ASYMMETRIC INFORMATION, SIGNALLING AND COMPETITION IN THE CREDIT MARKET

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Abstract

This paper examines how credit market structure affects signalling incentives under informational asymmetry between banks and firms. The existence of separating equilibria depends on competitive levels and on contract differentiation. Low competition and limited contract differentiation guarantee separation and quality pricing. High competition reduces signalling costs and the informative power of contracts; as a result signalling equilibria do not exist and asymmetric information remains unsolved. Moreover, when all projects are viable, full competiton imposes a trade-off between market coverage and price-efficiency. With nonviability such a trade-off desappears.

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1   Introduction

The present paper investigates the links between credit market structure and asymmetric information. In particular, I address the question of whether the competition in the loan market prevents agents from overcoming asymmetric information in the context of a spatial competition model *à la* Salop (1979). By endogenizing the location of firms around the circle, a relationship between the signalling decision and the level of competition is established: if banking competition is intense, singalling incentives of good firms dramatically shrink and no separating equilibria exist. Instead, with less competition (large market shares) incentives for signalling arise and at least a partial separating equilibrium is reached. It follows that in highly competitive environements the market failure due to informational asymmetries is more likely to remain unsolved. The result relies on the following intuitions. Young good firms, experiencing the credit market for the first time, have to send a signal to obtain high-quality pricing. One way to signal is to relocate on the circle towards positions associated to the preference for what we call "complex" or "informative contracts", which consist in a simple loan contract plus the costly provision of information about the quality and the characteristics of the project. The bank believes that all relocated firms are of high-quality in separating equilibria because relocation is costly and relatively more affordable to good firms. The key point is that the incentive to relocate crucially depends on the number of competitors and also on the degree of horizontal contract differentiation. We distinuish between local monopoly and competition. Under full competition there is a large variety of contracts with high informative content: banks add more information to their supply of standard contracts. As such informative content increases, the informative power of contracts declines because cheaper and more substitute-highly informative products are available to *all* firms. In fact, low-quality firms can afford informative financial contracting and are incentivated to mimic high-quality firms. As a result asking for compelx contracts no longer provides indications about quality.

While more competition reduces the amount of information required for separation, less contract differentiation lowers the unitary cost of the signal. The combined effect of contract differentiation and competition is to affect the *informative value* of financial contracts and, in turn, the signalling process.

In the case of local monopoly the separating equilibrium conditions do not depend on the number of competitors, but on the degree of contract differentiation, i.e. the cost of the signal. If such a cost is sufficiently greater than zero, i.e. the degree of financial contract differentiation is high, signalling pay and separation is acheived. The monopolisitc framework is analysed to outline the role horizontal contract differentiation (heterogeneity in preferences) plays in the signalling device. While markets shares are undoubtly relevant only in the latter configuration, differentiation affects the equilibrium conditions in both local monopoly and competition. We shall see in more details how the existence of heterogeneity in preferences is determinant in the signalling game of high-quality firms.

This paper refers to the literature on banking market structure and asymmetric information. Recent works find several links between market structure and asymmetric information in the banking industry. Boas and Mohr (1999) show that, in more concentrated markets, banks screen borrowers more intensively because they compete more aggressively for highly profitable borrowers[1]. Dell'Ariccia, Friedman and Marquez (1999) find that adverse selection may be a source of entry barrier. Incumbent banks face informative advantages over potential entrants because they know more about their clients. As a result, informational asymmetries between lenders have deterrent effects on entry decisions.

Dell'Ariccia (2000) studies the relationship between screening incentives and competition. As the ratio between new-untested and old-rejected borrowers increases, banks tend to relax screening standards and expand credit. This may lead to a deterioration in portfolios and banking profitability.

While many works pay attention to screening, this paper focuses on signalling as the key mechanisms to contrast informational asymmetries. I consider relocation as a signal of quality and any decision to relocate pays only in non-fully competitive markets. Such a result is relevant because predicts that competition may be inconsistent with the resolution of the asymmetric information-market failure and may generates the standard results of inefficient pricing rules.

Recent literature examines credit market competition in a lender-borrower relation setting; this model does not directly involve relationship banking. Banks are not *ex-ante* interested in long run relationships with clients because they of-

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[1]For further details, see Boas and Morh (1999).

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fer simple contracts or transactional loans. Rather, we can think of relocation as the demand for a stronger bank-firm relationship. Young good firms demand for high-quality credit conditions, consulting and financial assistance by choosing complex contracting and sharing information with the bank: in this sense, banks are somewhat asked to be more involved into firms' activity.

Boot and Thakor (2000) have shown how competition influcences the decision to invest in relationship lending. The authors find that more competition in the banking sector induces lenders to invest more in relationship lending, while capital market competition produces the opposite effect.

Hauswald and Marquez (2000) investigate how competiton impacts the ability of banks to extract informational rents from lending relationships. Competition erodes the informational rents of banks, which specialize in their core segment, investing more in stable relationships with borrowers. In this model, the distance gives information about quality, while in the present model what provides information about quality is the relocation towards informative contracts.

Finally, Petersen and Rajan (1995) show that young firms receive more credit at low rates in concentrated markets: creditors smooth interest rates over the life cycle, charging lower-than-competitive rates when firms are young and higher-than-competitive rates when firms are old. Market power gives banks room for initial loss but future profit sharing.

The rest of the paper is organized as follows. Section two presents the hypotheses underlying the basic model, which is solved for the equilibrium prices under symmetric information in section three. In section four I remove the symmetric information assumption and study the relationship between market structure and singalling incentives. The condition for separating equilibrium are derived for the case of local monopoly and full competition. Section five investigates some welfare and efficiency properties under signalling. The concluding remarks are to be found in section six.

2   The Model

I consider a simple risk-neutral economy composed of lenders (banks) and borrowers (firms)[2]. Lenders compete in prices to attract heterogenous firms which invest on risky projects. In point I-IV we shall describe the investment projects, the agents and their information set and the structure of the market in which lenders and borrowers operate.

I. Borrowers.

Borrowers have no private funds to finance thier projects and demand credit from a bank. They ask 1 unit of capital. Firms are endowed of a technology which transforms the uniraty capital into a random cash flow $\tilde{Z}$ with the following schedule:

$$\tilde{Z} = \begin{cases} Z > 0 & p_\theta \\ 0 & 1 - p_\theta \end{cases}$$

where Z is the cash flow, $\theta \in \{h, l\}$ denotes the borrower's "type" and p_θ his repayment/success probability. More precisely, borrowers come in two types, "good" (h) and "bad" (l), or high-quality types and low-quality types. Each of them is identified by a success probability p_θ.

For a type θ the expected return is $E_\theta[\tilde{Z}] = p_\theta Z$, while the expected gross profit is $p_\theta(Z - R)$, where $R > 1$ is the repayment due to the bank. For the moment we assume the viablility of all projects, $p_\theta Z \geq R \; \forall \; \theta$ (we will remove this hypothesys ahead), whilst the repayment probability is higher for good projects, i.e. $p_h > p_l$.

II. Lenders.

As it will be explained in point IV, we assume N banks to produce one good, "loans", which are granted to borrowers in a unitary fixed size. The lending activity is realized at fixed per-project cost or costant marginal cost c. Borrowers receiving the loan are asked to repay the gross rate R_i [3].

Lenders seek to maximize expected profits, taking into account the total cost of

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[2]Hereafter we will use firms, projects and borrowers as synonimus as well banks and lenders.

[3]Note that $R_i = R_i(\theta)$ if the bank is able to offer separated contracts, reflecting the borrower's *specific* probability of success. This certainly occurs in the case of symmetric

the lending activity and the repayment probability of the firms.

III. Information.

Borrowers are informed about their type, while lenders are not. Asymmetric information arises on the type variable θ. Instead, the poportions of high quality and low quality projects in the economy are publicly observable and are known to be λ and $1 - \lambda$ respectively.

IV. Market structure.

The market is described by a circular city *à la* Salop (1979) of length 1. The banks locate equidistantly around the cirle and their number is equal to N. We focus on the interactions between two adjacent banks, say $i, i = 1, 2, ..., N$ and $j, j = 1, 2, ..., N - 1$, $i \neq j$, and suppose that there is a bank i located at an arbitrary point $x = 0$ and another bank j located at $x = \frac{1}{N}$ from i. The distance x is meant to be a borrower-lender distance, that is the distance between the borrower and the specific bank i serving it.

The population of borrowing firms is uniformly distributed on the circle. In particular, in each point of the circle there is a high-quality firm with probability λ and a low-quality firm with probability $(1 - \lambda)$[4]. Firms face travel costs to borrow from a generic bank i and the cost per-unit of distance is β. Hence to travel distance x, a total cost βx must be sustained.

In a non-spatial view, β measures the degree of product differentiation and the market power of the banks. For $\beta = 0$ there is no horizontal product differentiation, and the system turns back to the competitive case[5]. I interpret β the degree of "financial contract complexity" or *informative power of contracts*, with the dis-

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information (see section 3). If, instead, separated contracts are not possible R_i will be the pooling equilibrium rate, incorporating the *average* probability of success.

[4]Alternatively, we can say that in each point of the circle there is a mass λ of good borrowers and a mass $(1 - \lambda)$ of bad borrowers.

[5]Interpreting the "location model approach" to horizontal product differentiation is way to introduce "location" or "address" into consumers's preferences, and to provide a measures of how close the brands actually produced are to the consumer's ideal brand. Also, the distance between the consumer and the firms may be a measure disutitlity to buy a less-than-ideal product (Oz Shy, 1996 p.149)

tance providing a measure of the preference for such a complexity (we shall see in section 4 that β has a particular meaning in the contex of signalling). Relatively complex contracts are those contracts which involve the additional provision of a range of services including consultancy, project financing, accounting services, internet banking and so on. Also complexity is refered to the contract informational content about the quality of the projects. In other words, asking for a certain degree of complexity means that firms demand for additional innovative services and spending some resourses in the production of infromation to proove creditworthness. Given a bank offering a simple loan contracts, borrowers close to her are "simple contract-lovers" or *non-informative-contracts lovers*, while borrowers located far away are "complex contracts-lovers" or *informative-contracts lovers*. The latter are those firms which prefer contracts with highly informative content about the projects' carachteristics and quality.

An important assumption is that θ and x are independent. *Ex ante* there is no reason to believe that good (bad) firms prefer to settle informative contracts (non-informative contracts). In fact, when information is symmetric, borrowers maintain their location and are priced according to type, and when the information is asymmetric types h need to relocate in order to signal their quality. In that case, good firms are required to express a preference for informative contracts.

Given the market structure presented above, borrowers have to decide about two actions: i) whether to demand for credit; ii) which bank to apply to.

i) Demand for credit occurs if the net profit from borrowing and investing is non-negative. Thus, a borrower θ will apply to bank if and only if his participation constraint (hereafter PC) holds, this constraint is given by $p_\theta(Z - R) - \beta x_\theta \geq 0$. Solving for x_θ with equality:

$$x_\theta = \frac{p_\theta(Z - R)}{\beta}. \tag{1}$$

PC (1) states that for a type θ the application is profitable up to x_θ, beyond which transportation costs overwhelm the expected gross profit. It is relevant to note that while a type h can apply for credit up to x_h, a type l can only apply up to $x_l < x_h$. Low-quality borrowers are less capable of sustaining credit costs due

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to their lower probability of success.

ii) It is important to remark that, all else being equal, firms choose to borrow from the nearest bank, i.e the one that entails the lowest distance-cost. Consider a borrower θ located between two adjacent banks, say i and j. Such a borrower weakly prefers bank i's offer if the profit obtained is no less than the profit obtained form bank j's offer. Hence, we have the following weak preference condition (WPC)

$$p_\theta(Z - R_i) - \beta x_\theta \geq p_\theta(Z - R_j) - \beta(\frac{1}{N} - x_\theta)$$

or

$$p_\theta R_i + \beta x_\theta \leq p_\theta R_j + \beta(\frac{1}{N} - x_\theta), \tag{2}$$

where R_i and R_j are the gross rates charged by banks i and j respectively. Thus, bank i will be chosen if the total cost of credit is no greater than the one associated with bank j. Solving (2) for x_θ under equality conditions, we have the following indifference condition (IC)[6]:

$$x_\theta = \frac{1}{2N} + \frac{p_\theta(R_j - R_i)}{2\beta} \tag{3}$$

It follows that the demand for bank i is:

$$Q_i^c(\theta) = 2x_\theta = \begin{cases} \frac{1}{N} + \frac{p_h(R_j - R_i)}{\beta} & \text{for } \theta = h \\ \\ \frac{1}{N} + \frac{p_l(R_j - R_i)}{\beta} & \text{for } \theta = l, \end{cases}$$

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[6]The IC establishes the location of the "marginal borrower" of type θ, i.e the borrower who is indifferent with respect to the offers of two adjacent banks.

where the subscript "c" indicates the demand in a competitive environment. The (linear) demand function for the bank i has standard properties: it is declining in N and in its own price, and increasing in the direct competitors' price.

An important point about PC (1) and IC (3) is that they represent the demand for the bank in two specific market configurations. In fact, for $\frac{1}{2N}$ large enough, i.e. N low, we get that $x_l < x_h < \frac{1}{2N}$. In this case any of the N banks competes for the two types of firm. Thus, exploiting the relations between x_l, x_h, and $\frac{1}{2N}$ and we can state the following definition:

Definition 1.
Under condition $\mu > 2p_h(Z - R_i) = \overline{\mu}$ the market is a local monopoly.

with $\mu = \beta/N$. Under local monopoly the number of banks low enough to eliminate baniking competition.

If N is such that $x_l < \frac{1}{2N} < x_h$, the bank starts to compete for high quality borrowers, maintaining the monopoly power on low-quality ones. We are now in an *intermediate case* where banks compete for high-quality firms only.

Definition 2.
Under condition $\underline{\mu} = 2p_l(Z - R_i) \leq \mu \leq \overline{\mu}$ the market structure is intermediate between local monopoly and full competition: we define it as partially competitive.

Partial competion is due to the fact that all good borrowers are able to demand credit up to $x_h > \frac{1}{2N}$ (their participation constraint is slack with many banks) and they compare bank i's offer with the closest competitor's offer. This means tha now alternative prices do matter.

Finally, when $\frac{1}{2N} < x_l < x_h$, banks compete for all types, and all firms are able to compare the offers of two adjacent banks. From hence, we obtain this last definition:

Definition 3.

Under condition $\mu < 2p_l(Z - R_i) = \underline{\mu}$, bank i competes for all types of borrowers, i.e. the market is fully competitive.

The parameter μ measures the *intensity of the competition* or the *competitive pressure* in terms of both number of incumbents and degree of market power achieved by banks via product differentiation. It will be clear in the next sections that this parameter is crucial to our analysis.

3 Symmetric information

In what follows we study the framework of symmetric information: lenders freely observe θ and make their loan policies accordingly. We first describe profit and then derive the equilibrium loan rates under local monopoly and competition.

Banks' Profits.

The existence of symmetric information allows lenders to distinguish between good and bad borrowers and to price them differently. In other words, we have the standard result $R_i = R_i(\theta)$. The expected average bank profit form financing high-quality projects is given by $\pi_i(h) = \lambda p_h R_i(h) - (1 + c)$, in the case of low-quality projects we have $\pi_i(l) = (1 - \lambda)p_l R_i(l) - (1 + c)$, where $R_i(h)$, $R_i(l)$ are the gross rates that bank i charges on borrowers of type h and l respectively. As we shall see, with informational symmetry the bank offers two separated contract with independent prices.

3.1 Pricing under local monopoly

Exploiting definition 1, the demand for the bank under local monopoly is:

$$Q_i^m(\theta) = 2x_\theta = \begin{cases} \frac{p_h(Z - R_i(h))}{\beta} \text{ for } \theta = h \\ \\ \frac{p_l(Z - R_i(l))}{\beta} \text{ for } \theta = l \end{cases}$$

The problem for the monopolistic bank is to maximize profits over the mass of

borrowers up to x_h. This problem is:

$$\max_{R_i(h), R_i(l)} \Pi_i(\theta) = \pi_i(h)[\frac{p_h(Z - R_i(h))}{\beta}] + \pi_i(l)[\frac{p_l(Z - R_i(l))}{\beta}] \qquad (4)$$

Differentiating (4) with respect to $R_i(h), R_i(l)$ yields to the following monpoly pricing rule:

$$R^m(\theta) = \begin{cases} R^m(h) = \frac{1}{2}[Z + \frac{1+c}{\lambda p_h}]] \\ \\ R^m(l) = \frac{1}{2}[Z + \frac{1+c}{(1-\lambda)p_l}] \end{cases} \qquad (5)$$

Rule (5) reflects the costs of lending, the borrowers' probability of success and the fact that banks and firms share the cash flow generated by the project. Note also that $R^m(l) > R^m(h)$ for $\frac{p_h}{p_l} > \frac{1-\lambda}{\lambda}$ and it is always satisfied for $\lambda = \frac{1}{2}$.

3.2   Pricing under full competition

When the environment is fully competitive, the demand faced by the bank i is given by $Q_i^c(\theta)$ (see point IV of section 2). To have a simpler notation we define $R_i(h) \equiv R(h)$ and $R_i(l) \equiv R(l)$. Because of equidistant positions, each bank will price borrowers according to type: $R_{j,h}$ and $R_{j,l}$ are the rates that bank j charges on type h and l respectively.

The bank maximizes profits over the mass of borrowers up to x_θ. The progam is:

$$\max_{R(h), R(l)} \Pi_i(\theta) = \pi_i(h)[\frac{1}{N} + \frac{p_h(R_{j,h} - R(h))}{\beta}] + \pi_i(l)[\frac{1}{N} + \frac{p_l(R_{j,l} - R(l))}{\beta}]. \qquad (6)$$

The profit function (6) has standard properties: it decreases with N, β and the cost c, and it increases with λ and p_θ. Substituting into (6) the values of $\pi_i(h)$ and $\pi_i(l)$ as defined in section 3, we compute the symmetric Nash equilibrium in prices by differentiating the profit function respect to R_h, R_l. We obtain the following

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separating pricing rule:

$$R^c(\theta) = \begin{cases} R^c(h) = \frac{1}{p_h}[\frac{(1+c)}{\lambda} + \frac{\beta}{N}] \\ \\ R^c(l) = \frac{1}{p_l}[\frac{1+c}{1-\lambda} + \frac{\beta}{N}], \end{cases} \tag{7}$$

The rule $(7)^7$ is consistent with what has been mentioned above. Each borrower is priced according to its type and for a sufficent degree of heterogeneity between firms we have the standard result $R^c(l) > R^c(h)$ [8] (see appendix A.1 for proof). Being $\mu = \frac{\beta}{N}$, N and β are interpreted in the same manner; as competition gets sharper ($N \to \infty$ and $\beta \to 0$) rates converge to the competitive levels, and are determined by p_θ, λ and c only.

4 Asymmetric information

As long as lenders do not observe borrowers' types, their price policy cannot be based on rules (5)and (7). It is well known that under informational asymmetry the economy is out of the first best world. Despite this, the market is not prevented from generating devices enabling some forms of type-discrimination. Indeed, in our model there can be a mechanism whereby borrowers are able to signal their quality. As we shall see that this mechanism is distance related. The idea relies on the fact that high-quality borrowers may switch of relocate in order to send a signal of quality to lenders. Hence, the "x" finally chosen can be a variable from which banks infer the borrowers' true type.

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[7]The second derivatives $\frac{\partial \Pi_i}{\partial R_i(\theta)} < 0 \ \forall \ \theta$ guarantee that problems (4) and (6) are both concave.

[8]Given prices (7) the bank i's per-loan rate of return is $p_\theta R_i(\theta) - (1+c)$. Such a rate of return is equal to $p_h R_i(h) - (1+c)$ in the case of a good firm and equal to $p_l R_i(l) - (1+c)$ in the case of a bad one. Because rule (7) depends on λ, the two rates are equalized only for an even distribution of the types in the economy.

4.1 Endogenous location and signalling

In section 3.1 and 3.2 we found equilibrium loan rates under the assumptions of symmetric information and *exogenous* location of the borrowers. With informational asymmetry we allow for *endogenous* location, in the sense that borrowing firms are given the possibility to relocate to other points of the circle in order to signal their type. Relocation is costly and such a cost is given by

$$s = |x - x_0|,$$

where x is the "final destination" and x_0 the initial location. In other words, borrowers wanting to move, *regardless* of type, incur in a cost proportional to the traveled distance[9]. The module implies that s is symmetric with respect to the location: wherever the firm moves from its initial position, it incurs in s.

In the space of financial contracts, moving towards locations far away from the bank means demanding highly informative contracts or sofisticated contracts, while moving towards locations closer to the bank implies demanding "simple loan contracts" or non-informative loan contracts. Borrowing firms with initial location close to the bank incur in low travel costs because they are not particularly interested in sofistication. They ask for low-informative contracts and this is true regardless of type. Instead, firms located far away are love non-standard contracts and give informational more importance. In other words, the distance from the bank reflects the preference for informative contracts.

For a given location, how borrowers evaluate information is *ex-ante* the same, but in order to signal high-quality firms must demand more information by switching position on the circle[10]. To clarify this point note that a borrower located at y from

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[9]The cost of the signal is assumed to be the same for all types. *Ex-ante* there is no reason to believe that good firms are willing to invest more in information because this element is refered to location and not to type. Then, we depart from the standard assumption that signalling costs are different according to types. For applications to other economic fields see Spence (1973) and Myers and Majluf (1984).

[10]The location of some firms is consistent with separation. It will be shown ahead that these firms have location sufficient for signalling and they are not involved in the relocation process.

a bank, gives information a total value of βy *regardless of his type*. Under informational asymmetry, (some) good firms must relocate in order to obtain high-quality pricing, *ex-post* giving information more value. In this way, they invest contract complexity and are returned with lower interest rates on loans.

The linear cost s is a simple but effective way to model a class of costs relevant in credit markets. In fact, investing in information mean, for instance, paying a rating agency certifying the quality of the project, or the effort an enteprenuer must put into the project to make it profitable, e.g. accurate feasability studies, forcasting how production and demand may evolve over the time, market research to ensure that the final product is worth selling. Thus,signalling through relocation may become a "pass" for high-quality credit application. Such a mechanism imposes an effort on good firms but allows banks to avoid costly screening.

4.2   The signalling game

We concentrate on bank i (hereafter we omit i). This bank is uninformed about θ, but does know that below x_l all firms apply for credit and for $x_h > x_l$ only high quality firms will apply. Given $x_h > x_l$, high quality borrowers may switch to the non-profitable region for low types, $[x_l, x_h)$, to signal their higher quality. More precisely, x_l is the point to which all good borrowers should switch in order to sustain the minimum cost consistent with separation. Accordingly, the game is based on the following sequence of actions:

1. borrowers move first. By comparing the pay-off of their current location and the payoff enjoyed at x_l they decide whether to relocate;
2. lenders offer two separating contracts or one pooling contract depending on the signal observed;
3. borrowers take their application decisions;
4. equilibrium is reached and final payoffs are assigned.

The distance x from the bank is the signal. We denote by $x(\theta)$ the location to be chosen by the type θ *conditional* on his actual position x_0, and by $\phi(x)$ the probability that the type is h having observed x.

At location $x(\theta)$ the bank charges the expected rate $R[x(\theta)] = \phi[x(\theta)]\bar{R} + (1 -$

$\phi[x(\theta)])\underline{\text{R}}$, where $\bar{R} \equiv R(h), \underline{\text{R}} \equiv R(l)$, respectively; later on in the paper it will also be specified which market structure these rates refer to.

The concept of equilibrium used in these class of models is the perfect Baysian equilibrium (PBE). The PBE of this game is a set of $\{x^*(h), x^*(l), R^*, \phi^*\}$ such that the profit for a borrower sending the signal $x(\theta)$ is maximized $\forall \theta$. Hence, $x^*(\theta)$ solves:

$$\max_{x(\theta)}[(p_\theta(Z - R^*[x(\theta)]) - \beta x(\theta))|x_0]$$

where $R^*(\theta) = \phi^*(x)\bar{R} + [1 - \phi^*(x)]\underline{\text{R}}$ is the equilibrium rate, which is anticipated by the borrower and included in the maximization problem. The rates borrowers consider in their maximization problem are also optimal for the bank because derived from problems (4) and (6).

In separating equilibria the bank faces the following system of beliefs[11]:
$\phi^*(x) = 1 \ \forall \ x \geq x_l; \ \phi^*(x) = 0 \ \forall \ x < x_l$.

4.3 Local monopoly

We first analyse the relocation decision under local monopoly and I shall extend the analysis to the competitive case in the next section. For the sake of simplicity, we use the monopoly rates $\underline{R} \equiv R^m(l)$ and $\overline{R} \equiv R^m(h)$.

Optimal location for low quality firms.
Low quality borrowers located above x_l will not ask for a loan because those locations produce high distance costs and negative profits. But it could be the case that a borrower of type l with initial locaton $x_0 = x_l$ profitably applies for a loan because of the lower equilibrium interest rate the bank charges at x_l. In fact, if signalling is possible the bank charges the rate $R^*(x_l) = \overline{R}$ in the region $x \in [x_l, x_h)$

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[11]This system of beliefs means that in equilibrium the bank assigns probability 0 of being a good borrower for all the locations $x < x_l$ even if there are some good borrowers "locked" in the region $[0, x_l)$ that cannot separate. This is consistent with the result of separation, but does not imply the outcome of complete separation.

and all borrowers l located in x_l could potentially apply for loan making positive profits. In order to obtain a separating equilibrium we have to find the condition under which that situation does not occur. Such a condition is:

$$p_l[Z - R^*(x_l)] - \beta x_l = p_l[Z - \overline{R}] - \beta x_l \leq 0.$$

By substituting the expression for x_l we get:

$$p_l[Z - R^*(x_l)] - \beta x_l = p_l[Z - \overline{R}] - \beta \frac{p_l[Z - \overline{R}]}{\beta} = 0. \tag{8}$$

and the condition is satisfied with equality.

Lemma 1.
Condition (8) is a sufficient condition for any separating equilibrium.

Result (8) indicates that low-quality borrowers located a $x = x_l$ makes zero profits even if charged $\overline{R} < \underline{R}$ and thus they do not apply for credit at x_l or above.
Two important implications of (8) are that all borrowers of types l located below x_l have no incentive to switch and those who are already located at x_l or above will not apply for credit because not profitable.
In the signalling game, the equilibrium values for low-quality borrowers are:
a) firms with initial location $x_0 \in [0, x_l)$, choose $x^*(l) = x_0$ and are assigned $\phi^*(x) = 0$. All borrowers continue to stay in that region and will apply for credit at the rate $R^*[x^*(l)] = \underline{R}$;
b) firms with initial location $x_0 \in [x_l, x_h)$ will not apply for credit.

Optimal location for high quality firms.
All borrowers of type h located above x_l will continue to stay in that region; their initial location x_0 is sufficient for signalling. We know from (9) that low-types will never demand credit above x_l and this is a sufficient condition for a separating equilibrium. A *necessary condition for a separating equilibrium* is that high-quality

borrowers located below x_l find profitable switching to x_l [12]. If *all* of them switch, we obtain complete separation.

Then, the analysis is focused on good borrowers located below x_l, who would need to move above to signal their quality. That is the case if the following relation holds: $\{[x^*(h) \geq x_l, \bar{R}] | x_o\} \succ \{[x^*(h) < x_l, \underline{R}] | x_0\}$. More precisely, a good borrower with initial location $x_0 \in [0, x_l)$, charged $R^*(x_0 < x_l)$, prefers to switch up to x_l if and only if

$$p_h R^*[x < x_l] + \beta x_0 \geq p_h R^*[x \geq x_l] + \beta x_l + (x_l - x_0)$$

or

$$p_h[\underline{R} - \overline{R}] \geq (1 + \beta)s \tag{9}$$

where $R^*(x \geq x_l) = \overline{R}$ and $R^*(x < x_l) = \underline{R}$.

In Condition (9) borrowers compare gains (the left-hand side) and costs (the right-hand side one) of relocation. The latter are the switching costs depending on the distance $(x_l - x_0)$, while the former is the price differential. Solving (9) for s we find that:

$$s \leq \frac{p_h(\underline{R} - \bar{R})}{1 + \beta} = \frac{p_h(1 + c)\delta}{1 + \beta} \equiv \bar{x}, \tag{10}$$

where $\delta = \frac{1}{2}[\frac{1}{(1-\lambda)p_l} - \frac{1}{\lambda p_h}]$.

Lemma 2.

Inequality (10) is a necessary condition for a separating equilibrium involving at least one borrower located at x_0.

Condition (10) implies that good borrowers with initial location sufficently close to x_l will switch, specifically those with distance $s \leq \bar{x}$ from x_l, meaning that low

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[12]If relocation were not allowed, two pricing strategies would be available to the bank: setting a profit-maximizing-pooling-price up to $x = x_h$ or screening borrower by announcing the prices $R_i = \underline{R}$ below x_l and $R_i = \overline{R}$ at x_l or above. This latter pricing rule would lead to separation, but it would be characterized by non-efficient pricing.

switching costs are consistent with relocation. Given that (10) depends on β we now address the question of its role in deciding relocation.

Characterizating of the equilibrium: the role of β.
For a detaild evaluation of the role of β in this analysis, we rearrange (10) to obtain:

$$H(\beta) = x_0 - \frac{p_l(Z - \bar{R})}{\beta} + \frac{p_h(\underline{R} - \bar{R})}{1 + \beta} \geq 0 \qquad (11)$$

.

Three are three important components in (11):

1. The initial location: the closer x_0 to x_l the lower the switching costs.

2. The rate differential $\frac{p_h(\underline{R} - \bar{R})}{1+\beta}$, that is the crucial incentive for relocation. As β increases, the price differential becomes less important and it is more difficult for condition (12) to hold.

3. The switching cost $\frac{p_l(Z - \bar{R})}{\beta}$ which are decreasing in β. This happens because for β large, the closer x_l to x_0, the lower the total switching costs.

Note that $\lim_{\beta \to 0} H(\beta) = -\infty$. This is crucial because if β is too low $H(\beta) < 0$ and there is no incentive for high-quality borrowers to separate.

Under local monopoly, the following proposition holds:

Proposition 1.
For $\beta < \bar{\beta}$ there exists no separating equilibria. A necessary condition for separating equilibra is $\beta \geq \underline{\beta}$.

Corollary 1.
In absence of separation, the outcome is a pooling equilibrium characterized by all good firms maintaining their initial location.

Proof. See appendix A.1

The interpretation of β in proposition 1 is now more clear. Firstly, β can be considered as the unitary price (cost) of the signal: if this price is too low, signalling is not believed credible by the bank because potentially exploited by low-type firms. Note that both switching costs and gains are decreasing with β, which can be

interpreted ad follows: for β small, the degree of financial differentiation is low and good firms incur in high costs in order to buy a differentiated-informative contract. In attempting to separate, good firms need to relocate far way from the bank and have to express the preference for a sofisticated-complex product. While this increases gains, it also increases relocation costs: then, as the signal price falls, more information must be produced by firms to achieve separation. In fact, as mentioned in section 1, βx is a measure of the informative value of contracts, where β is the price and the distance x is the quantity: *a decrease in β (price effect) will require "more" x (quantity effect) to satisfy the minimum value of information consistent with signalling*[13]. As a result relocation costs increase and it is more difficult for signalling to occur.

While in monopolistic markets the relevant parameter affecting signalling is β, under full competition a key role is also played by N, which influences x_l and, in turn, the amount of information consistent with separation.

Secondly, β measures the heteorgeneity of borrowers in terms of preference for the bank's financial supply. If heterogeneity exists, loan contracts attract borrowers in different measures and this allows new young firms to reveal their type by expressing a preference "informative-contracts". If heterogenity did not exist, such a relocation device would not be possible because all firms would ask for the same contract [14]. Given that signalling outcomes are generated by minimum levels of β, which also captures the degree of market non-competitivness, we can say that banks must posses a market power to overcome asymmetric information and inefficent pricing policies.

Proposition 2.

A necessary condition for a semi-separating equilibrium is $\beta \in [\underline{\beta}, \overline{\beta}]$. $\beta > \overline{\beta}$ is a necessary condition for complete separation.

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[13]For instance, consider a borrower of high-quality located at distance $w < x_l$ from the bank. The (minimum) value of the information consistent with separation at $x = w$ is $I = I(\beta) = \beta(x_l - w) = p_l(Z - \bar{R}) - \beta w$. Because $\frac{\partial I(\beta)}{\partial \beta} = -w$, β has a negative impact on the overall informative value firms located at w must produce in order to separate.

[14]Note that, the greater the heterogeneity, i.e higher γ and/or $\frac{p_h}{p_l}$, the required minimum β is lower, because high quality borrowers gain more from the price differential once they switch to x_l.

Corollary 2.

In a semi-separating equilibrium good firms with location $\bar{x} < x \leq x_l$ will separate and good firms with location $0 \leq x < \bar{x}$ remain in that region and will be priced $\underline{R} > \overline{R}$. Under complete separation all good firms choose to relocate and are finally located at x_l or above.

Proof. See appendix A.

Proposition 2 says that, for some values of β, signalling equilibria are characterized by incomplete separation, with some good firms locked in the no-signalling region, where separation is for them unfeasible.

It important to underline that not *all* good borrowers incur in signalling costs. Such costs are in fact sustained only by those firms located below x_l. Good firms located above x_l will not incur in s because their initial location is sufficient for signalling[15]. The latter are known to be efficient and to undertake good investment projects: they have already singalled their type in previous periods and are now reaping the benefits. The former, on the other hand, are those young firms experiencing the credit market for the first time, and need to emerge from the mass of new firms applying for credit.

Differentaiting the profit/incenitve function (11) with respect to β, we find that $\frac{\partial H(\cdot)}{\partial \beta} > 0$ if and only if:

$$-\frac{p_h(\underline{R} - \bar{R})}{(1+\beta)^2} + \frac{p_l(Z - \bar{R})}{\beta^2} > 0.$$

Solving for β, we obtain:

$$\beta < \frac{1}{\sqrt{\frac{p_h}{p_l}\frac{\gamma}{(Z-\underline{R})}} - 1} \equiv \beta^* \tag{12}$$

Lemma 3.

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[15] The initial location can also be seen as the firm's *reputation endowment*. This reputation is high for $x \geq x_l$ and low for $x < x_l$.

For $\beta \in [\underline{\beta}, \beta^*]$, $H(\beta)$ is increasing in β, for $\beta > \beta^*$ $H(\beta)$ is decreasing.

Interpreting expression (12) and (14) toghether means that, the incentives to relocate arise for a minimum value $\underline{\beta}$. Beyond this value, signalling is activated and high-quality borrowers start to separate. Complete separation is obtained for $\beta > \overline{\beta}$. But for $\beta > \beta^*$, the marginal incentive to switch decreases. This result is consistent with signalling, but implies that as the market power of banks increases profits and surplus are reduced. In other words, firms pay more for a marginal increase in the market power parameter to continue the signalling game.

4.4   Singalling under full competition

In the case of local monopoly borrowers face the following situation: $x_l < x_h < \frac{1}{2N}$, while in the intermediate case $x_l \leq \frac{1}{2N} \leq x_h$, banks compete for high-quality borrowers and still have market power on low-quality ones. In this latter framework signalling still works, but now the set X_i of types h located above x_l and sending the signal to the bank i depends on N: $X_i(N) = \{x; x^*(h) = x_0, \forall x \in [x_l, 1/2N < x_h]\}$. As $\frac{1}{2N} \to x_l$, the set $X_i \to \oslash$, and the only feasible $x^*(h)$ is $x^*(h) \leq \frac{1}{2N}$ for all the good borrowers. As the number of banks grows, X_i tends to be smaller and smaller, at the limit an empty set when $\frac{1}{2N} < x_l$. This is the case in which good firms are locked in their initial location all participation constraints is slack, and there exists no location consistent with signalling equilibria. The fall of X_i reduces the room for relocation of firms with location $x \in [0, x_l)$; bank i's market share involving firms with locations $x \in [x_l, \frac{1}{2N}]$ also shrinks, and a larger proportion of these latter firms send their signal to the closest competing banks.

To show that under full competition signalling in no longer active, we proove that there exists no point $x \in [0, \frac{1}{2N}]$ at which high-quality borrowers are in condition to relocate and credibly signal. Hence, it is sufficient to show that at the extreme point, $\frac{1}{2N}$ or below it, low quality firms are able to profitably ask for credit (the sufficient condition for signalling does not hold). We consider again condition (8):

$$p_l[Z - R^*(x = x_l)] - \beta x_l = p_l[Z - \overline{R}] - \beta x_l$$

and evaluate it in the case of full competition, $\frac{1}{2N} = x_l$, where x_l is the signalling threshold. No signalling equilibria exist if:

$$p_l[Z - R^*(\frac{1}{2N})] - \frac{\beta}{2N} = p_l[Z - \overline{R}^c] - \frac{\beta}{2N} > 0 \tag{13}$$

and solving for $\mu = \frac{\beta}{N}$, we have the following condition[16]:

$$\mu = \beta\frac{1}{N} < [p_l Z - \frac{p_l(1+c)}{p_h\lambda}][\frac{2p_h}{2+p_h}] = \hat{\mu} \tag{14}$$

Proposition 3.
For $\mu < \hat{\mu}$ the competitive pressure is such that no sparating equilibrium exists.

Corollary 3.
For $\mu < \hat{\mu}$ high-quality firms do not relocate and will be priced the same rate of low quality firms. The outcome is a pooling equilibrium.

For $\frac{1}{2N} \in [x_l, x_h)$, competition involves high-quality firms only. The signalling mechanism still works and the necessary condition for separation is:

$$p_h[\underline{R} - \overline{R}^c] > (1 + \beta)(x_l - x_0) \tag{15}$$

Good borrowers compare the gain in term of price differential[17] with the sum of the switching costs and the travel costs. The left-hand side term in square bracket of (15) is the difference between the low-quality monopoly rate that is applied in the region $[0, x_l)$ and the high-quality competitive rate that is applied from $x = x_l$[18]. Solving (15) for the market share, we have that:

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[16]Solving (15) for the market share $\frac{1}{N}$ we havoe no singalling for $\frac{\hat{1}}{N} < (\frac{2+p_h}{\beta})[p_l Z - \frac{(1+c)}{p_h\lambda}]$.

[17]See appendix A.2 for details.

[18]Remember that in the "low-quality region", the bank believes all firms are of low quality and price them accordingly. Further more, given that we are in a partially competitive environment, the bank maintains its market power on low quality, and this explains why the rate charged in the region $[0, x_l)$ is $\underline{R} = R^m(l)$. Instead, at x_l the high quality rate is applied, but from that threshold the bank competes for high quality borrowers; then, the prevailing rate will be the high-quality competitive rate.

$$\frac{1}{N} > \frac{Z\rho - (1+\beta)x_o - (1+c)\omega}{\alpha} \equiv M_I, \tag{16}$$

Setting $x_o = 0$

$$\frac{1}{N} > \frac{Z\rho - (1+c)\omega}{\alpha} \equiv M_C \tag{17}$$

which gives the market share consistent with full separation [19]. M_I and M_C identify the minimum market share consistent with incomplete and complete separation respectively. It is straightforward to see that $M_C > M_I$. Using (16) and (17) we can state the following propostition:

Proposition 4.

The necessary condition for separating equilibria depends on the competitive level. The characterization of the equilibria in terms of market share gives the following results:

I. $M_I < \frac{1}{N} < M_C$ is a necessary condition for any separating equilibrium and for $\frac{1}{N} \in [M_I, M_C]$ we obtain semi-separating equilibria.

II. For $\frac{1}{N} > M_C$ we have complete separation.

Intuitions behind proposition 3.

With N fixed, the degree of differentiation is exogenously given and it is equal to $\Delta = \beta dx$, where dx is the distance between the bank and the marginal borrower, which has location $x = \frac{1}{2N}$. Then, $\Delta = \frac{\beta}{2N} = \frac{\mu}{2}$ is a positive funcion of μ. The overall product differentiation shrinks as the competition gets more intense. The parameter β and N act in the same direction. When N increases, many banks populate the market and offer cheaper subsitute financial contracts. Given the cost β, the greater substituibility implies lower costs of information provision and make the signalling possible to all borrowers. The intensity of competition relaxes partiticipation constraints and makes informative contracts affordable to all firms.

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[19]We have: $\alpha = \frac{(1+\beta)p_l}{p_h}$, $\rho = [\frac{(1+\beta)}{\beta} - \frac{1}{2}]$ and $\omega = (\frac{p_h}{2(1-\lambda)} - \frac{1}{\lambda} - \frac{(1+\beta)p_l}{p_h \lambda})$.

On the one hand, the effect of β is to vary the heterogeneity in preferences and the degree of contract differentiation. In particular, for β small the cost of the signal is low, and good firms relocation incentives are weakened. On the other hand, larger values N imply sharp competition given by the increased variety of informative contracts; this, in turn, induce mimicking by demanding for cheaper informative financial instruments.

It is important to underline that the market share is interpreted as the quantity of information incorporated in contracts, while β is the unitary cost of such an information[20]. In other words, β represents the *price*, while the market share represents the *quantity* of information required for separation[21]. When the price is low all firms are in condition to buy the contract necessary to separate and the information extracted from the relocation process is not sufficient to guarantee credible signalling. Moreover, when market shares are too small, low-types can afford to the reduced amount of information required for separation, loosening again the credibility of the signalling process. In conclusion we interpret μ as the value information has in the signalling mechanism[22]. The fall of μ due to compe-

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[20]A limited number of highly informative contracts (less contract differentiation) indeed makes relocation costly. As the variety increases (more differentiation) contracts become more substitute: a greater number of banks offer contracts that are closer to the firms' most preferd ones. As a result the incentives driving good firms to relocate tend to decline. This point helps to clarify the relationship between of informational content and information power of contracts. With low number of banks few contracts are offered with low informational content but high informational power. As the competition increases, more contracts are supplied, and each of them is closer to the best one all firms. In other words, banks offer a larger variety of informative contracts which are cheaper and more subsititute, characterized by more informational content but less informational power.

[21]The raise of N reduces the borrower-lender distance and relax partitipation constraints. The distance is a measure of the amount of information incorporated in the signal, i.e. the informative power of relocation. As N increases, the collapse of overall distances makes switching less costly for low-types: as a result, signalling loses its informational power. Also note the interesting trade-off between market share and the contract differentiation parameter β: when the information power of contracts is low (N large), the price β must be high in order to have $\mu > \hat{\mu}$ and vice versa.

[22]The sufficient condition for separation is expressed in term of μ, while the necessary conditions for complete and incomplete separation are expressed in terms of market shares. This does not affect the interpretation of the results because β and N act in the same

tition lowers the value of information to advantage of low-quality firms. Then, the informative power of relocation dramatically shrinks and signalling is not beleived credible.

4.5   Nonviability and competition

Assuming nonviability for low-types, i.e. $p_l Z < R$, asymmetric information is indeed severe because low-quality firms are no longer creditworthy. In this context, banks aim to finance only good firms because successfull application of bad firms would reduce the average quality of projects and good firms want to separate in order to obtain credit at the rate $R = R_i(h)$. With respect to the viability case, signalling is even more important because if separation is reached good firms are financed (at the high-quality interest rate) and banks avoid to finance insolvent firms. If only partial separation is reached, some good firms are locked in the no-financing region because believed to be of type l. As a result, a fraction of the most profitable firms does not obtain credit [23].

Under nonviability the sufficient condition for separating equilibria is still (14): the profit for a borrower located at x_l must be non-positive. The necessary condition for separation is:

$$\frac{1}{N} > \frac{1}{\beta}[p_h(Z - \frac{x_o}{e - p_h}) - \frac{1 + c}{\lambda}] \equiv \underline{M}_{NV} \tag{18}$$

where $e = \frac{p_l(1+\beta)}{\beta}$. Setting $x_o = 0$ for full separation, we obtain:

$$\frac{1}{N} > \frac{1}{\beta}[p_h(Z - \frac{1 + c}{\lambda})] \equiv \overline{M}_{NV} \tag{19}$$

---

direction, i.e. lowering the value of information in the signalling game. For istance, if $\beta = 0$ the righ-hand side of (16) explodes and there exists no market share value consistent with separation.

[23]The implication of severe incomplete separation is the destruction of firms potentially able to generate high profits.

Proof. See appendix A.7.

It is straightforward to see that $\overline{M}_{NV} > \underline{M}_{NV}$ (NV indicates the market shares under nonviability). Conditions (18)-(19) simply constraint the markets share of banks to be no smaller than $\underline{M}_{NV}$ for minimum separating condition and no smaller than $\overline{M}_{NV}$ for full separation. If competition is intense (14) does not hold and no separating equilibria exist.

For some values of p_h and p_l we obtain the interesting situation that $\overline{M}_{NV} > 2x_l$, i.e. the market share consistent with full separation is lower than the one associated to the full competition [24]. Under this condition, further competition generates two opposite effects: it increases the number of financed firms (the market is covered only in full competition) but reduces the proportion of good firms able to switch. Indeed, there is no way to increase efficiency when the competition is greater than the level consistent with full separation. Other and more detailed considerations about efficiency are reported in the next section.

5   Efficiency and welfare: some considerations

In this section we study some efficiency and welfare properties generated by the signalling. We shall mainly refer to the case of competition.

Before analyzing the competitive case, we make one point involving local monopoly. Under local monopoly there exists value of β that maximizes the profits of high-quality switching firms, and this value is β^*. This result does not depend on the initial location x_0 and is conditional on the relocation decision formalized in (12). Instead, the no-switching condition for low-quality borrowers is not affected by β, even though, for them the higher β the lower the profits and surplus. Moreover, $\beta^* > \hat{\beta}$, which implies that, once full separation is acheived, there is still room for welfare improving of high-quality firms. With $\beta = \beta^*$ singalling yields full separation and the maximum welfare is achieved by good-switching firms. We now turn to competition.

When banks compete for both types of firms the no-signalling framework dominates. In such a context the aggregate profits of high-quality firms are:

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[24]See appendix A.8 for proof.

$$\Gamma_H = \lambda[p_h(Z - R^p) - 2N \int_0^{\frac{1}{2N}} \beta x dx]$$

and aggregate profits of low-quality firms are:

$$\Gamma_L = (1 - \lambda)[p_l(Z - R^p) - 2N \int_0^{\frac{1}{2N}} \beta x dx]$$

where R is the rate obtained in absence of signalling (see appendix A.3 for derivation) [25]. The firms' aggregate profits are:

$$\Gamma = \Gamma_H + \Gamma_L = p(Z - R^p) - 2N \int_0^{\frac{1}{2N}} \beta x dx \qquad (20)$$

with $p \equiv p_h\lambda + p_l(1 - \lambda)$ denoting the average probability of repayment in the economy. When signalling is not active, all borrowers incur in the travel costs only. The aggregate travel costs are $2N \int_0^{\frac{1}{2N}} \beta x dx = \frac{\beta}{4N}$. Substuting this latter integral and the expression of R^p in (20) we find that:

$$\Pi_f = pZ - (1 + c) - \frac{\beta}{N}(\frac{1}{4} + \frac{2p}{p_h + p_l}) \qquad (21)$$

Aggregate profits are increasing in N and declining in β. Borrowing firms gain more when the number of incumbents is large and travel costs low.

Under singalling welfare evaluations are more complex because net profits of good switching firms are also affected by signalling costs and gains. Aggregate gross profits of high-quality firms are given by the sum of three components: the profits of the locked-in firms (if any), the profit of the switching firms and the profit of firms with location sufficient for signalling:

$$\Pi_{GS} = \lambda p_h[(Z - \underline{R}) + (Z + \underline{R} - \overline{R}^c) + (Z - \overline{R}^c)] = \lambda p_h[3Z - 2\overline{R}^c],$$

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[25]The rate R^p is obtained from the maximization problem of bank i under no signalling. In that case the bank cannot distinguish the borrowers' type and charges the pooling rate R^p to all firms belonging to its market share.

while the aggregate costs are:

$$C_s = 2N[\int_{x_l(N)}^{\frac{1}{2N}} \beta x dx + \int_{x_i(N)}^{x_l(N)} \beta[x_l(N) - x_i(N)]r dr]$$

where x_i is the location of the borrower indifferent between switching or not. The first term is square bracket in Π_{GS} is the profit for locked-in borrowers. This term vanishes under full separation ($x = 0$ and $x_i(N) = 0$). The other two terms in square bracket are the gross profit for the borrowers located and relocated in the signalling region. The first integral in C_s is the sum of travel costs for all good firms finally located at x_l or above, and the second one is the sum of the switching costs for those previously located below x_l.

Competition affects good firms aggregate profit in several direction. If, on one side, competition lowers prices and increases gross profits, on the other, it reduces overall travel costs above $N = N_{sh}$ (see appendix A.4). Overall travel costs provide a measure of the informational power of the contracts settled by firms. In the case of good firms, such costs are increasing up to N_{sh} and decreasing above, with the consequence that low level of competition are consitent with informative contracts and, in turn, signalling. When competition is intense the value of information incorporated in the contracts shrinks and there is no more room for credible signalling.

Competition increases switching costs via $x'_l(N) > 0$ but, at the same time, it reduces them by lowering the proportion of switching firms, because $x_i(N)$ tends to x_l for N large. Intuitively, there may exist a value $\tilde{N}$ above which costs are decreasing. The idea is that when N increases starting from low values, relocation costs increase because of the outward shift of x_l; this effect dominates the "proportion" effect, that is a lower fraction of firms are in condition to swtich. As a result signalling costs increase and relocation does have a rilevant informative power. When N is very large, the fraction of switching firms becomes smaller and switching costs fall. Contracts are less informative, making "mimic" possible for low-types and signal not credible.

Gross profits of low-quality firms are:

$$TCL = (1 - \lambda)[p_l(Z - \underline{R}) - 2N\int_0^{x_l(N)} \beta x dx] \tag{22}$$

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Under signalling travel costs for low-quality firms are increasing above $N = N_{sl}$ (see appendix A.5) because the competition implies a larger proportion of financed investment projects, involving, in turn, higher overall travel costs for borrowers. Given that high costs enhance the informational power of low-types contracts relative to high-type ones, this is a source for potential mimic and non-credible signalling. Below N_{sl} the competition is not intense, travel costs are decreasing and the informational value of contracts is negligble.

Travel costs for all types are decreasing in N when the no-signalling regime works[26]. As a result, the volume of information contened in the contracts becomes irrilevant.

It is worth noting two interesting implication of competition:

$i)$ competition lowers the proportion of firms signalling to a given bank. In fact, as reported in section 3.4, the set $X_i(N)$ "decreases" with N: competition erodes the bank's market share and profits from good firms whose position is sufficient from signalling; those firms, old and efficent, still separate but a fraction switches the signal to the closest competing bank.

$ii)$ in the case of full competition the market is covered; all projects are financed and the highest level of investment in the economy is reached[27]. This latter result crucially depends on the assumption of viability for low qualilty firms and arises an interesting trade-off. Less than full competition, on the one hand, generates non-financed viable projects and output lower than its efficient level; on the other hand, is consistent signalling and efficent pricing. Instead, under full competition we obtain inefficient pricing rules, with rates that may worsen credit conditions of high-quality firms (the pooling rate can be greater than the high-quality competitive rate. See appendix A.6 for analitical details). *With full competition generates efficiency in terms market coverage (efficiency in quantities) but not in pricing*[28].

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[26]In fact, by equation (20), total travel costs are $TC = \frac{4}{\beta N}$. Derivating TC with respect to N we obtain $\partial TC / \partial N = -\beta / 4N^2$.

[27]When $\frac{1}{2N} > x_h$ all the projects in the region $[0, x_l)$ are financed; a proportion λ is financed in the region $[x_l, x_h)$; zero projects are financed in the region $[x_h, \frac{1}{2N}]$. The larger N, the greater the fraction of good profects that obtains credit.

[28]This paper mainly aims to show how competition generates a trad-off between efficiency in qualtity and in pricing, but it would be interesting in future research to provide

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Removing the viablility assumption for low-quality firms, the results are strengthened. In fact, adverse selection is more severe because low-quality firms are not credit-worthy. Signalling becomes even more crucial to the bank because the problem is not only efficient pricing but also separating good firms from bad insolvent firms. Signalling is fondamental for good firms to separate and for lenders to avoid bankrupty risks due to potential ineffient credit policies. The important implication of nonviability is that full competition no longer implies efficiency in quantities given that banks finance the largest proportion of firms facing the impossibility to separate good from bad ones. Under the assumption $p_h = 2p_l$, we obtain that, for $\frac{1}{N} < \overline{M}_{NV}$ (the actual market share of the bank is lower than the one consistent with full separation), one further entry in the market would reduce the number of switching firms and increase number of good firms obtaining credit [29]. These two latter effects are likely to offset, with the result that it is not possible to gain more efficiency by raising the level of competition.

6 Concluding remarks

This model predicts that competition can limit the possibility to overcome asymmetric information between lenders and borrowers.

Conditional to local monopoly we find that what matter in the signalling process is the contract differentiation parameter, that we interpret as the price of the signal. Such a price must be sufficiently high to guarantee separation of high-quality firms. Moreover, because contract differentiation also measures the degree of market power of banks, we conclude that such a degree must be sufficiently different from zero to make separation feasible.

In the case of competition we obtain the following results. The existence of separating equilibria depends on contract differentiation but also on market shares.

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quantification. In particular, it is worth investigating if, under signalling, the loss of efficiency is offset by the gains of relocation

[29] It seems that competition does modify the overall proportion of financed firms, rather change the distributions of financed firms. If switching involves those young firms at the beginning of their credit history, the competition destroy the possibility these firms to emerge from the mass of new firms in the market and advantages the financing of old firms.

If market shares are relatively small, separation and efficient pricing are acheived. The results rely on the fact that, with sharp competition, the market is populated by many banks offering informative substitute contracts, which become affordable to low-quality firms as well. It follows that relocation is less informative and contracts lose their power to inform about quality. As a result singalling is no longer non credibly and separating equilibria do not exist.

Less than full competition yields efficient pricing and signalling of good firms, but it is inconsistent with the market coverage in the case of viability of all projects. If low-quality firms have positive net present value (viability) signalling equilibria are consistent with efficient pricing but inconsistent with market coverage. Separating equilibria generate efficient-quality pricing but, imposing a non-fully competitive market structure, prevent from financing the maximum level of investment projects. With negative present value (nonviability), the existence of insolvent firms makes adverse selection more severe. The problem of banks is more complex than pricing, and involves the decision to accord or deny credit. With complete separation, partial competition allows all good firms to successfully apply for credit, receiving efficent contract pricing, while insolvent firms are denied credit. This result generates both price efficiency and investment efficieny for some parameter values (see section 5). In fact, above the competitive level consistent with full separation, there is no way to increase efficieny because, on the one hand, more investment projects would be financed but, on the other, a lower proportion of firms would be able to relocate and to obtain credit.

This model may have business cycle implications, which can be object of future research. Under local monopoly and non viability of low-types in both sectors of banks and firms may exist rents. This attracts new entries, boosts competition and increases investment and output. The expansion of economy is driven by the credit market competition. As competition becomes more intense signalling breaks down, the number of good firms obtaining finance shrinks, investment and output decrease. With reduced market shares separation is no longer feasible and pooling equilibria may involve higher interest rates, lower average quality of firms and the deterioration of banking profitability. The economy slows down and profit contraction leads to bank's exit and larger market shares. Again, the reactivation of signalling can be the source of future fluctuations.

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Appendix

A.

The function $H(\beta)$ is such that:

$$H(\beta) \geq 0 \iff \beta \geq \frac{p_l[Z - \overline{R}] - p_h\gamma}{x_0 + p_h\gamma} = \underline{\beta},$$

with $\gamma = \underline{R} - \overline{R}$. This is the lower bound for β, i.e. the minimum value consistent with separation. For all $\beta < \underline{beta}$ no sepratating equilibria exist.

Setting $x_0 = 0$, with some handling we have:

$$H[(\beta)|_{x_0=0}] \geq 0 \iff \beta \geq \frac{1}{\frac{p_h}{p_l}\frac{\gamma}{(Z-\overline{R})} - 1} = \overline{\beta}$$

with $\overline{\beta} > \underline{\beta}$. This is the upper bound of β i.e. the value of β consistent with incomplete sepratation. In fact, above $\overline{\beta}$ we have complete separation equilibria.

A.1.

For $\lambda = \frac{1}{2}$, the proportions of the two types in the economy is the same, low quality borrowers are charged with $R^c(l) > R^c(h)$ reflecting their lower probability of repayment. In general

$$R^c(l) > R^c(h) \iff \frac{1}{p_l}[\frac{(1+c)}{1-\lambda} + \frac{\beta}{N}] > \frac{1}{p_h}[\frac{(1+c)}{\lambda} + \frac{\beta}{N}],$$

which is verified for $\frac{p_h}{p_l} > \frac{1-\lambda}{\lambda}[\frac{(1+c)+\lambda\mu}{(1+c)+(1-\lambda)\mu}]$, i.e. fo a degree of heterogeneity among borrowers sufficiently large.

A.2. The gain in terms of price differential is positive under condition $\underline{R} > \overline{R}^c$, which occur if $Z > (1+c)[\frac{1}{2p_h\lambda} - \frac{1}{1-\lambda}] + \frac{2\beta}{N}$, i.e. for Z sufficiently large.

A.3.

The pooling price R^p solves the following program:

$$\max_{R^p}\{[pR_i^p - (1+c)][(\frac{1}{N} + \frac{p_h(R_j^p - R_i^p)}{\beta}) + (\frac{1}{N} + \frac{p_l(R_j^p - R_i^p)}{\beta})]\} =$$

$$\max_{R^p}\{[pR^p - (1+c)][\frac{2}{N} + \frac{(p_h + p_l)(R_j^p - R_i^p)}{\beta})]\}.$$

Imposing symmetric prices, the first order condition implies:

$$\frac{2p}{N} = [pR_i^p - (1+c)]\frac{(p_h + p_l)}{\beta}$$

and solving for R_i^p:

$$R_i^p = R^p = \frac{(1+c)}{p} + \frac{2\beta}{(p_h + p_l)N}.$$

A.4. Under signalling, travel costs for high quality firms are:

$$TCH = 2N \int_{x_l}^{\frac{1}{2N}} \beta x\, dx = \beta N \frac{x_l^2}{2} \Big|_{x_l}^{\frac{1}{2N}} =$$

$$2N\beta[\frac{1}{4N^2} - x_l^2] = \frac{\beta}{4N} - \frac{N}{\beta}[p_l(Z - \overline{R}^c)]^2 =$$

$$\frac{\beta}{4N} - ARN^2 - \frac{RD^2}{N} > 0$$

where $R \equiv \frac{p_l^2}{\beta}$, $A \equiv (Z - \frac{1+c}{p_h\lambda})$ and $D = \frac{\beta}{p_h}$. Derivating:

$$\frac{\partial TCH}{\partial N} = -\frac{\beta}{4N^2} + \frac{RD}{N^2} - AR^2 =$$

$$\frac{1}{N^2}[\frac{RD^2}{N} - \frac{\beta}{4}] - AR > 0,$$

then, by substituting A, D and R and handling,

$$N < \frac{\beta[\frac{p_L}{p_h} - \frac{1}{2}]}{p_l(Z - \frac{1+c}{p_h\lambda})} \equiv N_{sh}.$$

For what regading the singnalling threshold, x_l is increasing in N:

$$\frac{\partial x_l}{\partial N} = x_l'(N) = \frac{\partial(p_l[Z - \frac{1}{p_h}(\frac{1+c}{\lambda} + \frac{\beta}{N})]\beta^{-1})}{\partial N} = \frac{\partial}{\partial N}(-\frac{p_l}{p_h}\frac{\beta}{N}).$$

Then,

$$x_l'(N) = \frac{p_l}{p_h}\frac{\beta}{N^2} > 0.$$

A.5.

Under signalling travel costs for low types are:

$$TCL = 2N\int_0^{x_l}\beta x\,dx = 2\beta Nx\Big|_0^{x_l} = N\beta x_l^2$$

With some handling and using R, A and D, we obtain

$$TCL = 2RN[A - \frac{D}{N}]^2 = RA^2N + \frac{RD^2}{N} - 2DR$$

Derivating TCL with respect to N.

$$\frac{\partial TCL}{\partial N} = RA^2 - \frac{RD^2}{N^2} > 0$$

and substituting R, D and A, this is verified for

$$N > \frac{\frac{\beta}{p_h}}{Z - \frac{1+c}{\lambda p_h}} \equiv N_{sl}.$$

A.6.

The pooling equilibrium rate R is greater than $\overline{R}^c$ if and only if

$$R^p = \frac{(1+c)}{p} + \frac{2\beta}{(p_h + p_l)N} > \frac{1}{p_h}[\frac{1+c}{\lambda} + \frac{\beta}{N}]$$

then, if

$$\frac{p_h(1+c)}{p} + \frac{2\mu}{(p_h + p_l)} < \frac{1+c}{\lambda} + \mu,$$

and, with some arrangements:

$$\mu[\frac{2p_h}{p_h + p_l} - 1] > (1+c)[\frac{1}{\lambda} - \frac{p_h}{p}] \iff \frac{\mu}{1+c} > [\frac{1-\lambda}{\lambda}\frac{p_l}{p}\frac{(p_h + p_l)}{(p_h - p_l)}].$$

A.7.

Good firms with location $[0, x_l)$ compare the profit of remaining in that region, which is zero because the bank beleives them to be low types and denies credit, with the profit of swiching and obtaining finance. The switching condition for good firms located below x_l is:

$$p_h(Z - \overline{R}^c) - \beta x_l - s > 0.$$

Then,

$$p_h(Z - \overline{R}^c) - \beta x_l - (x_l - x_o) > 0 \iff \overline{R}^c(\delta - p_h) > z - \frac{x_o}{\delta - p_h}.$$

with $\delta = \frac{(1+\beta)p_l}{\beta}$. Substituting the expression for $\overline{R}^c$ and solving for $\frac{1}{N}$ we have:

$$\frac{1}{N} > \frac{1}{\beta}[p_h(Z - \frac{x_o}{e - p_h}) - \frac{1+c)}{\lambda}] \equiv \underline{M_s}$$

and, conditional on $x_o = 0$

$$\frac{1}{N} > \frac{1}{\beta}[p_h(Z - \frac{1+c}{\lambda})] \equiv \overline{M_s}$$

we obtain the separating and full separating equilibrium conditions. *Q.E.D.*.

A.8. Comparing the $2x_l$ and the $\overline{M}_{NV}$ we have that:

$$\overline{M_{NV}} > 2x_h \iff p_h(Z - \frac{1+c}{\lambda}) > 2p_l[Z - \overline{R}^c] =$$

$$p_h(Z - \frac{1+c}{\lambda}) > 2p_l(Z - \overline{R}^c) \Rightarrow \frac{(1+c)}{\lambda}(\frac{2p_l}{p_h} - p_h) > Z(2p_l - p_h) - \frac{2p_l\beta}{p_h N}$$

Rearranging, we obtain:

$$k > \frac{1}{v}[Zp_h^2(2p_l - 1) - 2p_l\mu]$$

with $k = 2p_l - p_h^2$ and $v = \frac{(1+c)}{\lambda}$ and $\mu = \frac{\beta}{N}$ as defined in point IV of section 2. Note that this condition is always satisfied for $p_h = 2p_l$, i.e. when the probaility of repayment of good projects is twice the probability of bad ones.

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