_\theta R'(p_\theta) - r_\theta = 0 \Leftrightarrow p_\theta = \frac{R(p_\vartheta) - r_\vartheta}{R'(p_\theta)} \tag{2}$$

Since $p_\theta > 0$ and $R'(p_\theta) > 0$ by assumption, $R(p_\theta) - r_\theta$ must be also larger than zero,i.e., $R(p_\theta) > r_\theta$, which implies that for a type-θ borrower to maximize his profits from the investment project, the return of the project must outweigh the lending cost. This last relation describes the project's viability constraint.

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

[9] 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.

$$p_\theta[R(p_\theta) - r_\theta] - \tau d_\theta \geq 0 \qquad (3)$$

Assuming that (3) holds with equality and solving for the distance variable d_θ, we obtain that:

$$d_\theta = \frac{p_\theta[R(p_\theta) - r_\theta]}{\tau} \qquad (4)$$

Equation (4) says 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 2 when banks have made them a price offer (either r_h, or r_l), we obtain the following two equations that are produced by (4) for each type of entrepreneur:

$$d_h = \frac{p_h[R(p_h) - r_h]}{\tau} \qquad (4a)$$

$$d_l = \frac{p_l[R(p_l) - r_l]}{\tau} \qquad (4b)$$

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. 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 is small enough 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:

$$p_\theta[R(p_\theta) - r_\theta^j] - \tau d_\theta = p_\theta[R(p_\vartheta) - r_\theta^{j+1}] - \tau(\frac{1}{n} - d_\theta) \qquad (5)$$

The indifference condition (5) shows the exact location of the type-θ marginal borrower.[10] Solving equation (5) for d_θ yields:

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

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

$$L_\theta^j(r_\theta^j, r_\theta^{j+1}) = 2d_\theta = \frac{1}{n} + \frac{p_\theta(r_\theta^{j+1} - r_\theta^j)}{\tau} \tag{7}$$

In case $r_\theta^j = r_\theta^{j+1}$, we get $L_\theta^j = \frac{1}{n}$, which implies that the *n* banks would be equally sharing the borrower population. In Salop's (1979) model, the ratio $\frac{1}{n}$ stands for a measure of bank's market power.

Proposition 1 *A bank attracts more customers by lowering its lending rate, whereas the converse holds true.*

Proof 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 is to say, by reducing its loan rate a bank can attract a larger number of borrowers. This result can also be reversed: an increase in the lending rate factor is enough to compel borrowers to move away from the expensive bank. Most importantly, neither the number of banks *n*, nor the level of transferring cost τ vitiates the potency of this proposition. This is to say, borrowers travel to the cheaper bank regardless of the degree of competition and the cost of traveling.

As already said, each bank prices borrowers according to their type. Consequently, for $\theta=h$, the loan demand function (Eq. 7) takes the following form:

[10] The marginal borrower is located half-way between bank *j* and bank *j+1*.

$$L_h^j(r_h^j, r_h^{j+1}) = 2d_h = \frac{1}{n} + \frac{p_h(r_h^{j+1} - r_h^j)}{\tau} \qquad (7a)$$

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

$$L_l^j(r_l^j, r_l^{j+1}) = 2d_l = \frac{1}{n} + \frac{p_l(r_l^{j+1} - r_l^j)}{\tau} \qquad (7b)$$

Proposition 2 *An increase in the number of competitor banks lowers the loan demand of individual banks*

Proof This proposition describes the impact of competition on the lending activity of individual banks. Relations (7a) and (7b) decrease in the number of banks, *n*, in the market. This implies that a higher degree of competition in the banking market lowers the loan demand in each individual bank. More precisely, as more competitors enter the banking sector, the demand for loans of individual banks declines as total demand is now splitted into a larger number of banks. However, the reader should be very careful not to infer that the *aggregate* loan demand also shrinks as a result of enhanced competition since (7a) and (7b) do not refer to equilibrium.

Let us now 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 $u_h^j(r_h^j) = qp_h r_h^j - (1+e)$ (8a) and $u_l^j(r_l^j) = (1-q)p_l r_l^j - (1+e)$ (8b), respectively. So, bank *j* solves the following maximization problem:

$$\max_{r_h^j, r_l^j} \pi^j(r^j, r^{j+1}) = u_h^j(r_h^h) L_h^j(r_h^j, r_h^{j+1}) + u_l^j(r_l^j) L_l^j(r_l^j, r_l^{j+1}) \qquad (9)$$

Substituting (7a), (7b), (8a), and (8b) into (9), we obtain:

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

$$+[(1-q)p_l r_l^j - (1+e)][\frac{1}{n} + \frac{p_l(r_l^{j+1} - r_l^j)}{\tau}] \qquad (10)$$

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):

$$r^{*j}_h = \frac{1}{p_h}[\frac{\tau}{n} + \frac{(1+e)}{q}], \text{ when } \theta = h \qquad (11a)$$

$$r^{*j}_l = \frac{1}{p_l}[\frac{\tau}{n} + \frac{(1+e)}{(1-q)}], \text{ when } \theta = l \qquad (11b)$$

Proposition 3 *An increase in competition reduces the equilibrium loan rate no matter the type of the borrower.*

Proof Relations (11a) and (11b) decrease with the number of banks *n*. This proposition provides support to the negative relationship between competition and the cost of lending, which is perfectly in line with the mainstream view. For instance, Boyd and De Nicolo (2005) and De Nicolo and Loukoianova (2007) find that banks charge lower loan rates when competition increases 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 is expected to enter the lending market attracted by the lower interest rates.

Proposition 4 *In high levels of competition transportation cost is irrelevant in the setting of the optimal loan rate*

Proof The first order conditions of (11a) and (11b) with respect to the number of banks *n* are $\frac{\partial r^{*j}_h}{\partial n} = -\frac{\tau}{p_h n^2} < 0$ and $\frac{\partial r^{*j}_l}{\partial n} = -\frac{\tau}{p_l n^2} < 0$, respectively. When $n >> 0$, we get $\tau / n \approx 0$, regardless of the magnitude of *τ*, which means that in a very competitive loan market where *n* is sufficiently large, the level of transportation cost *τ* 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 ($\tau / n \to 0$).

Proposition 5 *Screening works as a buffer mechanism for banks against excessive risk taking*

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 11(a) and 11(b) produces $r_h^j < r_l^j$ as $\frac{1}{p_h}[\frac{\tau}{n} + 2(1+e)] < \frac{1}{p_l}[\frac{\tau}{n} + 2(1+e)] \Leftrightarrow p_h > p_l$, which holds by assumption. The inequality $r_h^j < r_l^j$ implies that the bank offers an inexpensive loan interest rate r_h to good entrepreneurs with high-quality projects and a lofty loan rate equal to r_l 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* -together with the administrative cost of lending which, as mentioned above, remains unchanged for either type 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 6 *Competition induces banks to invest more in screening*

Proof Relation (11a) can be written as follows:

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

If we compute the first derivative of the above equation with respect to *n*, we get: $\frac{\partial e}{\partial n} = \frac{\tau q}{n^2}$, which is positive since $\tau q > 0$, (τ, q>0, by assumption).[11] Hence, the greater the number of competitors in the banking market, the larger the screening cost that

[11] It is straightforward that we obtain the same results if, following the same process, we differentiate (11b) instead of (11a).

each one incurs. In simple terms, this proposition implies that banks invest more in screening technology when competition increases. Put it differently, under mounting competition, banks have to pay a higher test cost e to obtain the true type of their credit applicants. That is, the threshold value of e for each bank which safeguards the perfect screening outcome increases due to intense competition.

The present proposition is in agreement with the results of the study 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. Also, this proposition is 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 (which is the case in the current study), demonstrate that competition negatively affects banks' willingness to generate information.

Proposition 7 *Good entrepreneurs are better in sustaining credit cost*

Proof If we look back at relations (2a) and (2b), then for $R(p_l) < R(p_h)$ and $r_l > r_h$ we get that $R(p_h) - r_h > R(p_l) - r_l$; and because $p_l < p_h$, for any given $\tau > 0$ we take $d_l < d_h$. The interpretation of this result is straightforward. While a good entrepreneur can apply for a loan up to d_h, a bad entrepreneur is restricted to apply not further than d_l. In other words, skilful borrowers are more capable of sustaining credit costs because of the higher probability of success of their projects and the respective higher returns.

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 the other banks that turn out to be relatively more expensive.[12] Conversely, the initiative of a

[12] The rationale behind borrower poaching can be traced in the study of Bouckaert and Degryse (2005) and that of Hauswald and Marquez (2006).

bank to raise its loan rate shrinks bank's clientele that seeks to travel to some 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 relatively cheaper institution. This is to say, distance plays no role in the decision of the entrepreneurs to travel to (abandon) a bank that has lowered (increased) its lending rates.

Our findings also suggest that fiercer competition lowers the demand for loans of individual banks. Intuitively, total demand is shared among a larger number of banks and hence the loan demand of individual institutions falls. If we measure bank's size in terms of total assets (which is indeed one of the most widely used proxies of bank size in the empirical banking literature), we can argue that competition shrinks the size of the existing banks.

We further find 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. That is, a larger number of banks gives rise to intensive price competition in the banking market. Notably, this relationship holds for all types of entrepreneur. That is, the interest rate paid by either type of borrower decreases as the market structure of the banking sector goes closer to perfect competition.

To continue, the importance of transportation cost in the setting of the equilibrium loan rates declines as the number of banks increases. The lower value of transportation cost as a result of higher competition coupled with the previous finding indicates that competition lowers 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 higher competition in the lending market.[13] A possible explanation of this finding is the following. The credit risk that banks face in a more competitive market tends to be

[13] We acknowledge that several other factors like, for example, the composition of loans, the bank size, and the ownership status of the bank may also influence screening incentives. However, the present study explicitly focuses on the link between the industry structure and bank screening activity. An analysis of the relevance of the above factors is out of the scope of the study and is left as an exercise for the interested reader.

higher. This happens 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 (see above). In order to protect themselves against increasing risk, banks decide to invest more in screening technology. That is, screening is the device that banks use to efficiently collect borrower-specific information. It works as a buffer mechanism against excessive risk-taking due to the enhanced presence of bad entrepreneurs in the lending market, who are found to be less capable of sustaining credit cost compared to the good ones. The interpretation that we offer here is reinforced by the view that the informational effectiveness of financial institutions is lower in more competitive markets (see Acharya et al., 2006). Consequently, in order to sustain the quality of information production in high levels, banks accept to incur a higher screening cost.

To summarize, we have demonstrated that market structure, bank lending behavior, and the incentives of banks to invest in information acquisition are strongly interrelated. In particular, we showed that a competitive banking industry consists of smaller banks that provide 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 of a less competitive market structure. By dealing with a larger number of loan applicants, banks, though small, invest more in screening technology to protect themselves from bad applicants, who entail higher credit risk.

5. Concluding remarks

In this paper, we have employed a model of spatial competition that incorporates informational asymmetries regarding borrower quality to examine the impact of industry structure on banks' credit behavior as well as on the screening technology that banks use to soften the information problem they face. Several appealing results are delivered.

First of all, 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. Next, results suggest that enhanced competition leads to a reduction in the demand for loans of individual banks as total loan demand is shared between a larger number of banks. We further provide support to the mainstream view that greater competition reduces lending cost. However, what is more important in this finding is that competition renders credit cheaper for all types of entrepreneurs, and not only for good or bad ones. Moreover, we document that transportation cost becomes less and less important in the setting of the equilibrium loan rates for large number of banks. All in all, intensified competition lowers loan rates as it reduces the distance between banks and borrowers, which favors the access of new entrepreneurs to the loan market.

Besides, one of the main contributions of this study to the extant literature is related to the positive effect that competition is found to exert on banks' incentives to screen loan applicants. In particular, we report that banks invest more in screening as a result of higher competition. A possible explanation for this finding is that banks are more easily mistaken in their lending decisions as the number of credit applicants increases due to enhanced competition. Banks thus resort to screening in order to protect themselves against bad entrepreneurs who are less capable of sustaining credit cost compared to the good ones.

We now turn to offer some possible extensions of our analysis. To start with, one of the key assumptions of our model is that entrepreneurs have no initial resources. If, instead, had their own capital that could be pledged as collateral or used as equity, self-selection and signaling devices that influence the screening incentives of banks would play a significant role in our analysis. More specifically, if we assume that collateral secures lending activity by effectively protecting banks against credit risk, then screening may not be appropriate. An extension of our model on these grounds would be a rather interesting and enlightening exercise.

The easier access of bank credit officers to worldwide electronic databases and other common information sources together with officers' resort to standard credit scoring models render the assumption of proprietary screening information made in this paper questionable. Therefore, as the correlation between screening outcomes is high in our days, we could relax the somewhat restricted assumption of proprietary information in the spirit of Cetorelli and Peretto (2000) and test whether this would alter the loan market outcome.

Finally, a potential criticism to our model is that it essentially ignores the liability side of banks' balance sheet. Had we assumed that banks also compete on the deposit market, the findings presented earlier would probably remain unchanged under the additional assumption that banks are able to raise or invest unlimited funds in interbank markets, or, alternatively, at the central bank, at some given rate.[14] However, as this proposition is somewhat speculative, further research on both sides of banks' balance sheet has to be done.

[14] Such a market environment would rather share many common features with that of Chiappori et al. (1995).

Appendix

Relation (10) can be written as follows

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

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

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

$$- \frac{e}{n} - \frac{ep_l r_l^{j+1} + ep_l r_l^j}{\tau} \qquad \text{(I)}$$

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

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

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

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

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

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

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

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

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

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

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