Could dishonest banks be disciplined ?

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Abstract

Could a credit bureau incite banks to report correct information about their borrowers? We show that banks will choose the incorrect information sharing in the last period to increase their profits. Interestingly, however, it is shown that this strategy is optimal at the second period only if the proportion of successful projects is superior to 50%. In that case the Credit Bureau should enforce a sufficiently high penalty in order to incite banks to share information honestly. The penalty threshold that conditions the efficiency of the credit bureau's role is endogenously derived.

JEL Classification: G21, D82, L14

Keywords: Information sharing, penalty, incitation mechanism, credit bureau.

1 Introduction

Many studies (e.g. Stiglitz and Weiss, 1981) showed that asymmetric information dampens the efficient functioning of credit markets. In one hand, the borrowers need to get information about interest rates offered by banks in order to make their deposit decision. In the other hand, banks collect information about their potential clients in order to offer them the volume of credit and the interest rate which corresponds to their risk class. This information search is costly for an individual bank and borrowers when there is no centralized organism in charge of its collection and distribution. Pagano and Jappelli (1993) show that lenders should choose the strategy of information sharing to increase the volume of lending and reduce information costs. This result is confirmed by Padilla and Pagano (1997) who show that the exchange of information not only reduces information asymmetry between lenders and borrowers, but also reduces moral hazard and adverse selection. This information sharing is facilitated by information brokers as Public Registers or Credit Bureaus that collect files and distribute information among the members of the information sharing system. Djankov et al. (2006) show that the presence of these two substitute organizations increase lending and favors the development of the information sharing system. However, banks might not have any incentive to exchange information if this strategy will erode their client niches. Thus, false information reporting ("dishonest" strategy) could be the strategy chosen by banks. This opportunistic behavior was analyzed by Semenova (2008) which investigated the following question: "*has a bank any incentive to get benefit from information sharing without losing its competitive advantage?*"

To answer this question, Semenova (2008) developed a two-period credit market model. This market is compound of two types of agents: two identical banks and a continuum of entrepreneurs applying for a loan of size one they need to undertake a project. The entrepreneurs which are divided into two groups: high-ability and low-ability, choose the bank with cheaper credit. Semenova (2008) shows that banks will choose the dishonest strategy in the second period because it generates higher profit. Interpreting this result she suggested that a Credit Bureau could be a solution to this misreporting market distortion. However, since his model doesn't include the Credit Bureau as an active agent, the suggested solution misses analytical foundations.

In this paper we try to answer the following question: *Could a credit bureau design an efficient mechanism to incite banks reporting correct information about their borrowers?*

To answer this question we depart from Semenova (2008) and propose two extensions. The first extension consists in adding a third period in order to explicit the Credit Bureau role. Indeed, no such role could take place in a two-period model since the dishonest strategy will remain the banks' optimal strategy during the second period whatever the incentive mechanism designed by the Credit Burau. Hence, the latter will intervene after discovering banks choosing the dishonest strategy during the second period. The Credit Bureau intervenes by withdrawing the bank's license (for the third period) and imposing a penalty that should be paid by the "dishonest" bank. We determine the efficient level of this penalty as a function of the different parameters of the model among which the characteristics of the credit market. This leads us to the second extension of the paper which is considering a number n of operating banks in the credit market which interact in a spatial competition framework as considered by Grimaud and Rochet (1994) and Salop (1979).

This extension generates a more realistic credit market structure than Semenova (2008) and enables us to analyze of the interconnection between the credit bureau role and credit market structure.

The remainder of the paper is organized as follows. Section 2 offers the model and the different interest rates in the case of honest reporting. Section 3 analyzes the role of Credit Bureau in the case of dishonest information sharing. Section 4 summarizes the findings.

2 Model

Departing from Semenova (2008) we propose an extended model with three periods and an active role for the Credit Bureau. The basic framework is the model developed by Padilla and Pagano (1997).

2.1 Environment

We consider a three-period credit market model with three actors: n identical banks indexed by (i=1,…,n), a continuum [0,1] of entrepreneurs and a Credit Bureau. Banks are located symmetrically around a circle of measure 1 and entrepreneurs are uniformly distributed around the circle. Each entrepreneur is situated between two banks *i* and *i+1* and needs a loan of size 1 to undertake an investment project. He is located at $x_i \in [0,1/n]$ from bank *i* and and $x_{i+1} = 1/n - x_i$ from bank *i+1*. To ask for a loan an entrepreneur should select a bank taking in account the interest rate it charges and the transportation cost t.x he supports to reach it. Entrepreneurs are divided into two types: high-ability entrepreneurs which are present in proportion γ and low-ability entrepreneurs which are in proportion 1- γ. High-ability entrepreneurs undertake risky projects yielding R^* with probability p and zero with probability (1-p). Whereas, low-ability entrepreneurs undertake bad projects yielding nothing in all states of the nature. The parameters γ and p are public information since the beginning of the first period. This means that banks know the exact proportion of each type of entrepreneurs and know that a proportion γp among the high-ability ones will end the first period with successful projects. However, initially, they are unable to distinguish individually a high-ability entrepreneur from a low-ability one. This information will be partially discovered at the end of the first period. In fact, the success of a project will signals the high-ability type of the entrepreneur he undertook. However, a failing project could be a bad project (undertook by a low-ability entrepreneur) or a risky project (undertook by a high-ability entrepreneur) who failed. Table 1 presents the composition of the entrepreneurs' population at the end of the first period (beginning of the second period) and at the end of the second period (beginning of the third period).

Table 1. The composition of the entrepreneurs' population

<table>
<tr><th>At the beginning of the 1st period</th><th colspan="2">At the beginning of the 2nd period</th><th colspan="2">At the beginning of the 3rd period</th></tr>
<tr><td rowspan="4">High-ability : γ</td><td rowspan="2">Solvent high-ability : γp</td><td rowspan="2">Solvent: γp</td><td>Solvent high-ability : γp^2</td><td rowspan="3">Solvent : $\gamma p^2 + \gamma p(1-p) = \gamma p$</td></tr>
<tr><td>Defaulting: $\gamma p(1-p)$</td></tr>
<tr><td rowspan="2">Defaulting high-ability: $\gamma(1-p)$</td><td rowspan="3">Defaulting: $1 - \gamma p$</td><td>Solvent : $\gamma p(1-p)$</td></tr>
<tr><td>Defaulting: $\gamma(1-p)^2$</td><td rowspan="2">Defaulting: $\gamma p(1-p) + \gamma(1-p)^2 + 1 - \gamma = 1 - \gamma p$</td></tr>
<tr><td>Low-ability: $1 - \gamma$</td><td>Defaulting low-ability: $1 - \gamma$</td><td>Default: $1 - \gamma$</td></tr>
</table>

Therefore, at the end of the first and second periods, the population of entrepreneurs is composed as following: γp the high-ability entrepreneurs whose risky projects succeed and $1 - \gamma p$ entrepreneurs with failed projects.

2.2 Time events

At the first period: Every bank $i=1,\ldots,n$ offers a gross interest rate R_{i1} for all types of entrepreneurs since it cannot distinguish between high-ability and low-ability ones. At the end of the first period, only a proportion p of the high-ability entrepreneurs have successful projects and repay their loans. We assume that banks can observe the interest rates charged by other banks. However, we assume that banks can not observe for whom the interest rate was charged. Every bank i chooses the gross interest rate R_{i1} to maximize its profit in the first period:

$$Max\ \Pi_{i1} = (\gamma p R_{i1} - \overline{R})D_i - f \tag{1}$$

Where $D_i = D_i\left(\overset{-}{R_{i1}}, \overset{+}{R_1}\right)$ is the demand of the bank i that is negatively dependent of R_{i1} and positively dependent of the two neighbors' interest rate R_1. The parameter $\overline{R} \leq \gamma p\ R_{i1}$ represents the exogenous cost of capital. The parameter f represents a fixed cost paid by each bank to adhere to the information sharing system run by the Credit Bureau.

At the second period: We assume that, at the beginning of the second period, banks share information about the past results of entrepreneurs and not their types. Padilla and Pagano (1999) show that this type of information sharing has a disciplinary effect on entrepreneurs. Bank i could report wrong information about its solvent high-ability clients in order to discourage competing banks attracting them and to be able to offer them relatively higher interest rates. In doing so, bank i makes additional profits on the loans granted to these solvent entrepreneurs. However, it runs the risk to be penalized by the Credit Bureau during the third period. This trade-off will be analyzed in the third section.

We assume that entrepreneurs have no self-financing capital and spend all their profits at the end of the first period. Thus, in order to undertake a project during the second period they have to apply for a new loan. At the beginning of the second period, banks have acquired new information about the successful entrepreneurs. This enables them to charge differentiated interest rates. Let's denote R_{i21} the gross interest rate charged by bank i to the proportion γp of the high-ability entrepreneurs whose projects succeed and repaid their first-period loan. We denote R_{i22}, the gross interest rate charged by bank i to the first period defaulting entrepreneurs (whether they are a high-ability or low-ability type). The latter are composed of the high-ability entrepreneurs whose risky projects failed (their proportion is $\gamma(1-p)$) and the low-ability entrepreneurs (their proportion is $1-\gamma$). Thus, the total proportion of defaulting entrepreneurs is $1-\gamma p$. Bank i fixes the gross interest rates (R_{i21}, R_{i22}) that maximize its second-period profit:

$$Max\ \Pi_{i2} = (pR_{i21} - \overline{R})D_{i1} + \left(\frac{\gamma p(1-p)}{1-\gamma p}R_{i22} - \overline{R}\right)D_{i2} \tag{2}$$

Where $D_{i1} = D_{i1}(\overset{-}{R_{i21}}, \overset{+}{R_{21}})$ and $D_{i2} = D_{i2}(\overset{-}{R_{i22}}, \overset{+}{R_{22}})$ are respectively the demand for loan addressed to bank i by the successful and defaulting entrepreneurs. Only a proportion p of the first category of loans will be repaid. Whereas, the proportion of successful projects financed by the second category of loans is $p\gamma(1-p)/(1-\gamma p)$. Indeed, as presented in Table 1, among the total proportion 1-γp only a proportion p of the γ(1-p) high-skilled entrepreneurs (whose projects failed in the first period) will succeed their projects during the second period.

<u>*At the third period:*</u> Again, every existing bank *i* charges differentiated interest rates depending on the borrowers' payment history. We denote R_{i31} the interest rate charged by bank *i* to the high-ability entrepreneurs whose type is revealed during the two precedent periods[1]. Therefore, their total proportion is $\mu_1 = 2p(1-p)\gamma + \gamma p^2$ or equivalently $\mu_1=(2-p)\gamma p$. Let's denote R_{i32} the gross interest rate charged to the proportion $(1-p)^2\gamma$ of high-ability entrepreneurs who defaulted during the two first periods and the proportion (1-γ) of low-ability entrepreneurs. Their total proportion is denoted $\mu_2 = (1-p)^2\gamma + 1-\gamma$. Bank i chooses the interest rates (R_{i31}, R_{i32}) that maximize its third period profit:

$$Max\ \Pi_{i3} = (pR_{i31} - \overline{R})D'_{i1} + \left(\frac{\gamma p(1-p)^2}{\mu_2}R_{i32} - \overline{R}\right)D'_{i2} \tag{3}$$

Where $D'_{i1} = D'_{i1}(\overset{-}{R_{i31}}, \overset{+}{R_{31}})$ and $D'_{i2} = D'_{i2}(\overset{-}{R_{i32}}, \overset{+}{R_{32}})$ are respectively the demand for loan addressed to bank *i* by the proportions μ_1 and μ_2 of the entrepreneurs. Only a proportion p of the first category of loans will be repaid. Whereas, the proportion of successful projects financed by the second category of loans is $p\gamma(1-p)^2/\mu_2$. Indeed, among the total proportion μ_2 only a proportion p of the $\gamma(1-p)^2$ high-skilled entrepreneurs (whose projects failed in the two first periods) will succeed their projects during the third period.

2.3 Entrepreneurs' utility

After obtaining a loan of size one at the beginning of period *j=1, 2, 3,* high-ability entrepreneur have to repay the principal and interests on the loan. This gross amount is also the gross interest rate which we denote R_{ij}. The choice of an entrepreneur to ask for a loan from bank *i* or bank *i+1* is the result of its utility *Uj* maximization at the beginning of period *j* :

$$U_j = p(R^* - R_{ij}) \tag{4}$$

Finally, we assume that a low-ability entrepreneur (who knows his type since the beginning of period 1) undertakes a bad project because it provides him a positive utility.

2.4 Interest rates in the case of honest information reporting

In this subsection we determine the gross interest rates charged by banks in the three periods in the case of an honest information sharing.

Proposition 1: In the case of honest information reporting:

1) The gross interest rate fixed by banks are given by

$$R_1 = \frac{\overline{R}}{\gamma p} + \frac{t}{n} \tag{5}$$

[1] They are composed of the high-ability entrepreneurs whose projects succeeded in the two periods (their proportion is γp^2 and those whose project succeed at period 1 or period 2 (their proportion is $2\gamma p(1-p)$).

$$R_{21} = \frac{\overline{R}}{p} + \frac{t}{n} \tag{6}$$

$$R_{22} = \frac{\overline{R}}{p}\left(1 + \frac{1-\gamma}{\gamma(1-p)}\right) + \frac{t}{n} \tag{7}$$

$$R_{31} = \frac{\overline{R}}{p} + \frac{t}{n} \tag{8}$$

$$R_{32} = \frac{\overline{R}}{p}\left(1 + \frac{1-\gamma}{\gamma(1-p)^2}\right) + \frac{t}{n} \tag{9}$$

2) The profit of an individual bank during the three periods is given by:

$$\Pi_1 = \frac{\gamma p t}{n^2} - f \tag{10}$$

$$\Pi_2 = \frac{(1-\gamma)\overline{R}}{n} + \frac{\gamma p t}{n^2} \tag{11}$$

$$\Pi_3 = \frac{(1-\gamma)\overline{R}}{n} + \frac{\gamma p t}{n^2} \tag{12}$$

Proof. See appendix.

This proposition shows also that the transportation cost (which could be interpreted as the unitary degree of differentiation between banks) increases the bank's profit. This is intuitive since the higher this cost the larger is the bank's local monopoly niche. At the contrarily, profits is decreasing with the number of banks.

3 Dishonest strategy and the role of Credit Bureau

In the previous section we assumed that banks are sharing correct information about their clients and that they charge interest rates depending on the entrepreneur's type. In maximizing their profits in each period they might share incorrect information about the solvent high-ability entrepreneurs when there is no control by the Credit Bureau. Nevertheless, all the actors of the credit market know that at the beginning of each period, there is a proportion γp of solvent high-ability entrepreneurs. In this case, following Semenova (2008), we assume that the dishonest strategy is based on two incorrect information reporting. The first one consists in reporting those solvent entrepreneurs as defaulters. The second one consists in reporting instead of them a proportion of defaulting entrepreneurs as high-ability entrepreneurs with successful projects. Proceeding this way, a bank may get additional profits in the second or third period. In our model, the Credit Bureau can discover this deviation at the beginning of the second or the third periods.

Competing banks and the Credit Bureau can observe[2] the additional profits realized by the dishonest bank. This abnormal profit signals to the Credit Bureau the dishonest bank which will bear a penalty in the case of second period deviation. In the remainder of this section we determine the (gross) interest rates applied in case of misreporting and the additional profits realized by the "dishonest" bank. We will also specify the penalty threshold that Credit Bureau should apply to prevent the information misreporting.

Depending on the values of the parameters γ and p we could identify two cases. In the first case, the proportion γp of high-ability entrepreneurs whose risky projects succeed is lower than the proportion $1 - \gamma p$ of all the defaulting entrepreneurs. This correspond to the case $1 - \gamma p > \gamma p$ or $\gamma p<1/2$ which we denote case 1. The second case denoted case 2 is the opposite and takes place when $\gamma p \geq 1/2$.

3.1 Case 1: $1 - \gamma p > \gamma p$ or $\gamma p<1/2$

Under this case, a bank choosing the dishonest strategy will report that all the proportion γp of its high-ability solvent clients as low-ability or high-ability defaulting entrepreneurs (since it can't distinguish the type of the defaulting entrepreneurs). Instead of them, it will select a proportion γp among the proportion $1 - \gamma p$ of its defaulting clients to report as solvent. This dishonest strategy could take place at the beginning of the second or the third periods.

3.1.1 *The dishonest strategy at the beginning of the third period*

Table 2 presents the reporting of a bank that chooses the honest strategy at the beginning of second period and the dishonest strategy at the beginning of the third period.

Table 2. Misreporting strategy only at the beginning of the 3rd period

Entrepreneurs' proportion	True type of the entrepreneur's	1st period outcome of the loan	Reported outcome at the beginning of the 2nd period	2nd period outcome of the loan	Reported outcome at the beginning of the 3rd period
γp	High-ability	Solvent	Solvent	Solvent γp^2	Solvent: γp^2
				Defaulting $\gamma p(1-p)$	Defaulting: $\gamma p(1-p)$
$\gamma(1-p)$	High-ability	Default	Default	Solvent $\gamma p(1-p)$	Defaulting: $\theta = \gamma(1-p)^2 + 1 - \gamma$
					Solvent: $\gamma[1+(1-p)(2p-1)]-1$
				Defaulting $\gamma(1-p)^2$	Solvent : $\gamma(1-p)^2$
$1 - \gamma$	Low-ability	Default	Default	Default $1 - \gamma$	Solvent : $1 - \gamma$

This bank realizes an additional profit through charging a higher interest rates $R_{3,2}$ (see equation (9)) for the proportion θ of the new-revealed high ability entrepreneurs. This is different from the case of an honest information reporting where the entire proportion $\gamma p + \gamma p(1-p)$ of revealed high-ability entrepreneurs (whose risky projects succeed at least once during the two first periods), are charged a

[2] Technically, the reported information quality control tools are varied. We can mention for example comparison of data reported by banks with those situated in the insurance agencies databases, the offices of taxation or other credit institutions.

lower interest rate $R_{3,1}$. We can easily show that the third period additional profit relatively to the honest strategy is given by:

$$\Delta\Pi_{i3}^{dh} = (R_{32} - R_{31})\frac{\theta}{n} = \frac{\overline{R}}{np}(1-\gamma)\left[1 + \frac{(1-\gamma)}{\gamma(1-p)^2}\right] \tag{14}$$

Whereas, the third period profit is given by $\Pi_{i3} + \Delta\Pi_{i3}^{dh}$ where Π_{i3} the profit in case of honest reporting given by equation (12). In this case, the Credit Bureau discovers the dishonest bank at the end of the third period after observing the additional profit. However, the exclusion from the credit market doesn't make a sense and the dishonest bank will not pay the penalty.

3.1.2 The dishonest strategy at the beginning of the second period

A bank that chooses this strategy will realize additional profits in the second period. However, it will be discovered by the Credit Bureau at the end of the second period. The latter will charge it a penalty and exclude it from the credit market during the third period. The additional profit of this bank relatively to its rivals will be realized through charging higher interest rate R_{22} on the loans granted to the proportion γp of solvent entrepreneurs instead of R_{21}. Using (6) and (7), it is straightforward to show that the additional profit (relatively to the second-period profit in case of honest strategy) :

$$\Delta\Pi_{i2}^{dh} = (R_{22} - R_{21})\frac{\gamma p}{n} = \frac{\overline{R}}{n}\frac{1-\gamma}{1-p} \tag{15}$$

Equation (15) shows that this additional profit is decreasing with the number of banks. If the credit market is competitive and the number of banks is high, we showed that interest rates decrease and so do profits. Hence, in a less competitive credit market, banks have more incentive to choose the dishonest information report strategy. To prevent banks from deviating, the Credit Bureau charges the bank a penalty C_1 and withdraws its license excluding it from the credit market. Thus, not only the bank pays the penalty C_1 but also abandon its third-period profit. Hence, a bank has no incentive to choose the dishonest strategy if the additional profit $\Delta\Pi_{i2}^{dh}$ realized during the second period minus the penalty C_1 is lower than the third period misreporting profit $\Pi_{i3} + \Delta\Pi_{i3}^{dh}$ which it abandons. Therefore, the penalty Credit Bureau should apply to prevent the misreporting strategy verifies:

$$\Delta\Pi_{i2}^{dh} - C_1 \quad \leq \quad \Pi_{i3} + \Delta\Pi_{i3}^{dh1} \tag{16}$$

Proposition 2:

When the proportion of successful project is inferior to 50% (case 1) the dishonest strategy isn't optimal at the second period.

*Proof. U*sing the expressions (14) and (15) and the fact that under case 1 we have $\gamma p < 1/2$ it is straightforward to show that $\Delta\Pi_{i2}^{dh} < \Delta\Pi_{i3}^{dh1}$. This means that condition (16) holds and the bank by itself hasn't an incentive to deviate at the second period. At the contrary, it is more profitable for it to misreport information at the beginning of period 3. Hence, when the proportion of successful projects are less than 50% there is no incentive for banks to deviate at the second period (this is because the condition $\gamma(1-p) + (1 - \gamma) > \gamma p$ is equivalent to $1/2 > \gamma p$).

3.2 Case 2: $1-\gamma p \leq \gamma p$ or $\gamma p \geq ½$

In this case, the proportion γp of high-ability entrepreneurs whose risky projects succeed is higher than all the defaulting entrepreneurs: $1-\gamma p$. A bank that chooses the dishonest strategy will report the proportion $1-\gamma p$ of defaulting entrepreneurs as high-ability ones. However, it should report an additional $\gamma p - (1-\gamma p) = 2\gamma p - 1$ as high-ability. It has no choice but selecting this latter proportion from the high-ability entrepreneurs whose projects effectively succeeded. The remaining proportion of them $(\gamma p - (2\gamma p - 1) = 1 - \gamma p$ will be reported as low-ability.

3.2.1 Misreporting at the beginning at the third period

This situation occurs when the bank reported honestly the information at the second period and decides to misreport at the beginning of the third period. Table 3 presents the misreporting strategy of the bank.

Table 3. Misreporting strategy only at the beginning of the 3rd period

Entrepreneurs' proportion	1st period outcome of the loan	Reported outcome at the beginning of the 2nd period	2nd period outcome of the loan	Reported outcome at the beginning of the 3rd period
High-ability : γ	Solvent: γp	Solvent	Solvent: γp^2	Solvent: γp^2
			Defaulting: $\gamma p(1-p)$	Defaulting: $\gamma p(1-p)$
	Default: $\gamma(1-p)$	Default	Solvent $\gamma\, p(1-p)$	Defaulting $\theta = \gamma(1-p)^2 + 1 - \gamma$
				Solvent $\gamma[1+(1-p)(2p-1)]-1$
			Defaulting $\gamma(1-p)^2$	Solvent : $\gamma(1-p)^2$
Low-ability : $1 - \gamma$	Default: $1 - \gamma$	Default	Default $1 - \gamma$	Solvent : $1 - \gamma$

This situation is equivalent to that described in subsection 3.1.1 and we obtain the same additional profit given by equation (14). In this case also, the Credit Bureau discovers the dishonest bank at the end of the third period after observing the additional profit. However, the exclusion from the credit market doesn't make a sense and the dishonest bank will not pay the penalty.

3.2.2 Misreporting at the beginning of the second period

This corresponds to a situation where the bank chose the dishonest strategy since the second period. Table 4 presents the misreporting strategy of the bank.

Table 4. Misreporting strategy at the beginning of the 2nd period

Entrepreneurs' proportion	1st period outcome of the loan	2nd period outcome of the loan	Reported type at the beginning of the 2nd period
High-ability : γ	Solvent: γp	Solvent : γp^2	Solvent : $p(2\gamma p- 1)$
			Default : $p(1 - \gamma p)$
		Defaulting: $\gamma p\,(1-p)$	Solvent: $(1-p)(2\gamma p- 1)$
			Defaulting: $(1-p)\,(1 - \gamma p)$
	Default: $\gamma(1-p)$	Solvent: $\gamma\, p\,(1-p)$	Solvent : $\gamma\, p(1-p)$

		Defaulting: $\gamma(1\text{-p})^2$	Solvent : $\gamma(1\text{-p})^2$
Low-ability :1 - γ	Default: 1 - γ	Defaulting: 1 - γ	Solvent: 1 - γ

Choosing this strategy, the bank will realize additional profits through charging the proportion $p(1 - \gamma p)$ of high-ability entrepreneurs' higher interest rate R_{22} instead of R_{21}. Using the expressions (6) and (7) of the interest rates, we can easily calculate the second period additional profit:

$$\Delta\Pi_{i2}^{dh2} = (R_{22} - R_{21})\frac{p(1-\gamma p)}{n} = \frac{\overline{R}}{n}\frac{(1-\gamma)(1-\gamma p)}{\gamma(1-p)} \tag{17}$$

Using equation (15), (17) and the condition $1\text{-}\gamma p \leq \gamma p \leq \gamma$ it is easy to show that the additional profit in case 1 is larger to that in the case 2: $\Delta\Pi_{i2}^{dh} \geq \Delta\Pi_{i2}^{dh2}$. Hence, the additional profits are higher when the proportion of high-ability entrepreneurs whose risky projects succeed is lower than those who default. This is because the scope of misreporting is larger for the bank.

Proposition 2.

When the proportion of successful project is superior to 50% (case 2: $\gamma p \geq ½$) the dishonest strategy isn't optimal at the second period if and only if:

- *the Credit Bureau withdraw the dishonest bank license during the third period If* $t \geq \bar{t}$
- *the Credit Bureau withdraw the dishonest bank license during the third period and imposes a penalty strictly superior to* $\overline{C}_2$ *if* $t < \bar{t}$ *where :*

$$\overline{C}_2 = \frac{\gamma p t}{n^2}\left(\bar{t} - t\right)$$

$$\bar{t} = \frac{n\overline{R}(1-\gamma)}{(\gamma(1-p)p)^2}\left[p(1-p) + \gamma p - 1\right] \tag{18}$$

Proof. Taking in account the penalty and the exclusion from the credit market during period 3, the total profit of the deviating bank is given by:

$$\Sigma\Pi_i^{dh2} = \Pi_{i1} + \Pi_{i2}^h + \Delta\Pi_{i2}^{dh2} - C_2 \tag{19}$$

Whereas the total profit of a bank choosing to deviate at the third period is given by

$$\Sigma\Pi_i^{dh1} = \Pi_{i1} + \Pi_{i2}^h + \Pi_{i3}^h + \Delta\Pi_{i3}^{dh1} \tag{20}$$

Where the additional profit $\Delta\Pi_{i3}^{dh1}$ is given by equation (14). Hence, the threshold penalty that delays the misreporting to the final period of the game should verify:

$$\Delta\Pi_{i2}^{dh2} - C_2 \leq \Pi_{i3}^h + \Delta\Pi_{i3}^{dh1} \tag{21}$$

And the penalty threshold is given by

$$\overline{C}_2 = \Delta\Pi_{i2}^{dh2} - \Pi_{i3}^{h} - \Delta\Pi_{i3}^{dh1} \tag{22}$$

Finally, using equations (12), (14), (17) and (22) we obtain the expression (18)

This proposition shows that the exclusion of the dishonest bank from the credit market during the third period is sufficient when the degree of differentiation of banks (the transport cost) $t \geq \bar{t}$ exceeds a determined threshold. The intuition behind this is related to the trade-off that the dishonest bank faces. When $t \geq \bar{t}$ the third-period profit exceeds the additional profit it could make if it chooses the dishonest strategy during the second period. However, when $t < \bar{t}$ its monopoly power as well as its third-period profit are lower (see equations 12 and 14). In this case, the additional profit it could make during the second period is higher than the third-period profit. Therefore, the credit bureau has to impose a complementary sanction which is a penalty strictly superior to $\overline{C}_2$. It is also interesting to note that an increase in one or more of the two dimensions of competition between banks (the transport cost *t* and their number *n)* lowers the penalty threshold $\overline{C}_2$.

Conclusion

In this paper we tried to answer the following question: Could a credit bureau design an efficient mechanism to incite banks communicating correct information about their borrowers?

To answer this question, we extend the model of Semenova, M. (2008, "*Information sharing in credit markets: incentives for incorrect information reporting*,"Comparative Economic Studies, Vol. 50, No. 3, pp. 381-415, 35) in two directions. The first extension consists in adding an explicit the role of the Credit Bureau in a third-period framework. The second extension is considering a credit market composed of *n* banks interacting in a spatial competition model à-la Salop (1979).

We confirm the result of Semenova (2008) showing that banks will choose the incorrect information sharing in the last period to increase their profits. Interestingly, however, it is shown that this strategy is optimal at the second period only if the proportion of successful projects in the economy is superior to 50%. In that case, the Credit Bureau could prevent the information's misreporting when it applies a sufficiently high penalty and withdraws the license of the deviating bank during the third period. It is shown that this penalty depends on many variables: the transportation cost, the proportion of high-ability entrepreneurs and the success probability of the risky investment projects. Applying a penalty below this threshold will not discourage the banks from choosing the dishonest strategy during the second and third periods.

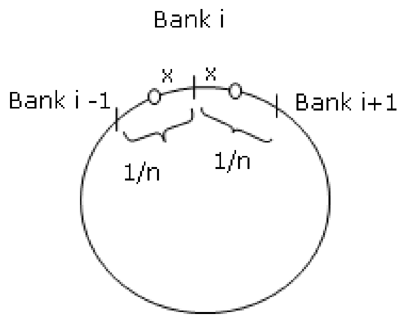
Appendix

Proof of proposition 1

Every bank i=1,…,n fixes the interest rate R_{i1} that maximizes its first period profit:

$$\Pi_{i1} = (\gamma p R_{i1} - \overline{R}) D_i - f \tag{A1}$$

where $D_i = D_i\left(\overset{-}{R_{i1}}, \overset{+}{R_1}\right)$: is the demand addressed to the bank i ; γ : the proportion of high-ability entrepreneurs; p: the probability of choosing successful projects; and $\overline{R}$: the banks'cost of capital. First, let's determine the expression of the demand D_i addressed to the bank i. Hence, we should determine the location x of the entrepreneur situated between bank i and bank i+1 and who is indifferent between the two banks when asking for a loan.



The bank i will offer the interest rate R_{i1} and the bank i+1 offers the interest rate R_1. The indifference condition consists in equalizing the total cost of the two loans that could be granted by the two banks:

$$R_{i1} + tx = R_1 + t(1/n \; - x) \tag{A2}$$

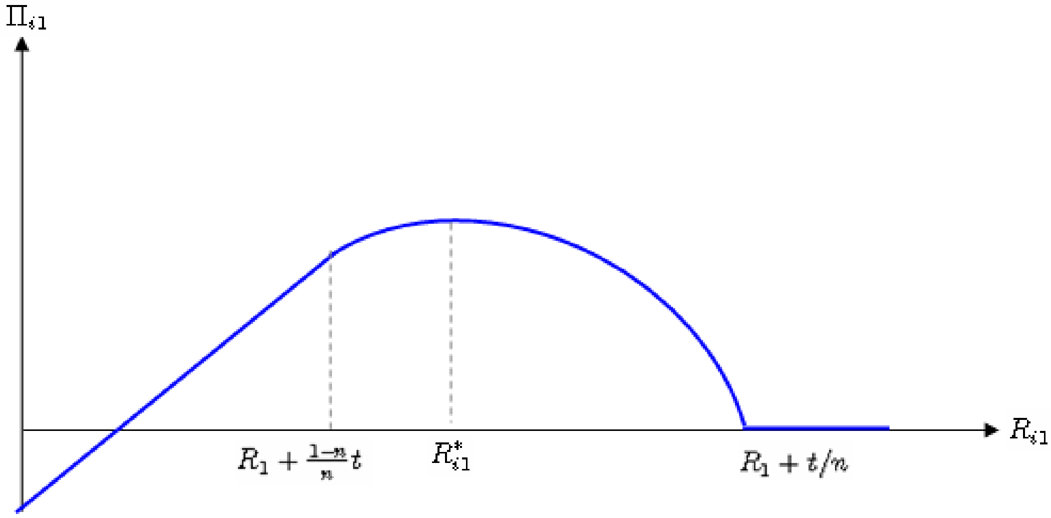
Then we can find the expression of bank's i demand:

$$D_i = D_i\left(\overset{-}{R_{i1}}, \overset{+}{R_1}\right) = 2x = \frac{R_1 - R_{i1} + t/n}{t} \tag{A3}$$

Thus,

$$D_i = \begin{cases} 0 & \text{if } R_{i1} \geq R_1 + t/n \\ \dfrac{R_1 - R_{i1} + t/n}{t} & \text{if } R_1 + \frac{1-n}{n}t \leq R_{i1} \leq R_1 + t/n \\ 1 & \text{if } R_{i1} \leq R_1 + \frac{1-n}{n}t \end{cases} \tag{A4}$$

Using, the expression $\Pi_{i1} = (\gamma p R_{i1} - \overline{R})D_i - f$ it is clear that the bank i profit is a concave function of R_{i1} as shown by the following figure:



Writing the first order condition, under the hypothesis that bank i considers the interest rate R_1 fixed by its rivals as exogenous (Cournot Competition), we find the gross interest rate R^*_{i1} that maximizes the profit :

$$R^*_{i1} = \frac{1}{2}\left(R_1 + t/n + \frac{\overline{R}}{\gamma p}\right) \tag{A5}$$

This value is strictly superior to $R_1 + \frac{1-n}{n}t$ under the condition $\overline{R} \leq \gamma p R_1$ which is necessary to guarantee a non-negative profit during the first period. Now, we use the symmetry of the problem and set $R^*_{i1} = R_1$ in (A5). Hence, we obtain

$$R_1 = \frac{\overline{R}}{\gamma p} + \frac{t}{n} \tag{A6}$$

Using (A1) we obtain the following expression of the first-period profit

$$\Pi_1 = \frac{\gamma p t}{n^2} - f \tag{A7}$$

It is now question to find the interest rates and the profit of the second period. The second period profit is given by

$$\Pi_{i2} = (pR_{i21} - \overline{R})D_{i1} + \left(\frac{\gamma p(1-p)}{1-\gamma p}R_{i22} - \overline{R}\right)D_{i2} \tag{A8}$$

Where $D_{i1} = D_{i1}(\overset{-}{R_{i21}}, \overset{+}{R_{21}})$ and $D_{i2} = D_{i2}(\overset{-}{R_{i22}}, \overset{+}{R_{22}})$ are respectively the demand for loan addressed to bank i by the successful entrepreneurs (whose proportion γp is uniformly distributed around the circle) and defaulting entrepreneurs (whose proportion 1-γp is uniformly distributed around the circle). Hence, the expressions of these two types of demand are analogous to (A4):

$$D_{i1} = \begin{cases} 0 & \text{if } R_{i21} \geq R_{21} + t/n \\ \gamma p \dfrac{R_{21} - R_{i21} + t/n}{t} & \text{if } R_{21} + \frac{1-n}{n}t \leq R_{i21} \leq R_{21} + t/n \\ \gamma p & \text{if } R_{i21} \leq R_{21} + \frac{1-n}{n}t \end{cases}$$

(A9)

$$D_{i2} = \begin{cases} 0 & \text{if } R_{i22} \geq R_{22} + t/n \\ (1-\gamma p) \dfrac{R_{22} - R_{i22} + t/n}{t} & \text{if } R_{22} + \frac{1-n}{n}t \leq R_{i22} \leq R_{22} + t/n \\ 1-\gamma p & \text{if } R_{i22} \leq R_{22} + \frac{1-n}{n}t \end{cases}$$

Noting that the maximization of Π_{i2} could be realized by maximizing separately its two components in (A8). In addition, these two separate problems are analogous to the maximization of Π_{i1}. To obtain, the solution we have just to choose $\gamma = 1$ and $f = 0$ in (A1) for the maximization of the first term and replace p by $\frac{p(1-p)}{1-\gamma p}$ and $f = 0$ in (A1) for the maximization of the second term. The remainder of the proof is the same.

We can find the remainder of the results following the same reasoning.

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