Public versus Private Signals in the Credit Market

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Abstract

It is increasingly being realized that the 'social infrastructure' of any economy is a key factor shaping its business environment. Social infrastructure includes not only the physical infrastructure of an economy, but also its legal framework, business regulations, extent of corruption in the economy etc...It has been observed that those economies having a better quality of social infrastructure consistently attract higher levels of domestic and foreign investment, as compared to economies plagued with corruption, poor implementation of laws and regulations governing business and poor social infrastructure. In a simple theoretical model which explicitly takes into account such factors, we point out one possible explanation why a lender (presumably a bank) would look to these economy wide, social infrastructure indicators instead of firm-specific indicators to determine its lending decisions. We conclude that in contrast to private signalling by firms in the credit market in the form of the collateral posted, it is these factors which will increasingly be looked upon as 'public' signals, determining the extent of investment in an economy.

keywords: adverse selection, moral hazard, public signals.

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1 Introduction

The level of investment in any economy, both domestic as well as foreign, depends to a large extent on the business environment in that economy. A country which has a poor implementation of laws and regulations governing its business contracts, a high level of bureaucratic inefficiency and corruption, poor quality of public services, poor infrastructure and political instability does not attract high levels of private investment. An environment conducive to the flourishing of private initiatives needs to be fostered both by the institutions within an economy as well the public policies which shape it. The laws and regulations in a country and public policies governing business practices constitute what is today called the "social infrastructure" of that economy (See Hall and Jones[10]). Several cross-country studies find that those countries which rank low on this social infrastructure index (countries plagued by corruption, predatory business practices, and rent seeking activities) are also stuck with low levels of investment, lower productivity and lower levels of income and growth. Mauro[13], for example, uses a data set consisting of subjective indices of bureaucratic honesty and efficiency to find a negative impact of corruption on investment levels. According to him, if Bangladesh were to achieve a one standard deviation increase in its bureaucratic efficiency its investment rate would rise by five percentage points. Hall and Jones[10], conclude that countries which consistently score high on the social infrastructure index achieve high rates of investment in physical and human capital. Recent studies in the transition economies[7], also indicate that wide spread predation and insecure property rights have depressed capital accumulation in these countries in all its dimensions. And lastly, Shang-Jin Wei[17], arrives at a similar conclusion with respect to foreign direct investments in the developing economies.

Based on the above empirical results, the object of this paper is to provide a possible "micro" link between social infrastructure indicators of an economy and investment decisions. The model is based on the results of an extensive survey carried out by the World Bank Group [18] of some 10,000 firms in 80 countries between late 1999 and mid-2000, on the business environment facing firms called the World Business Environment Survey (WBES, 2000). One of the crucial observations in this survey was that in economies having poor laws and regulations governing business practices, firms suffered a lower yield than expected. In the transition economies of Eastern Europe, developing East Asia and and South Asia, an average of around 5 percent of the total revenues was lost on account of poor laws and regulations

regarding business practices. This was in contrast to firms in OECD countries and the newly industrialized East Asia where around 86 percent of the firms reported no loss of revenue due to such factors. [1]

This paper will answer the issue of how these economy wide indicators governing business environment in a country enter into a bank's decision making process. Why would a bank look to these economy-wide indicators instead of firm-specific indicators in taking its lending decisions? The mainstay of the explanation will be the existence of asymmetric information in the credit market. We essentially build on two models, (a) Hellwig[11], which takes into consideration ex-ante, pre-contractual adverse selection problems in a three stage dynamic game being played between the lenders and borrowers in the credit market, and (b) Aghion and Bolton[1], which deals with post-contractual moral hazard issues in the credit market. Increasing the contract space of the banks to include both the interest and the collateral allowed for the possibility of the banks using collateral as a self-selection device and avoiding the problem of adverse selection[6]. In this paper, we allow banks to simultaneously choose interest rates and collateral requirements, but in addition to the pre-contractual information asymmetry, we add second layer of information asymmetry in the form of a post-contractual, moral hazard problem.

This paper then shows that due to this interaction between selection and incentive effects, collateral loses its relevance as a self-selection device. Lenders would then increasingly resort to public signals like social infrastructure indicators in taking their lending decisions. It is through this link that such public indicators which define the business environment of an economy affect

[1]Respondents in this survey were asked if it was common for firms "in their line of business to have to pay some irregular 'additional payments' to get things done?" In South Asia and Developing East Asia more than 60% of the firms said this was always, mostly or frequently the case. In Africa, more than half of the firms reported that such payments were at least frequently required. In the transition economies of Central and Eastern Europe, around a third of the firms provided such responses. Only in the OECD countries and the industrialized East Asia could this response be described as rare - around 12% of the firms. To gauge the actual impact of such payments, WBES enquired about the total percentage of revenues paid as "unofficial payments" to public officials. These payments are the highest in the transition economies of Eastern and Central Europe at 5.5% of revenues, in South Asia (which consists of India, Pakistan and Bangladesh) it was 5%, while in developing East Asia, it was 4.6% of the total revenues. In contrast, 86.3% of the firms in the newly industrialized East Asia, and 83% of the firms in the OECD countries reported paying 0% of their revenues in bribes [3].

the investment levels in that economy. Economies having a poor social-infrastructure have lower levels of lending. Thus, in a simple theoretical model which explicitly takes into account a parameter of social infrastructure (the possibility that because of poor implementation of laws, corruption, need for 'irregular payments' to bureaucrats etc... firms do not earn their full revenue, which they would under ideal circumstances), we show how economies ranking low on the corruption index have higher levels of investment. This would also explain, for example, given the global nature of investment portfolios, there is an increasing emphasis on collecting and understanding country risk measures by institutional investors.

The paper is organized as follows, section 2 introduces the model. Section 3 establishes the key result of the existence of a pooling equilibrium in the credit market. Section 4 discusses the effect of social infrastructure on this equilibrium, and the conclusion is given in section 5.

2 Model

Agents : Identical agents who are endowed with 1 unit of labor (l), which they supply inelastically. They are also endowed with wealth ($w < 1$), which can be deposited in a bank, or used as collateral to obtain loans from the bank. The agents are risk-neutral, live for 2 periods and they produce in the first period and consume in the second. These agents have 2 choices: to be workers in a routine activity which only requires labor (and thus deposit w in the banks), or to undertake an entrepreneurial project which requires them to combine 1 unit of labor with 1 unit of capital. Workers get a deterministic return Z. Potential entrepreneurs have to borrow 1 unit of capital in order to undertake the project. More about the entrepreneurial project will be said below.

Banks : Banks in this economy are risk-neutral and act as Betrand Competitors in a market where they obtain elastically supplied funds. We normalize the gross deposit rate at which the banks obtain these funds to be one. Since we assume banks to be Betrand competitors, they make zero profits in equilibrium on the projects they lend.

Projects : The returns from the project are Uncertain. The uncertainty in this project stems from two sources,

Ex-Ante - The project has a success probability of p. This is however not known ex-ante either to the potential entrepreneur or to the banker. What the entrepreneur does know ex-ante is

the return from the project, if it is successful. It is in determining the returns from a successful project that this model takes into the social infrastructure of the economy. In an ideal situation, a successful project will yield the entrepreneur its full yield (Y_F). However, firms lose revenue in a business environment which is constrictive and predatory. In this model, let the proportion of firms who have to suffer a lower yield on account of poor social infrastructure be γ. Let this lower yield be denoted Y_L. (Firms could potentially suffer a range of low yields on this project on account of such payments, but we summarize it to be Y_L, and $Y_L < Y_F$). Whether their yield is Y_F or Y_L is the private information of the firms. γ, however is an indicator of the social infrastructure, which is public information. Higher the γ, higher is the proportion of firms who have to lose revenue on account of factors such as corruption, bribery, lobbying for award of government contracts, payments for procurement of public services etc...and greater is the size of this 'shadow' or unofficial economy.[2]

Ex-post : In the post-contractual ex-post scenario, the success probability (p) gets determined. p is an indicator of the effort put in by both types of entrepreneurs, once they secure a loan contract and have to implement the project. It is optimally chosen only after acceptance of the loan contract. Since the probability of success p is an indication of the the individual's effort, there is an effort cost c(p). Following Aghion and Bolton[1], we assume a uniform convex cost function across individuals,

A 1 $c(p) = \frac{p^2}{2}$.

The project is high yielding. We explicitly assume 'high yielding' to be,

A 2 $Y_i - 1 > Z, \quad \forall i \in \{F, L\}$. *The expected value of the net returns from the project exceed the opportunity cost of the project to all agents.*

Thus there exist incentives for all agents to undertake the project.

[2]This assumption implies that firms who choose to make such payments are not engaged in 'predation'(where predation includes rent-seeking and dupe activities [7]). Therefore, it is very different from the Murphy, Schleifer and Vishny hypothesis [4] where firms choose between productive and predatory activities depending upon the returns guaranteed to them by the system. Here we have a single productive project, but on account of the poor social infrastructure, some firms have to make illegal payments to carry out the project. This assumption is closer to the Grossman and Kim [9] hypothesis where some firms are moral and would not engage in corrupt practices, and some firms are amoral and would engage in corruption. In this model however, the morality of firms is not fixed or given, but it is a function of the parameter γ, which is determined by the institutions and public policies of an economy, and thereby amenable to change.

3 Capital Market Equilibrium

Taking into consideration, this two-layered information asymmetry, the capital market equilibrium is obtained in the following way,

The optimal loan contract: Assume there exists only a standard debt contract for investing funds (issuing equity is costly). As in the model of Bester [6], banks offer a loan contract consisting of a pair $\langle r, c\rangle$ where r is the gross interest rate charged and c is the collateral that the borrowers are willing to put up. We also make the following additional assumption,

A 3 *Collateralizing is costly. Collateral of value c_i to the borrower gives to the bank a value of βc_i, in the event the borrower defaults, where $\beta \in (0, 1)$.*[3]

As in Hellwig [11], the a 3 stage sequential game is being played in the credit market. This game explicitly takes into account dynamic reactions of borrowers. The optimal loan contract can be seen as a solution to a 3 stage game,

Stage I: Banks offer contracts $\langle r_i, c_i\rangle$.

Stage II: Given the contracts the borrower i chooses p such that it maximizes her expected revenue from the project net of (a) repayment cost (b) effort costs. The borrower chooses the contract most attractive to him. He can choose only a single contract.

Stage III : The banks may accept or reject the loan applications they have recieved in Stage II.

The optimal contract $\langle \hat{r_i}, \hat{c_i}\rangle$; $\forall i$ = H, L is a set of contract offers which determine the equilibrium in this 3 stage game. i.e. given $\langle \hat{r_i}, \hat{c_i}\rangle$ $\forall i$ = H, L

- Banks make zero profits on each contract and
- No bank has the incentive to offer a different loan contract than the ones offered.

We define U_{ij} to be the utility to agent of type i applying for a loan contract meant for type j.

3.1 Equilibrium when the banks can distinguish types

As a benchmark, we solve first the case when banks can distinguish between types. The banks are aware of the illegal payments that have to be made by firms, i.e they are aware of whether

[3]The assumption of the bank not being able to realize the full value for the collateral in case of default by the borrower, apart from having real world justifications is also crucial for the existence of equilibrium in a risk neutral environment. See Clemenz [8].

the revenue of the firms is Y_F or Y_L. This is the solution in the absence of adverse selection, when banks have to tackle only the post contractual moral hazard problem. They are not aware of the effort that will be put in by the borrowers after they get the contract. The problem for the entrepreneur is,

$\underbrace{Max}_{p_i,r_i,c_i} U_{ii} = p_i(Y_i - r_i) - (1-p_i)c_i - \frac{p_i^2}{2}$ s.t.

(i) the Zero profit constraint for the banks: $R_b \equiv p_i r_i + (1-p_i)\beta c_i = 1$.

(ii) the self selection constraints $U_{ii} \geq U_{ij}$.

(iii) The Individual Rationality constraint $U_{ii} > Z$.

In the full-information case, the self-selection constraints do not bind. Therefore, the borrower solves

$$\begin{aligned} \underbrace{Max}_{p_i,r_i,c_i} \quad &: \quad p_i(y_i - r_i) - (1-p_i)c_i - \frac{p_i^2}{2} \\ s.t. \quad R_b \quad &\equiv \quad p_i^* r_i + (1-p_i^*)\beta c_i = 1 \\ U_{ii}^* \quad &= \quad Z \end{aligned}$$

Where p_i^* refers to the equilibrium choice of effort by the entrepreneur, and U_{ii}^* refers to the equilibrium level of utility, once the effort has been chosen. Before we give the full information solution we see that the equilibrium effort level p_i^*, given the interest rate r_i and collateral c_i has to satisfy the following conditions,

$$p_i^* = y_i - r_i + c_i \qquad where \quad 0 < p_i^* \leq 1. \quad \forall i. \tag{1}$$

$$U_{ii}^* \equiv \frac{(p_i^*)^2}{2} - c_i = Z. \quad \forall i. \tag{2}$$

(2.1) is the condition on the probabilities and (2.2) is the individual rationality (IR) condition which determines the entry of the potential entrepreneur. We see that the equilibrium level of effort, or the probability of success of the project is dependent not only on terms of the contract, but also the efficiency of the social infrastructure which determines Y_i. So, $p = p(Y_i, r_i, c_i)$. The above formulation thus enables to get a simple probability function, where the probability of success (effort) is positively related to the business environment within which firms in the economy have to carry out their business projects, the collateral which they are able to post, and negatively related to the gross interest rate which they have to pay on the loan. The full

information solution is

$$c_i = w. \tag{3}$$

$$r_i = \frac{1}{2}\{Y_i + (1+\beta)w - [(Y_i + (1+\beta)w)^2 + 4(\beta w(1 - Y_i - w) - 1)]^{\frac{1}{2}}\}. \tag{4}$$

There are two things to note about this Full Information solution:

(i) Though the maximization problem involves solving 3 unknowns given a system of 2 equations - one of the unknowns, namely c_i, gets determined by the nature of the game being played in the credit market. The banks would prefer to take maximum collateral from all agents ($c_i = w$). The reason being that the expected returns of the bank R_b increases with the collateral posted, viz. $\frac{\partial R_b}{\partial c_i} > 0$, but $\frac{\partial R_b}{\partial r_i}$ is ambiguous. Since,

$$\frac{\partial R_b}{\partial r_i} = p_i + (r_i - \beta c_i)\frac{\partial p_i}{\partial r_i} \qquad where \quad \frac{\partial p_i}{\partial r_i} < 0 \tag{5}$$

The effort that the entrepreneurs put in, which defines the success probability (p) is negatively related to r, but positively related to the collateral, c. Thus the banks would require the borrowers to use all their wealth as collateral, and determine the interest rate subject to this. Loan applications with any other amount of collateral would be rejected by the bank in Stage III and knowing this, in equilibrium no such application would be forthcoming. The solution to r_i in (4) is then a solution to a quadratic equation. It is obtained by plugging p_i^* and $c_i = w$ in the the Zero profit condition of the bank, given in (i) [4].

(ii) When the banks can separate out the types, individual contracts can be designed by the banks, such that corruption can be weeded out to an extent. As we see below, firms who engage in corrupt practices are charged a higher interest rate, as compared to the more honest firms.

$$\frac{\partial r_i}{\partial Y_i} < 0 \quad \Rightarrow \quad r_F < r_L \tag{6}$$

3.2 Asymmetric information equilibrium in the presence of both adverse selection and moral hazard:

The full information equilibrium does give us a clue into the equilibrium that we will reach when the banks are unaware of the revenues of the firms who apply for loans. In considering

[4]We take the root with the lesser value. Both the lenders and the borrowers know the rules of the game, and if there exists more than one solution, the lowest among these (viz. the one associated with the higher effort p) will be compatible with pareto efficiency.

the separating equilibrium as a solution, we see the following,
In the r-c plane, totally differentiate $U^*_{ii} = (\frac{(p^*)^2}{2} - c_i)$ to get in the context of borrowers,

$$\frac{dr_i}{dc_i} = \frac{p^* - 1}{p^*} \quad < 0. \tag{7}$$

(7) establishes that the indifference curves of the borrowers in the r-c space are downward sloping, and satisfy the single crossing property. viz. the borrower who expects to make unofficial payments and get a lower return Y_L, has a lower MRS as compared to the borrower who expects his full yield from the project Y_F. For a small reduction in the interest rates, the latter is willing to post more collateral as compared to the former.

However, the other condition for the existence of a separating equilibrium is that the zero-profit curves for the banks should be flatter than the indifference curves of the borrowers. We show that this condition cannot be satisfied and therefore, the types cannot be sorted out by the banks. The contracts cannot be self selected and we have the following, [Proof in the appendix].

> ***T1*** *Non-existence of a separating equilibrium in the credit market when banks have to tackle both adverse selection and moral hazard issues simultaneously.*

When collateral is also used to monitor the effort put in by heterogenous borrowers after a loan contract is accepted, collateral ceases to be a screening device to screen out the efficient borrowers from the inefficient. Technically **T1** establishes that in this model, the zero-profit curves of the banks are steeper than the indifference curves of the borrowers, which violates the necessary condition for the existence of a separating equilibrium. What this means is that in spite of the the bank having an additional instrument in the form of collateral, it still cannot have perfect control. It is not possible for the banks to separate out the corrupt firms from the non-corrupt firms. Collateral, in this case, cannot be used as a self-selection device by the borrowers. The intuition behind this result is that collateral is akin to "monitoring costs" in this model. By making the borrowers put in all their wealth as collateral the banks are ensuring that the entrepreneurs of both types put in maximum effort after the contract is accepted. By taking collateral, banks try to solve the moral hazard issues which arise in the credit market.

Thus, in this model where both adverse selection and incentive effects are considered simultaneously, existence of private signalling in a separating equilibrium may not be possible.

Collateral is used by banks to solve moral hazard problems - it does not serve as a screening device to screen out the corrupt firms from the non-corrupt. The only equilibrium which exists in this economy is the complete pooling equilibrium, where only one type of a bank contract is offered to everybody.

Pooling Equilibrium : The solution to this pooling equilibrium is given by

$$c = w.$$
$$r = \tfrac{1}{2}\{\hat{Y} + (1+\beta)w - [(\hat{Y} + (1+\beta)w)^2 + 4(\beta w(1 - \hat{Y} - w) - 1)]^{\frac{1}{2}}\}.$$

where $\hat{Y} \equiv Y_F - \gamma(Y_F - Y_L)$.

Once we have established that no separating equilibrium can exist, the solution to the pooling equilibrium follows the same logic as given in the Full information case (3) and (4). However, since the banks are not aware of the actual yields that the entrepreneurs get from the project, they have to offer the contract on the basis of the average yield that the perceive in the economy, depending upon the γ, or the social infrastructure parameter. So, $\hat{Y}$ is the average productivity in the economy as perceived by the banks. The reason for taking maximum collateral ($c = w$) remains the same as given in the Full information case, where since loan applications can be rejected by the banks in Stage III, therefore in equilibrium, no applications with $c < w$ will be forthcoming.

For ease of computation WLOG[5] assume $\beta = 1$. The pooling equilibrium is then given by

$$c = w. \tag{8}$$
$$r = \frac{1}{2}\{\hat{Y} + 2w - [\hat{Y}^2 + 4w - 4]^{\frac{1}{2}}\}. \tag{9}$$

$\hat{Y}$, the average yield of the project in the economy, is defined as before.

[5] $\beta < 1$ is the necessary condition for $\exists$ of a separating equilibrium in a risk neutral environment. Proof of **T1** shows that even when $\beta \in (\beta^*, 1)$ a pooling equilibrium pareto dominates. Therefore we can assume $\beta = 1$, WLOG.

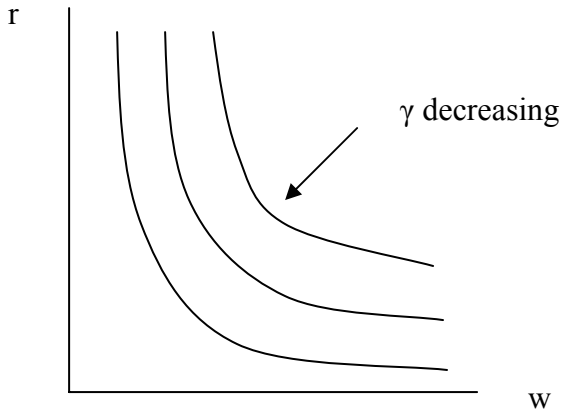
4 Social Infrastructure and Credit Rationing

We now introduce another form of heterogeneity in the model. We assume that individuals differ in wealth (w). This heterogeneity is observable and differences in the wealth of borrowers is public knowledge. We assume that the wealth is distributed as per a c.d.f $F(w)$. We retain the assumption of all wealth being used as collateral in borrowing. Lenders can now classify borrowers as per risk, on the basis of an observable indicator, the wealth they have to post as collateral. Given that collateral is positively associated with effort (and negatively associated with risk), the banks classify the poor borrowers to be riskier than the rich borrowers. This classification determines the interest rates that will be charged to each class. We also get the familiar result[5] that the interest rates in this economy are negatively related to the wealth that can be posted as collateral. There exists credit rationing in this economy, such that all borrowers below the critical wealth group w^* do not have access to credit. We can show the following, [Proof in the appendix]:

> **P1** *In a pooling equilibrium in the credit market, the social infrastructure of the economy determines the critical w^*, which defines the extent of credit rationing in this economy.*

The intuition is straight forward - given the social infrastructure parameter γ of an economy, collateral is used then in monitoring the effort exerted by the entrepreneurs in such an economy. Entrepreneurs posting more collateral are seen to be safer risks, irrespective of their actual returns from the project and are charged lower interest rates. (7) also determines the critical wealth group w^* (calculation in the appendix), below which no lending will be done by the banks. All borrowers having wealth less than w^*, irrespective of their actual yield from the project, will be rationed from the credit market. This will occur in spite of the fact that lending is socially optimal. It is perceived by the banks that lending to this group does not make the banks break-even at any interest rate. w^* is a function of the social infrastructure index of the economy γ. Higher the value of this parameter, greater will be the proportion of the population that will be barred from the credit market. A high γ means that a greater proportion of firms have to indulge in bribery and other unofficial payments - this indicates the poor quality of social infrastructure in the economy. Therefore, given a distribution of wealth in the economy, the extent of credit rationing is greater when the social infrastructure of the

economy is poor (γ is high). The banks will then play safe by lending only to the wealthier groups having sufficient collateral. This is shown in the diagram below where the interest rates in the economy are negatively related to the amount of wealth posted as collateral, given the economy's social infrastructure indicator present in γ. With a decrease in γ, and thereby an increase in $\hat{Y}$, there is a shift of this curve to the left. For a given distribution of wealth, lower



the social infrastructure parameter γ, both the cost of funds r and w^*, the critical wealth level below which borrowers are barred from borrowing, is reduced. The extent of credit rationing of borrowers below a w^* thus depends upon the social infrastructure indicator of the economy.

4.1 Effect of a decrease in the parameter γ

From the section above, it is now easy to conclude about the effects of policy driven initiatives which reduce γ, the proportion of firms who have to resort to unofficial payments and corruption, viz. the size of the 'shadow' or unofficial economy.

(a) There are the "price effects" through the interest rates. We see that $\frac{\partial r}{\partial \gamma} > 0$. So with a decrease in the parameter γ, the cost of borrowing in the economy is reduced. Therefore, this result suggests that economies ranking low on the corruption index would also be able to obtain funds at cheaper rates than those economies which are plagued by corruption and rent seeking activities.

(b) There is also an "entry" effect, related to the extent of credit rationing in this economy.

With the decrease in γ, the cut off w^* is reduced, since $\frac{\partial w^*}{\partial \gamma} > 0$. While credit rationing is a possible outcome in many models of asymmetric information, this possibility is made severe in the presence of corruption, inefficiencies in implementation of laws, and all those factors which hamper the firms from conducting their businesses. Therefore policy initiatives to reduce γ will ameliorate the degree of credit rationing in such economies.

These results are important because they suggest that as asymmetric information models about the credit market are made more realistic to include a range of information asymmetries, the scope for private signalling is reduced. Public signals in the form of laws and regulations, infrastructure, and the quality of bureaucratic services will then be increasingly used to determine the extent of investment in an economy. The relevance of such public signals lies in the fact that in an imperfectly informed world, they expand the information set that is available to the economy. In an environment stemmed with several types of information asymmetries, such public indicators can thus provide valuable signals pointing out opportunities for private investments.

5 Conclusion

The aim of this paper was to provide one among the many possible explanations to a common query : What are the reasons for investment levels being higher in a country like Singapore as compared to a country like Bangladesh? The answer to this is given within the context of asymmetric information in the credit market. In this paper we make it possible for both adverse selection and moral hazard problems to work simultaneously in the credit market. It is fairly clear that as asymmetric models are made more complex to include both adverse selection and moral hazard, the existence of a separating equilibrium is jeopardized and the possibility a pooling equilibrium increases. With the interplay of these two types of asymmetric information problems, lenders can no longer depend on private signals like wealth to post as collateral in determining their investment decisions. It is then shown that in the presence of such a multi-layered asymmetric information structure - since private signals get obfuscated, there will be a greater reliance on 'public' signals. An efficient legal and judicial system, a smoothly functioning bureaucracy, good quality of public services, an environment where firms are not compelled to make "irregular payments" to get their work done, are all such 'public'

indicators. It is factors like these which are increasingly defining the lending and investment decisions of today. Singapore is able to publicly signal its intentions to investors. The same cannot be said about Bangladesh.

Appendix:

I. Proof of T1:

The slope of the indifference curves in the r - c plane is given by totally differentiating U_{ii}, which is given as follows,

$$\begin{aligned} U_{ii} &= \frac{(Y_i - r_i + c_i)^2}{2} - c_i \\ \Rightarrow \frac{dr_i}{dc_i}_{(borrowers)} &= \frac{(Y_i - r_i + c_i) - 1}{(Y_i - r_i + c_i)} \quad < \quad 0. \end{aligned}$$

Since $(Y_i - r_i + c_i)$, we know is the equilibrium probability of success of the project denoted as p^*, and $p^* < 1$.

The isorevenue curves of the banks is given by

$$\begin{aligned} R_b &= p^* r_i + (1 - P^*)\beta c_i \\ \frac{dr}{dc}_{(banks)} &= \frac{-\frac{\partial R_b}{\partial c}}{\frac{\partial R_b}{\partial r}} \\ \frac{\partial R_b}{\partial c} &= \frac{\partial p^*}{\partial c}(r_i - \beta c_i) + (1 - p^*)\beta \quad > 0 \quad \forall \beta \in (0,1). \\ \frac{\partial R_b}{\partial r} &= \frac{\partial p^*}{\partial r}(r_i - \beta c_i) + p^* \quad \gtrless 0 \quad since \quad \frac{\partial p^*}{\partial r} < 0. \\ \frac{\partial R_b}{\partial r} &> 0 \quad iff \quad (r_i - \beta c_i) < p^* \\ & iff \quad 1 > \beta > \frac{r_i - p^*}{c_i} > 0 \end{aligned}$$

Which puts very stringent conditions on the returns from the project Y_i, viz.

$$2(r_i - c_i) < Y_i < (2r_i - c_i) \tag{10}$$

Given the above, there is an additional condition on β,

$$1 > \beta > \frac{r_i - p^*}{c_i} \equiv \beta^* \tag{11}$$

Given the two conditions on Y_i and β above, we will have the isorevenue curve of the banks negative in the r-c space.

$$\frac{dr}{dc}_{(banks)} = -\frac{[(1 - p^*)\beta + (r_i - \beta c_i)]}{p^* - (r_i - \beta c_i)} \tag{12}$$

Given that both the indifference curves of borrowers and the isorevenue curves of the banks are negative in the r-c space, the necessary condition for the existence of a separating equilibrium is that

$$\left|\frac{dr}{dc}\right|_{(banks)} < \left|\frac{dr}{dc}\right|_{(borrowers)} \tag{13}$$

i.e. the indifference curves of the borrowers should be steeper in the r-c space than the isorevenue curves of the banks.

$$\begin{aligned} \left|\frac{dr}{dc}\right|_{(borrowers)} &= \frac{1-p^*}{p^*} \\ \left|\frac{dr}{dc}\right|_{(banks)} &= \frac{\beta(1-p^*)+(r_i-\beta c_i)}{p^*-(r_i-\beta c_i)} \end{aligned}$$

We now show that 13 above cannot be satisfied. Taking the denominators of the two terms, we see that $p^* - (r_i - \beta c_i) < p^*$. Therefore, the necessary condition for the existence of a separating equilibrium depends upon the value of the numerators in both the terms. Which is,

$$\begin{aligned} \beta(1-p^*) + r_i - \beta c_i &< 1-p^* \\ \beta &< \frac{(1-p^*)-r_i}{(1-p^*)-c_i} \end{aligned}$$

We know $(1-p^*)-r_i < 0$, since r_i is the gross interest rate and therefore > 1. Therefore taking the denominator of the RHS, we now have to consider two possibilities, $(1-p^*)-c_i \gtrless 0$.

$$\begin{aligned} &if \quad (1-p^*)-c_i > 0 \quad \Rightarrow \qquad \beta < 0 \\ &if \quad (1-p^*)-c_i < 0 \quad \Rightarrow \qquad \beta > 1 \quad (since \quad |1-p_i-r_i| > |1-p_i-c_i|) \end{aligned}$$

Which is a contradiction to our assumption **A 3**. Therefore, even if the isorevenue curves of the bank turn out to be negative in the r-c space, a separating equilibrium cannot exist as they turn out to be steeper than the indifference curves of the borrowers ■

II. Proof of P1 :

$$\frac{\partial r}{\partial w} = 1 - \frac{1}{(\hat{Y}+4w-4)^{\frac{1}{2}}}. \tag{14}$$

In order to prove that $\frac{\partial r}{\partial w} < 0$, we have to show the following,

$$0 < \hat{Y} + 4w - 4 < 1. \tag{15}$$

Note that from the definition of r given in (7), we have

$$\hat{Y} + 4w - 4 \equiv \hat{Y} - 2(r-w).$$

$\hat{Y} - 2(r-w) > 0$, which follows from the proof of **T1**. And it follows from the definition of p^* that $0 < \hat{Y} + 4w - 4 < 1$. So, we see that,

$$\frac{\partial r}{\partial w} < 0. \tag{16}$$

Given a distribution of wealth F(w), there is no solution to (7) when

$$\hat{Y} + 4w - 4 \leqslant 0.$$

This defines the cut off w^* for which there is no solution to (7), and it is given by,

$$w^* \equiv 1 - \frac{Y_F - \gamma(Y_F - Y_L)}{4} \tag{17}$$

What this means is that that below a collateral level of w^*, banks are not willing to lend since they cannot break even on such contracts. Therefore, all agents with wealth $\in [0, w^*]$ will not be able to borrow even if they want to. As we see, $\frac{\partial w^*}{\partial \gamma} > 0$. Therefore the critical point of credit rationing gets lower with a reduction in the parameter γ ■

References

[1] **Aghion, Phillipe and Bolton, Patrick.** "A Theory of Trickle-Down Growth and Development" *Review of Economic Studies,* 84 Issue 2(1997).

[2] **Bardhan, Pranab** "Corruption and Development: A Review of Issues" *Journal of Economic Literature* Vol.35 No.3 Sept. (1997).

[3] **Batra, Geeta; Kaufman, Daniel and Stone, Andrew** "Voices of Firms, 2000: Findings of the World Business Environment Survey" *World Bank* (forthcoming).

[4] **Baumol, William J.** "Entrepreneurship: Productive, Unproductive and Destructive" *Journal of Political Economy* Vol.98 Issue 5 Oct.(1990).

[5] **Bernanke Ben and Gertler, Mark.** "Financial Fragility and Economic Performance" *Quarterly Journal of Economics,* Vol. 105, Issue 1 (1990).

[6] **Bester, H.** "Screening Versus Rationing in Credit Markets with Imperfect Information" *American Economic Review,* Vol. 75, Issue 4 (1985).

[7] **Buiter, Willem H** "From Perdition to accumulation? The second transition decade in Russia" *Economics of Transition* Vol.8 No.3. (2000)

[8] **Clemenz, Gerhard.** "A Note on the Non-Existence of Rationing Equilibrium in the Besanko-Thakor Model" *International Economic Review,* Vol. 34, Issue 3 (1993).

[9] **Grossman, H.I. and Kim, Minseong.** "Is moral disposition rewarded?" *Journal of Banking and Finance* Vol. 26, (2002).

[10] **Hall, Robert E. and Jones, Charles I.** "Why do some countries produce so much more output per worker than others?" *Quarterly Journal of Economics* Feb (1999).

[11] **Hellwig, Martin.** "Some Recent Developments in the Theory of Competition in Markets with Adverse Selection" *European Economic Review,* Feb/Mar (1987).

[12] **Hoff, Karla; Braverman, Avishay and Stiglitz, Joseph E.** "The Economics of Rural Organization, Theory Practice and Policy" *World Bank* (1993).

[13] **Mauro, Paulo.** "Corruption and Growth" *The Quarterly Journal of Economics* Vol.110 Issue 3 August (1995).

[14] **Stiglitz, J. E.** "Information and the Change in the Paradigm in Economics" *American Economic Review,* Vol. 92, No. 3, June (2002)

[15] **Stiglitz, Joseph E. and Weiss, Andrew.** "Credit Rationing in Markets with Imperfect Information" *American Economic Review* Vol. 71, Issue 3 (1981).

[16] **Stiglitz, Joseph E. and Weiss, Andrew.** "Credit rationing and collateral" *Recent developments in corporate finace* (ed) Jeremy Edwards, Julian Franks, Colin Mayer and Stephen Schefer. Cambridge University Press (1986).

[17] **Wei, Shang-Jin** "Local Corruption and Global Capital Flows" *Brookings Papers on economic Activity* Vol 2 (2000).

[18] **The World Bank Group** "The World Business Environment Survey, 2000." http://info.worldbank.org/governance/wbes/.

[19] **World Bank, (ed)** "Building Institutions for Markets: 2002 World Development Report." Oxford University Press, New York. 2002.