

Corporate Ownership as a Means to Solve Adverse Selection Problems in a Model of Asymmetric Information and Credit Rationing

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Abstract

This paper analyzes an asymmetric information model where the financing needs of entrepreneurs are obtained from two sources. We show that adverse selection is only important if the credit constraint of banks is not too tight. Next, we show that banks can induce a pattern of corporate ownership, whereby safe firms end up owning shares in risky firms. This particular type of an incentive compatible debt contract can solve the adverse selection problem caused by credit rationing under asymmetric information. Our theory gives a theoretical backing for the existence of business groups containing firms that operate in diversified markets.

JEL classification: O1, O16, I3

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1. INTRODUCTION

In a world with asymmetric information between banks and firms, simple debt contracts may suffer from the lemon problem. The reason is that banks have to charge a common interest rate for all firms if firms cannot be identified. This may result in safe firms staying out of the market and only risky firms entering the market. In other words, risky firms drive out the safe firms, and this is inefficient from a social point of view, assuming that the projects of safe firms are economically viable and socially valuable. So, asymmetric information may lead to equilibrium rationing of external funds available for real investment (Stiglitz and Weiss, 1981)

The existing literature considers different mechanisms by which adverse selection problems can be solved. Some authors point to the need of government intervention by means of subsidies or taxes (see, e.g. Gale, 1990). The problem of this solution is that government interventions often have a cost. Other authors show that introducing collateral as an additional instrument for banks can solve the adverse selection problem. A basic reference is Bester (1985) who shows that a separating equilibrium with no credit rationing will result if banks compete by choosing collateral requirements and the lending rate simultaneously. This solution, however, is not useful for most developing countries or emerging markets since collateral is often not available.

The recent literature on micro credit institutions, such as the Grameen Bank (see e.g. Morduch, 1999a and Ghatak and Guinnane, 1999), offers a possibility to solve adverse selection problems, which seems to be more relevant for developing countries. This literature deals with financial linkages in the form of cross-guarantees of loans. It is argued that debt contracts with joint liability, such that successful firms are forced to pay a joint liability component if another affiliated firm fails, may improve efficiency. The key to this result is that debt contracts containing a joint-liability component provide incentives for assortative matching (Becker, 1993) implying that similar types of firms group together (Ghatak, 2000). Ghatak and Kali (2000) apply the joint-liability framework to explain the working of business groups in emerging markets. The

assortative matching property enables banks to price discriminate between borrowers since the group of risky firms is less willing to accept an increase in the joint-liability component than the group of safe firms. However, it seems as if the little empirical evidence available refutes the basic message of the joint liability literature. For instance, Sadoulet and Carpenter (1999) find strong evidence that firms of different types form groups, which implies that assortative matching does not hold. Moreover, several authors question the effectiveness of joint-liability programmes (see Diagne, 1998, and the references therein). There are also some theoretical problems (discussed below in Section 5) with the assortative matching solution (Gangopadhyay and Lensink, 2001).

The aim of this paper is to point at another possibility to solve adverse selection problems, which we think is empirically very relevant and does not have the theoretical problems of the joint-liability solution. In particular, the paper shows that banks can solve adverse selection problems caused by asymmetric information by offering an incentive compatible contract that induces a risky and a safe firm to group together. The debt contract is such that the risky firm becomes liable for the failure of the safe firm. So, in contrast to the *full* joint liability contracts in which both firms become liable for the failure of the other firm, our contract is a *limited* joint liability contract. We will term this a one-sided joint liability (OJL) contract. The contract can be characterized as one where a safe firm owns a part of the risky firm. The analysis is done by using a simple asymmetric information model, where the financing needs of firms are obtained from two sources. As far as we know, no study has done this before.

In addition to the literature mentioned above, the literature that tries to explain conglomerate mergers on financial grounds has some similarities to our paper. However, in contrast to our paper, that literature does not consider the link between debt contracts and the type of firms, distinguished by their probability of success, that group together. The similarity with our paper stems from the basic idea that mergers can be beneficial since they may lower borrowing costs. Lewellen (1971) is a well-known example. He shows that a merger of two firms can be beneficial since a merger may lead to a fall in the

probability of default. If this leads to an increase in bank borrowing, the merger may be value increasing. In his model, the advantage of a merger is the result of the fact that corporate interest expenses are tax deductible, so that replacing equity with debt lowers the total cost of capital. See also Higgins and Schall (1975) and Galai and Masulis (1976) for a discussion. A major difference with our paper is that the literature on mergers implicitly assumes that, in line with the joint-liability literature, after the merger each enterprise guarantees the other's debt in case of default. In our paper, such guarantees are not directly a part of the debt contract. However, by virtue of ownership of shares in the successful firm, a firm has income even when its revenues are zero from its own project. It is as if, a firm pledges the income from the ownership of another firm to pay its debt obligations on the project it itself controls. So, there are no cross-guarantees, but there is a one-sided joint-liability contract.

The paper is organized as follows. Section 2 and Section 3 deal with stand-alone firms in a model with full information and asymmetric information, respectively. We compare the social surplus for both cases, assuming that there are too little funds available from the bank. Section 4 derives an incentive compatible debt contract that induces safe firms to take over risky firms. Section 5 discusses a possible empirical application of our theory. Section 6 concludes.

2. THE FULL INFORMATION MODEL

There is a continuum of risk neutral entrepreneurs in the interval $[0,1]$. There is one risky project available with each entrepreneur, so that entrepreneurs and projects are interchangeable. There are two types of projects, and hence, entrepreneurs. The project types are distinguished by their probability of success p . Let p_t be the probability of success of project type t , $t = r, s$, and R_t be the output when the project succeeds. Both types of projects yield a zero return if unsuccessful.

A.1: $0 < p_r < p_s < 1$ and $p_r R_r = p_s R_s = \mu$.¹

Using the second order stochastic dominance as a definition of risk (Rothschild and Stiglitz, 1970), we term the s entrepreneurs as the safe borrowers and the r entrepreneurs as the risky borrowers. Also observe that, A.1 implies that $R_r > R_s$. Each project requires a unit of investment. Entrepreneurs do not have initial wealth, so they cannot self-finance their projects. Each entrepreneur decides on investing in the project, and hence raising funds from outside lenders, or not undertaking the project.

The set-up of the model so far resembles the models by e.g. Stiglitz and Weiss (1981) and Mankiw (1986). However, in contrast to these models we assume that there are two sources of funds, a debt market and an equity market. The supplier of funds in the debt market is a bank that offers limited liability debt contracts, but may be unable to satisfy the demand for the full one unit of investment by all entrepreneurs. If the bank does not supply the entire unit of investment, the remainder is obtained from the stock market. Let q be the cost of funds raised from the stock market and ρ the opportunity cost of the bank's resources.

A.2: $\mu \geq q > \rho \geq 1$

A.3: *The bank is risk neutral and makes zero profits. The stock market is competitive.*²

A.2 makes two major points. First, it says that all projects are viable even at the higher cost of equity. This is not necessary in our model, but makes it simpler to analyze. Observe that, if $q \geq \mu > \rho$, then there exists a ratio of debt to equity, L , such that $\mu = (1 - L)q + L\rho$. However, this will restrict our solutions to debt equity ratios that are higher than L . Since we want to concentrate on the incentive to form groups because of asymmetric information, we do not want to have an additional source of complication.

Second, A.2 implies that equity is more expensive than a bank debt. In an emerging economy or a developing economy context, we can characterize the cheaper source as a nationalized development bank or a micro-credit institution with subsidized government or external funds, or any deposit-taking bank with (implicit or explicit) deposit insurance. The more expensive source could be the stock market, a non-bank financial institution, the informal credit market, etc. In most of the currently emerging Asian economies, where banks are often directly or indirectly protected through government policy, and stock markets are still to be fully developed, such a characterization, of the equity cost being higher than bank debt, will hold. These features have also been historically evident in countries like Japan and South Korea. More generally, even in the most developed financial markets, no project is entirely debt financed. Also, credit rationing is a widely observed phenomenon in all markets. Our approach allows us to study these aspects.

There are several possibilities to explain the coexistence of alternative types of finance (see Freixas and Rochet, 1997, chapter 2). Most available models try to explain why some firms issue direct debt (equity issue) and some firms use intermediated finance (bank debt), despite the fact that direct debt is assumed to be cheaper. The basic idea is that due to moral hazard problems in a world of asymmetric information not all firms are able to issue direct debt. A very well known example is Diamond (1991). He assumes that firms need to build up a reputation before they can issue direct debt. These models, however, cannot explain the coexistence of cheap and expensive sources of finance with full information.

In this paper, we consider another reason for the coexistence of alternative sources of funds. We simply assume that the bank has insufficient funds. This implies that with full information also, entrepreneurs need to obtain funds from two sources. Credit rationing is in this case a result of a lack of funds with banks, and not because of moral hazard. Our assumption regarding the lack of funds with the bank is a consequence of the so-called dis-equilibrium credit rationing. In contrast to equilibrium rationing as a

result of asymmetric information, analyzed by e.g. Stiglitz and Weiss (1981) and also considered in section 3 of this paper, dis-equilibrium rationing assumes that the price mechanism does not work perfectly. Our approach imparts a dose of realism into the model, especially for the case of emerging economies. The reason is that most emerging markets have not yet fully liberalized the financial sector and government controlled banks, or directed credit policies favoring certain types of investment, are still common in these countries. Being cheaper than the market rate, such credit is naturally characterized by excess demand and, hence, there is a certain amount of credit rationing on these projects even in the case of full information.

In particular, we assume the following:

A.4: *The total funds with the bank, \bar{I} , is such that $\frac{1}{2} < \bar{I} \leq 1$.*

Note that the range of solutions also contains the case of unlimited funds of banks (characterized by $\bar{I} = 1$). Let the proportion of safe and risky projects be the same.³ Let I_t be the amount of funds offered by the bank to project type t , $t = r, s$. Given equal proportions of safe and risky firms, and full information, we must have

$$(1) \quad \frac{1}{2}I_r + \frac{1}{2}I_s = \bar{I}$$

The entrepreneur makes a profit of $\mu - p_t d_t - q(1 - I_t)$, where d_t is the (limited liability) debt claim of the bank from firm type t , $t = s, r$. Under full information, and zero profit for banks, $p_t d_t = \rho I_t$. Thus, the entrepreneur's profit can be written as $\mu - q + (q - \rho)I_t$. The total surplus, S , generated by these projects will be the sum of

profits by the safe and risky entrepreneurs, since banks exactly cover costs. With the measure of each firm type being $(1/2)$, we have

$$(2) \quad \begin{aligned} S &= \frac{1}{2}[\mu - q + (q - \rho)I_s] + \frac{1}{2}[\mu - q + (q - \rho)I_r] \\ &= \mu - q + (q - \rho)\frac{I_s + I_r}{2} = \mu - q + (q - \rho)\bar{I} \end{aligned}$$

Clearly, the surplus is increasing in \bar{I} , given A.2. This is because efficiency demands that the lowest priced funds get used up first. Also, the total surplus is independent of the distribution of bank funds between the safe and risky projects. Consequently, any I_s and I_r that satisfy (1) maximize the total surplus. In particular, $I_s = I_r = \bar{I}$ is a solution to the problem.

Note that under full information, unlimited funds and A.1 to A.3, the bank will demand a debt claim d_i from each project such that $p_i d_i = \rho$ for a unit of investment in each project. Each entrepreneur then gets $\mu - p_i d_i = \mu - \rho$. This is the optimal outcome from a social point of view if the price mechanism would work perfectly. In this case, the more expensive source of funds, say the equity market, will not exist and consequently all entrepreneurs invest and only use the cheapest funds available. This is the general outcome in most full information models, but only one of the possible solutions in our model.

3. THE MODEL WITH ASYMMETRIC INFORMATION

So far we have been assuming that the project types are common knowledge. In this section, we assume that this is private knowledge with the entrepreneur. Given our assumptions on equal proportions of safe and risky projects, if all projects take bank finance, the bank has to assume that the probability of getting repaid is the average probability of success, $\bar{p} = (p_s + p_r)/2$. Since the bank cannot distinguish between

good and bad projects, it offers the same contract to everybody. If d is the bank claim, and I the bank loan, the bank will put $\bar{p}d = \rho I$. The return to an entrepreneur of type t , $t = s, r$, is,

$$\mu - \frac{p_t}{\bar{p}} \rho I - q(1 - I) = \mu - q + (q - \frac{p_t}{\bar{p}} \rho) I$$

This expression allows us to focus on the major problem we want to address. If firms are entirely financed by debt, the expected profit to the entrepreneur is $\mu - \frac{p_t}{\bar{p}} \rho$.

Alternatively, if firms are entirely equity financed, then the cost to the firm is q and, hence, the expected profit to the entrepreneur is $\mu - q$. So, the profit of the entrepreneur improves by an amount $(q - \frac{p_t}{\bar{p}} \rho)$ for each unit of bank investment. We make the following assumption:

A.5: $q < \frac{p_s}{\bar{p}} \rho$

Observe that, given A.2 and A.5, $[q - \frac{p}{\bar{p}} \rho] < 0 < [q - \frac{p}{\bar{p}} \rho]$. Thus, while safe firms will not take a limited liability contract from the bank, the risky firms will. But the bank should know this and, hence, cannot assume that the probability of success on a project to which it has lent is \bar{p} . The bank is better off putting a debt claim that satisfies $p_r d = \rho I$, instead. If all risky projects take all their money from the bank, the total demand for loans will be $(1/2)$, since the measure of risky firms is $(1/2)$, and the bank can satisfy this demand, since, by assumption, $\bar{I} > (1/2)$. We state the following result.

Proposition 1: *Suppose the bank cannot identify the project type, which is privately known to entrepreneurs. Under A.1-A.5, the bank gives a loan equal to 1 for a debt claim of (ρ / p_r) . All risky firms borrow from the bank and the safe firms do not. The bank has excess funds of $\bar{I} - (1/2)$. The total surplus with the entrepreneurs is less than that in the full information case.*

Proof: We only need to show that the total surplus is less than the full information case. In this scenario, where safe projects are funded entirely through the stock market and the risky projects entirely through a debt contract the surplus with the entrepreneurs is:

$$(3) \quad S = \frac{1}{2}[\mu - q] + \frac{1}{2}[\mu - \rho] = \mu - q + \frac{1}{2}(q - \rho) < \mu - q + (q - \rho)\bar{I}$$

The last term on the right of (3) is the same as the last term in equation (2) and the last inequality follows from A.4.

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It follows immediately that this result also holds with unlimited funds of banks ($\bar{I} = 1$). So, in addition to the dis-equilibrium credit rationing caused by a lack of bank funds, there is now also a cost in terms of a lower surplus due to equilibrium credit rationing. Despite the fact that there is an excess demand for credit and there are excess funds, banks are not willing to increase the loan interest rate due to adverse selection. This is basically the Stiglitz-Weiss (1981) result.⁴ It should be noted that the coexistence of cheap and expensive funds, in contrast to Section 2, is now primarily explained by problems of asymmetric information, in line with the analysis of the usual models.

Proposition 2: *Suppose A.1-A.3 and A.5 hold, but instead of A.4, we have $(1/2) \geq \bar{I} > 0$. Then, if project type is private information to entrepreneurs only, then*

the bank offers a loan equal to $2\bar{I}$ for a debt claim of $\frac{2\rho\bar{I}}{p_r}$. All risky firms borrow from the bank and the safe firms do not. The total surplus with the entrepreneurs is the same as in the situation where the bank knows the project types.

Proof: If I is the loan given by the bank, and all risky firms take the loan, the total demand from them will be $(1/2)I$. If $I = 2\bar{I}$, all the bank funds are exhausted. Observe that, since $2\bar{I} \leq 1$, the risky projects have to obtain funds from the equity market also. The expression for S now becomes

$$S = \frac{1}{2}[\mu - q] + \frac{1}{2}[\mu - q + (q - \rho)2\bar{I}]$$

and this is exactly the same as that in (2).

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The reason for this outcome is that as long as $\bar{I} > (1/2)$, some cheap bank funds are wasted if there is asymmetric information since safe firms are not borrowing from the banks. However, if there is full information all bank funds will be used. If $\bar{I} \leq (1/2)$, all cheap bank funds are used, both in the situation of perfect information as well as when there is asymmetric information. Observe that the credit constraint here has two implications. One is the fact that $\bar{I} < 1$. The other is that such a constraint is essential if both the equity and debt markets are to function with $q > \rho$.

4. COMBINING PROJECTS

In the previous section we showed under what conditions the return to entrepreneurs is affected in the presence of a credit constraint and when project types are private information to the project owners. In this section we will show that it is possible for a

bank to devise contracts that combine projects in such a way that even when A.4 and A.5 hold, the outcome is such that the surplus with the entrepreneurs is the same as that under full information.

Suppose the bank gives the following set of contracts. To a single entrepreneur who asks for a loan, it offers a standalone (SA) contract (d_A, I_A) where, d_A is the limited liability debt claim by the bank against a loan of $(\rho I_A)/p_r$. However, if two entrepreneurs come together and apply for a combined loan, then it offers the contract (d_J, I_J) to the two firms. It is the nature of d_J that is important here. In particular, such a contract specifies that one of the two entrepreneurs will be liable for the failure of the other project. We will term this a one-sided joint liability (OJL) loan. More specifically, the one who holds the OJL will not only pay d_J when it is successful, it will pay another d_J when it is successful but the other is not. The loan the two firms together gets for this equals $2I_J$. Our OJL contract in fact corresponds to a takeover of one firm (the firm who becomes liable for the failure of the other firm) by another firm (the owner).

Our purpose here is to argue that the bank can successfully encourage firms to get together in such a way that a type n , $n = s, r$, will get together with a type m , $m = r, s$. Define the ordered pair (m, n) to mean that m takes on the liability of n . We consider the two entrepreneurs together, and denote the payoffs they jointly make to the bank as $D(m, n)$. Since we are considering a pair of entrepreneurs, we have four possible states -- both successful, only one successful (and there are two such states) and, neither successful. Then,

$$(4) \quad D(m, n) = \begin{cases} 2d_J & \text{with probability } p_m p_n \\ 2d_J & \text{with probability } p_m (1 - p_n) \\ d_J & \text{with probability } (1 - p_m) p_n \\ 0 & \text{with probability } (1 - p_m)(1 - p_n) \end{cases}$$

The first line of (4) is the payment each makes if both are successful. The second line says that if n fails and m succeeds, m pays off its own debt as well as that of n . *This is under the assumption that the return to the successful firm m , R_m is large enough to pay $2d_J$.* The third line signifies that n has no liability for m and hence, the bank gets paid the dues from n only. The fourth line says that if both fail, no payments are made to the bank. If $ED(m, n)$ denotes the expected (combined) payoff to the bank, then

$$(5) \quad ED(m, n) = [p_m(2 - p_n) + p_n]d_J$$

Recall that the pair needs 2 units of investment and the bank gives them an amount $2I_J$. The joint profit of the pair (m, n) is given by

(6)

$$\begin{aligned} E\Pi(m, n) &= p_m p_n (R_m + R_n - 2d_J) + p_m (1 - p_n) (R_m - 2d_J) + (1 - p_m) p_n (R_n - d_J) \\ &\quad - 2q(1 - I_J) \\ &= 2(\mu - q) + 2qI_J - d_J [p_m(2 - p_n) + p_n] \\ &= 2(\mu - q) + 2qI_J - ED(m, n) \end{aligned}$$

For the rest of our paper, we will consider the following types of contracts:

C1: *The standalone, or SA, contract (d_A, I_A) and the one-sided joint liability, or OJL, contract (d_J, I_J) , satisfy the following properties:*

- (a) $d_A = \frac{\rho I_A}{p_r}$
- (b) $d_J = \frac{2\rho I_J}{p_r(2 - p_s) + p_s}$
- (c) $I_A \leq I_J = \bar{I}$

Let $E\pi_m(m, n)$ be the (expected) profit of firm m , and $E\pi_n(m, n)$ be the profit of the firm n , when they form the pair (m, n) . Recall that this implies that m takes on the liability of n . If a firm m goes alone, we will denote its profit as $E\pi_m(\phi)$. Suppose that m and n form a pair. If both are of the same type, it is natural to assume that they will equally divide the surplus. Then, from (6),

$$(7) \quad E\pi_m(m, m) = \frac{1}{2} E\Pi(m, m) = (\mu - q) + qI_J - \frac{1}{2} ED(m, m), \quad m = s, r$$

For the standalone firm,

$$(8) \quad E\pi_m(\phi) = (\mu - q) + qI_A - \frac{p_m}{p_r} \rho I_A = (\mu - q) + (q - p_m \frac{\rho}{p_r}) I_A$$

Given A.5, and that $p_r < \bar{p}$, it follows that a safe firm will never take a standalone contract. It can do better by accessing only the equity market, where it gets a return $(\mu - q)$. Thus, if a safe firm obtains any debt, it must be paired with some other firm.

For each pair formed by the safe firm, we have,

$$(9) \quad ED(s, s) = [p_s(2 - p_s) + p_s] d_J$$

$$(10) \quad ED(r, s) = [p_r(2 - p_s) + p_s] d_J$$

$$(11) \quad ED(s, r) = [p_s(2 - p_r) + p_r] d_J$$

The only other possible pair is made up of two risky firms.

$$(13) \quad ED(r, r) = [p_r(2 - p_r) + p_r]d_J$$

From (6), the lower is $ED(m, n)$, the higher is the profit of the pair. Thus, to determine what groups get formed, we need to consider the relative values of $ED(.,.)$.

For an OJL contract to be meaningful, the firm that takes on the liability of another firm, must have a high enough return, when successful, to pay not only its own debt obligation, but that of the other firm also. This will always be the case if $R_s \geq 2d_j$. In particular, we make the following assumption.

$$\mathbf{A.6:} \quad \frac{\mu}{\rho} \geq \frac{4\bar{I}}{1 + (2 - p_s)\frac{p_r}{p_s}}$$

At $\bar{I} = (1/2)$, the numerator on the right-hand-side of A.6 is equal to 2. At p_r close to p_s , the denominator is greater than 2. Recall that A.4 had $\bar{I} > (1/2)$. From A.2, we know that A.6 will always be satisfied for \bar{I} arbitrarily close to, but greater than, $(1/2)$, if the probabilities of success of the two types of firms are not too far apart. Also, observe that, the inequality is more likely to be satisfied if μ is sufficiently high compared to ρ .

Lemma 1: *Under A.1-A.6, and C.1, neither type of entrepreneur accepts the SA contract.*

Proof: From equation (8), using A.5, we have already shown that a safe firm will not accept the SA contract. This is because it could do better by accessing the equity market alone.

The return to the risky entrepreneur from the SA contract is, from (8),

$$E\pi_r(\phi) = (\mu - q) + (q - p_m \frac{\rho}{p_r})I_A = (\mu - q) + (q - \rho)I_A$$

We now show that if it joins hand with another risky entrepreneur, then it can pay its obligations when it succeeds and the other fails. For this, we need,

$$R_r \geq 2d_J = \frac{4\rho\bar{I}}{p_r(2-p_s) + p_s}$$

$$\Leftrightarrow \frac{\mu}{\rho} \geq \frac{4\bar{I}}{(2-p_s) + \frac{p_s}{p_r}}$$

which is always true, given A.6. This is because, $(2-p_s) + \frac{p_s}{p_r} > (2-p_s)\frac{p_r}{p_s} + 1$ for

$p_s > p_r$. Now, from (7) and (13), the risky firm gets

$$\begin{aligned} \frac{1}{2}E\Pi(r,r) &= (\mu - q) + (q - \rho \frac{p_r(2-p_r) + p_r}{p_r(2-p_s) + p_s})I_J \\ &> (\mu - q) + (q - \rho)I_J \\ &\geq (\mu - q) + (q - \rho)I_A = E\pi_r(\phi) \end{aligned}$$

The first equality follows from the definition of d_J (C.1(b)). The strict inequality follows because

$$\frac{p_r(2-p_r) + p_r}{p_r(2-p_s) + p_s} < 1$$

$$\Leftrightarrow p_r(2-p_r) + p_r < p_r(2-p_s) + p_s \Leftrightarrow p_r(p_s - p_r) < p_s - p_r \Leftrightarrow p_r < 1$$

The weak inequality follows from C.1(c). Thus, a risky firm can always do better by forming a group with another risky firm.

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Thus, no firm uses the SA contract. However, we will now show that it is possible for safe firms to access bank credits by combining with a risky firm. In particular, we will argue that the ordered pair (r, s) , where a risky firm takes on the liability of a safe firm, is optimal for the entrepreneurs.

Proposition 3: *Let A.1-A.6 hold and the bank gives contracts specified by C.1. Recall that there are equal number of safe and risky firms, or $\theta = (1/2)$. Also, let*

$$q \geq \rho \left[1 + \frac{(p_r + p_s)(1 - p_r)}{p_r(2 - p_s) + p_s} \right] \text{ and } I_J = \bar{I}.$$

Then, a risky firm takes on the liability of the safe firm. The total surplus with the entrepreneurs is the same as in the situation where the bank knows the project types. Banks get zero profits

Proof:

Step 1: We first show that, given A.6, it is possible for both types of firms to take on the liability of any other firm. Recalling that A.1 implies $R_r > R_s$, it is sufficient to show that

$$R_s \geq 2d_J = \frac{4\rho\bar{I}}{p_r(2 - p_s) + p_s} \Leftrightarrow \frac{\mu}{\rho} \geq \frac{4\bar{I}}{(2 - p_s)\frac{p_r}{p_s} + 1}, \text{ which is A.6.}$$

Step 2: From Lemma 1, we know that, given C.1, a risky firm is assured of $\frac{1}{2}E\Pi(r, r)$.

Thus, for it to form a pair with a safe firm, it must be assured of at least this much. A risky and a safe firm can form a pair in two ways --- (r, s) , risky taking on the liability of the safe, and (s, r) , where the safe takes on the liability of the risky. In the first case,

$$\begin{aligned}
E\pi_s(r, s) &= E\Pi(r, s) - \frac{1}{2}E\Pi(r, r) \\
&= 2(\mu - q) + 2qI_J - [p_r(2 - p_s) + p_s]d_J - \frac{1}{2}\{2(\mu - q) + 2qI_J - [p_r(2 - p_r) + p_r]d_J\} \\
&= (\mu - q) + qI_J - \{p_r(2 - p_s) + p_s - \frac{1}{2}[p_r(2 - p_r) + p_r]\}d_J
\end{aligned}$$

In the second case, the safe firm gets,

$$\begin{aligned}
E\pi_s(s, r) &= E\Pi(s, r) - \frac{1}{2}E\Pi(r, r) \\
&= 2(\mu - q) + 2qI_J - [p_s(2 - p_r) + p_r]d_J - \frac{1}{2}\{2(\mu - q) + 2qI_J - [p_r(2 - p_r) + p_r]d_J\} \\
&= (\mu - q) + qI_J - \{p_s(2 - p_r) + p_r - \frac{1}{2}[p_r(2 - p_r) + p_r]\}d_J
\end{aligned}$$

Observe that,

$$\begin{aligned}
E\pi_s(r, s) &> E\pi_s(s, r) \\
\Leftrightarrow p_r(2 - p_s) + p_s - \frac{1}{2}[p_r(2 - p_r) + p_r] &< p_r(2 - p_r) + p_r - \frac{1}{2}[p_r(2 - p_r) + p_r] \\
\Leftrightarrow p_s - p_r &< 2(p_s - p_r)
\end{aligned}$$

which is lays true. Thus, the safe firm will not form the pair (s, r) .

Step 3: Consider two safe firms forming a group. From (7),

$$\begin{aligned}
E\pi_s(s, s) &= \frac{1}{2}E\Pi(s, s) \\
&= (\mu - q) + qI_J - \frac{1}{2}[p_s(2 - p_s) + p_s]d_J
\end{aligned}$$

From Step 2, we need to compare this return with $E\pi_s(r, s)$.

$$\begin{aligned}
& E\pi_s(r, s) > E\pi_s(s, s) \\
& \Leftrightarrow p_r(2 - p_s) + p_s - \frac{1}{2}[p_r(2 - p_r) + p_r] < \frac{1}{2}[p_s(2 - p_s) + p_s] \\
& \Leftrightarrow 4p_r - 2p_r p_s + 2p_s < 2p_s - p_s^2 + p_s + 2p_r - p_r^2 + p_r \\
& \Leftrightarrow (p_s - p_r)^2 < (p_s - p_r)
\end{aligned}$$

which is true since $0 < p_r < p_s < 1$. Thus, a safe firm will not form a group with another safe firm.

Step 4: We will now show that it pays the safe firm to induce a risky firm to take on its liability. From Lemma 1, we know that if it goes alone, it will confine itself to raising equity since that is better than the SA contract. Given Steps 1 and 2, we need to show that the safe firm can do better by forming the group (r, s) rather than going alone, i.e.,

$$\begin{aligned}
& E\pi_s(r, s) \geq (\mu - q) \\
& \Leftrightarrow (\mu - q) + qI_J + d_J \left[\frac{1}{2} \{p_r(2 - p_r) + p_r\} - \{p_r(2 - p_s) + p_s\} \right] \geq (\mu - q) \\
& \Leftrightarrow q \geq \frac{2\rho}{p_r(2 - p_s) + p_s} \left[-\frac{1}{2} \{p_r(2 - p_r) + p_r\} + \{p_r(2 - p_s) + p_s\} \right] \\
& \Leftrightarrow q \geq \rho \frac{p_r(1 + p_r) + 2p_s(1 - p_r)}{p_r(2 - p_s) + p_s} = \rho \left[1 + \frac{(p_r + p_s)(1 - p_r)}{p_r(2 - p_s) + p_s} \right] > \rho
\end{aligned}$$

which is our condition in the Proposition.

Putting together Steps 2, 3 and 4, we know that a safe firm can induce a risky firm to take on its liability.

Step 5: The fact that the total surplus with the entrepreneurs is the same as in the situation where the bank knows the project types follows directly from comparing total

group profits with (2). Recall that we have equal numbers of safe and risky firms, or $\theta = (1/2)$. Thus, if a risky firm takes over the liability of a safe firm, the surplus with the entrepreneurs is the sum of the profits made by each pair (r, s) . The total measure of such pairs is one-half, and we have

$$S = \frac{1}{2} E\Pi(r, s) = (\mu - q) + qI_J - \frac{1}{2} d_J [p_r(2 - p_s) + p_s]$$

Plugging in the expression for d_J , and remembering that the total funds with the bank equals \bar{I} , it follows that,

$$S = \mu - q + (q - \rho)\bar{I},$$

which equals (2).

It should also be noted that the conditions under which a risky firm takes on the liability of the safe firm do not depend on \bar{I} , so that our OJL contract solves the adverse selection problem both in the cases of limited and unlimited bank funds. With unlimited funds our OJL contract leads to a surplus with entrepreneurs of $S = \mu - \rho$, which equals the first best.

Step 6: Finally, we need to prove that banks make zero profits and that the range on q is feasible. The fact that banks make zero profit is immediate from plugging in the value of d_J in equation (5) and observing that this is equal to the total cost of funding the group, $2\rho I_J$. For the range on q to be meaningful, given A.5, we need

$$p_s \frac{\rho}{p} > \rho \frac{p_r(1 + p_r) + 2p_s(1 - p_r)}{p_r(2 - p_s) + p_s} \text{ which follows when } \bar{p} = \frac{1}{2}(p_s + p_r).$$

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5. DISCUSSION

As a result of the success of the Grameen Bank's model there is a growing literature on group lending with joint liability. Several authors, however, start to question whether the success of the Grameen Bank is primarily related to the joint liability debt contract. Jain (1996), for instance, argues that the socioeconomic context and the organizational structure, including strong leadership and emphasis on training, is the prime reason for the success. In addition, Morduch (1999a p. 1579) states that the role of group lending with joint liability has been exaggerated. There is also growing evidence that micro-finance institutions like the Grameen bank cannot survive without being continuously subsidized. Morduch (1999b) estimates that the effective subsidies to the Grameen bank are about US\$175 million for the 1985-1996 period. According to him, this is the reason why private commercial banks have not started to create group-lending programs like the Grameen bank in order to lend to the poor.

The joint liability clause is an important reason for both the ineffectiveness of many group lending programs and the need for subsidies. Indeed, there are serious theoretical problems with the joint-liability approach. Suppose firm A forms a group with firm B. While they pay r for their own loan, they pay c in case the other fails. Ghatak (2000) shows that the solution requires that $c > r$. So the pair pays more to the bank when one of them fails and the other succeeds, $c + r$, compared to the case when both succeed, $r + r$. This makes it rational for the succeeding firm to pass on an amount r to the failing firm, who then pays to the creditor its committed payment. Thus, while the creditor expected to get $c + r$ with some probability, this argument suggests that it may never get this payment. The zero profit calculation of the creditor, therefore, breaks down (Gangopadhyay and Lensink, 2001). Consequently, the lender will make a loss and will need to be subsidized.

The theoretical and empirical problems with joint-liability calls for a rethinking of its role in micro-finance activities, especially since micro-finance programs are expected to grow considerably in the near future (Ledgerwood, 1999). The OJL contract we have derived in this paper can serve as a basic framework that can be used to develop

a new form of a *limited* joint liability contract that does not have the theoretical problems of the *full* joint liability solution.⁵ Our OJL contract can solve the adverse selection problem by using the advantages of peer pressure related to group lending. At the same time, the OJL contract, in contrast to the joint liability equilibria worked out in Ghatak (2000), does not violate the ex post rationality.

Our OJL contract also has some implications for the study of conglomerates and business groups. The joint liability literature suggests that business groups should contain firms with similar risk profiles (Ghatak, 2000 and Ghatak and Kali, 2000). Our theory, however, expects the opposite: firms with opposite risk profiles should form business groups. It is difficult to make a direct link between the theoretical concept of risk profiles and actual behavior of firms, but one would expect that our theory would imply that firms producing different products and operating in different markets would get together. There is ample empirical evidence that shows that indeed firms in business groups often operate in diversified markets (see footnote 17 in Ghatak and Kali, forthcoming).⁶ Our model simply gives a theoretical explanation for this.

Finally, our theory suggests a particular direction of corporate ownership. In our model, a risky firm taking over the liability of a safe firm is formally equivalent to a safe firm owning a risky firm. Observe that, an OJL contract is implemented through the payment of a failed safe firm's debt obligations, from the returns of a successful risky firm. Given the hierarchy of claims, a successful risky firm first pays its own debt obligations. Its shares are then worth $R_r - d_J$. If the failed safe firm owns a fraction

$\frac{d_J}{R_r - d_J}$ of the risky firm, then its return is equal to d_J and, it can meet its debt

obligations even when it fails. On an OJL loan of $2\bar{I}$, the bank faces two default states -- with probability $(1 - p_r)p_s$ it gets back only d_J , and with probability

$(1 - p_r)(1 - p_s)$ it gets back nothing. Alternatively, if it has a loan portfolio made up of two separate SA contracts, it faces default in three states, with probabilities $(1 - p_r)p_s$,

$(1 - p_s)p_r$ and $(1 - p_r)(1 - p_s)$. The bank, therefore, makes a higher return from lending to combined projects. In a competitive environment, therefore, the terms of an OJL contract are better for the firms. Observe that, at $I_A = I_J$, $d_A > d_J$. This may explain why, the emerging market literature cites evidence of group firms finding it easier to get credit, compared to standalone firms.

6. CONCLUDING REMARKS

This paper analyzes a simple asymmetric information model where the financing needs of entrepreneurs are obtained from two sources. We first compare the surplus with the entrepreneurs under full, and asymmetric, information if banks are funds constrained. We show that adverse selection is only important if the credit constraint of banks is not too tight. The reason is that in the case where the credit constraint of banks is very tight, all cheap bank funds get used. Hence, there is no inefficiency resulting from excess bank funds when some projects cannot raise debt.

Next, we use the model to derive a particular type of an incentive compatible debt contract, that can solve the adverse selection problem caused by credit rationing under asymmetric information. We show that banks can induce a pattern of corporate ownership, whereby safe firms end up owning shares in risky firms. This leads to a first best outcome. We label such a contract a one-sided joint liability contract to make the comparison with the recent wave of literature on joint liability lending.

In contrast to the debt contracts applied by the joint liability literature, our debt contract does not imply the assortative matching property, since different types of firms group together. Our theory, therefore, gives a theoretical backing for the existence of business groups containing firms that operate in diversified markets.

In addition, our theory does not suffer from a major theoretical shortcoming of joint liability contracts. Joint liability contracts suffer from being ex post irrational, which probably is an important reason for the ongoing need to subsidize micro-finance group lending programs. Our theory does not have this problem, and thus can be used as an

important guide for developing new forms of joint liability contracts in future group-lending programs.

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¹ The assumption of equal expected returns for all projects is in line with Stiglitz and Weiss (1981), but in contrast to De Meza and Webb (1987). De Meza and Webb (1987) assume that payoffs in states are all the same for all projects, while the expected returns differ.

² We assume that a bank (debt market) exists, and abstract from the possibility that endogenous intermediary coalitions emerge which evaluate projects *ex ante* in such a way that firms' incentives are affected, leading to a Pareto-optimal allocation. For this type of models, see e.g. Boyd and Prescott (1986) and Williamson (1988). More in general, our model does not consider possible monitoring activities of banks which may improve the efficiency of the decentralized outcomes with asymmetric information (see e.g. Diamond, 1984 and Ramakrishnan and Thakor, 1984).

³ This is a simplifying assumption. In general, one can have η to be the number of safe projects and $(1-\eta)$ to be the number of risky projects.

⁴ The Stiglitz-Weiss (1981) outcome leads to underinvestment from a social point of view. Note that some authors, e.g. De Meza and Webb (1987), show that asymmetric information may also lead to overinvestment. In the latter paper there is no credit rationing. This is basically a consequence of their assumption that payoffs in different states are the same for all projects. In a recent paper, De Meza and Webb (2000) show that excessive lending from a social point of view may also occur in combination with a credit-rationing equilibrium.

⁵ The term *limited* joint liability contract is borrowed from Diagne (1998). Diagne (1998) points out that a *full* joint liability contract is ineffective since it probably has a negative effect on voluntary savings. He shows that some form of a *limited* joint liability contract may improve on this outcome.

⁶ It should be noted that Ghatak and Kali (2000) explain the existence of business groups with firms that operate in diversified markets by pointing out that these firms are probably similar in terms of quality.