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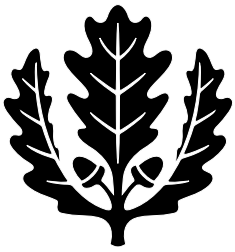

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Abstract

Credit markets with asymmetric information often prefer credit rationing as a profit maximizing device. This paper asks whether the presence of informal credit markets reduces the cost of credit rationing, that is, whether it can alleviate the impact of asymmetric information based on the available information. We used a dynamic general equilibrium model with heterogenous agents to assess this. Using Indian credit market data our study shows that the presence of informal credit market can reduce the cost of credit rationing by separating high risk firms from the low risk firms in the informal market. But even after this improvement, the steady state capital accumulation is still much lower as compared to incentive based market clearing rates. Through self revelation of each firm's type, based on the incentive mechanism, banks can diversify their risk by achieving a separating equilibrium in the loan market. The incentive mechanism helps banks to increase capital accumulation in the long run by charging lower rates and lending relatively higher amount to the less risky firms. Another important finding of this study is that self-revelation leads to very significant welfare improvement, as measured by consumptiuon equivalence.

Journal of Economic Literature Classification: O16, O17, E26

Keywords: credit rationing, informal credit markets, self revelation mechanism

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1 Introduction:

When formal credit markets are imperfect due to asymmetric information, credit rationing is the most common practice to minimize bank's exposure to risk. But experience from different developing countries reveals that credit rationing in the formal credit market leads to the steady growth of informal credit market. In this paper, we specify a dynamic general equilibrium model with heterogenous borrowers and informal credit market to answer the following three questions: First, does rationing in the formal credit market create a recurrence of low capital accumulation under asymmetric information even in the presence of informal credit market? Second, is market clearing loan rate less efficient for higher capital accumulation when investment projects experience different probabilities of success? And finally, can the change in regime lead to a significant welfare gain?

Our study shows that the presence of informal credit market can reduce the cost of credit rationing by separating high risk firms from the low risk firms based on their available information. But even after this improvement, the steady state capital accumulation is still much lower as compared to incentive based market clearing rates. Through revelation of each firm's type, based on the incentive mechanism, banks can diversify their risk by achieving a separating equilibrium in the loan market. Incentive mechanism helps banks to increase capital accumulation in the long run by charging lower rates and lending relatively higher amount to the less risky firms.

Another important contribution of our study is to show a major social welfare improvement from credit rationing regime to self revelation regime. The consumption equivalence indicates that given the proportion of high and low risk firms as well as their success rates, social welfare can be improved substantially from credit rationing to self revelation regime. To check the robustness of our findings we estimated consumption equivalence for different proportion of high risk firms and different degrees of their success rate. Our findings in this regard suggest that the lowest possible consumption equivalence is always well above than that under credit rationing.

The two key features of this paper are that, first, capital accumulation can be intermediated through either bank or informal credit market. Second is the assumption of het-

erogenous firms, defined on the basis of degree of risk involved in the production process. Informal credit channel is composed of households and informal moneylenders like traders or landlords. Households provide loan to their low risk relatives or friends only when they are rejected by the bank due to rationing. In our model, we consider that households have resource constraints and, due to that, they cannot cater all the low risk borrowers rejected from formal sector.

Moneylenders serve as the final source of funds in this market and assumed to have enough funds to cater to the borrowers rejected by formal sector and households. As a result of credit rationing in the formal sector and resource constraint in households sector, they face a pool of both high risk and low risk borrowers. In order to glean the available information to separate each firm, based on their risk type, moneylenders are needed to incur certain information cost.

The existing literature on credit market imperfection lacks unanimity on how financial development should take place in the presence of asymmetric information. Stiglitz and Weiss (1981) justify credit rationing by pointing out that the lender's expected profit will decline with an increase in the interest rate under some circumstances. This leads to an excess demand and loan rationing. In Juffe-Russel (1976), good borrowers cannot be distinguished from economically rational borrowers. Rationing occurs in this case because of restricted loan sizes, and, the excess demand cause lower fraction of default. Williamson (1986, 1987a, 1987b) pointed out how debt contracts and credit rationing are inseparable, even in the absence of asymmetric information. According to him credit rationing occurs if the lenders have to incur monitoring cost.

However, there are certain limitations of this credit rationing approach. From the development economics perspective, credit crunch due to rationing in the formal credit market fosters the development of informal credit market. In this market, the lenders often combine credit with trading in crops and selling general merchandize (Bell (1990), Siamwalla et al (1990)). According to this view, the growth of informal market due to such interlocking of credit with other contracts creates a disincentive to invest in productive capital. The policy prescription made by economists in this regard is to expand formal credit in order to provide

credit at cheaper rate to those who need it "..to put the moneylenders in their place" (AU India Rural Credit Survey).

Bester (1985) provides an alternative theoretical view against credit rationing. According to this view, if banks compete by choosing collateral requirements and differentiated interest rates (separating equilibrium) simultaneously, then credit rationing will not occur. He further added that it is possible to use different contracts as a self-selection mechanism. Preferences for low interest and high collateral or vice versa lead to this self-selection.

But Bester's proposal of separating equilibrium, based on collateral, is also not always viable. If the separation is not done costlessly it produces inefficient outcomes. Against this view of using collateral as a sorting device, Besanko and Thakor (1987) find that it is valid only when there is no collateral constraint. When collateral constraint is binding lenders cannot sort borrowers out based on collateral and rationing is the only solution.

Our model differs from these above mentioned approaches in several respects. First, in earlier works (Stiglitz and Weiss (1981), Jaffe and Russel (1976)), the formal market is considered to be the only source of credit and the rejected borrowers do not have any other source of external funds. In contrast, we introduce an informal credit channel as an alternative source of funds. The introduction of this extra source of funds, though appears to be very expensive, reduces the social cost of credit rationing and leads to higher level of capital accumulation. Second, Bester (1985), Besanko and Thakor (1987) have pointed out theoretically that separating equilibrium can lead to better outcome compared to credit rationing if collateral is used as a sorting devise. But if the borrowers face collateral constraints (Besanko and Thakor (1987)) then this sorting devise does not hold and, in that case, rationing will occur. Our model shows that the separating equilibrium can be achieved through direct revelation or self selection based on price incentive costlessly and no collateral is required. Moreover, this endogenous pricing can ensure hedging against risk by charging higher price and offering less to the high risk firms as compared to the low risk firms. And this price differential can be considered as the risk premium.

Our study is organized in five sections. Apart from introduction, section-1 encompasses the background literature as well as contribution of this paper. Section-2 discusses the base

line model with heterogenous agents in a dynamic general equilibrium framework. Section-3 deals with the equilibrium analysis under steady state while Section-4 deals with the quantification of our model through calibration and estimation of some parameter values. Last section concludes.

2 The Base Line Model

The economy consists of four types of decision makers : firms, banks, households and informal moneylenders. There are two types of firms - low risk and high risk. Firms produce their own capital by converting available loans either from banks or from informal markets. Both of these loans are assumed to be perfectly substitute to each other. Firms prefer to borrow from the formal sector because there is a wedge between the interest rate charged by informal moneylenders and the banks.

Banks offer deposit contracts, maturing in the end of the period. They also sell shares in the financial market to diversify their risks. Banks convert this deposits and stocks into loans without any cost and extend them to the firms.

Households maximize their life time utility from consumption and total amount of loans being offered by them to the low risk relatives and friends, and, loans from formal sector to both high and low risk firms for production purpose. Due to resource constraint households can satisfy only a fraction of the entire demand of low risk loans from the friends or relatives. This induces the low risk borrowers to go for formal sector loans first instead of going for the household sector loan. When they are rejected by the formal sector they come to the households.

The combination of formal and households loan to firms gives household utility because households are aware of the exorbitantly high rate of interest charged by money lenders. They do not prefer their low risk relatives or friends to go to moneylenders for loan unless they are not covered by formal sector or households. Similarly, households may have friends or relatives with high risk projects. Priority wise households always prefer to offer loans to their low risk relatives or friends first. But because of their resource constraint they can only

serve a fraction of their low risk relatives or friends. Therefore, households always prefer both their high and low risk relatives or friends to be covered by formal sector. Thus, total volume of loan offered by formal sector along with low risk households loan gives households a positive utility.

Households generally do not charge any interest rates for their loans. They only extend loans when

- they know the owner of the firms from very close circuit like friend or family members and
- the projects taken up by these firms are less risky.

So far households periodic earning is concerned, they receive wage at the end of the previous period from supplying one unit of labor. Households also receive the principal and interest from their deposit and stocks kept in the bank.

In our model, informal money lenders are risk neutral and lend in the informal market when excess demand for loan spills over from the formal market because of credit rationing. The reallocative effect of credit rationing induces the informal money lenders to offer more loans in the informal market instead of savings with banks.

Another important feature of our model is the assumption of informational cost that these money lenders face. Households resource constraint leads some low risk firms to take loans from the moneylenders after being rejected by banks. To separate the low risk from the high risk firms moneylenders incur such cost. This assumption is justified in the context of India because as we see from the data available that, there is wedge between the low risk households and informal market loan rates[1].

Finally, we assume that population is constant so there is no aggregation bias with treating average quantities as aggregate quantities.

The adverse selection problem in our model is arising from the asymmetric information between banks and the different types of firms. As mentioned earlier, we assumed only two

[1]Fig. 2, based on available households level data, shows a separation of loans in the informal markets at different interest rates

types of firms. We followed De Meza and Webb (1987)[2] characterization in this regard. According to this characterization, firms production is a random outcome. All projects (high or low risk irrespective) yield the same return when they succeed or fail. But they differ in their probability of success. Low risk firms have the higher probability of success as compared to the high risk firms.

Given this characterization, low risk firms will always have a higher demand for loan as compared to the high risk firms. In that case, under perfect information, low risk firms with higher demand will have to pay higher price for same loan as compared to high risk firms. But under asymmetric information, if these firms hide their type and take the guise of low demand firms, they can get this loan at the same price as the low demand firms do. Since banks do not have the information regarding the type of each firm, they face a seemingly identical pool of high and low risk firms. Moreover, to pose themselves identical as the low demand firms, low risk firms with their higher demand have to conceal their extra demand from the banks. Low risk firms know that households supply only low risk loans at a zero percent interest rate. As a result, there is always a possibility for them to enjoy an extra amount of surplus if they hide their type. This adverse selection problem forces the banks to ration credit to hedge against risk.

2.1 Model Specification: Firms

As mentioned earlier, firms production process is composed of two stages. In the first stage firms convert their borrowing into capital. In the second stage firms utilize their capital to produce a single consumption good as final product. Firms can borrow from either banks or from households or moneylenders. They consider the same amount of loan taken from each sector as perfect substitutes to each other. Given this backdrop, the two stages of production process can be written as :

Stage 1: Firms produce their own capital. Firms do not have any initial wealth. So, they have to borrow in order to produce their capital. Firms produce capital using the following

[2]De Meza and Webb (1987), pp. 282

linear function:

$$K_t = L_t + T_{i,t} \qquad\qquad i = HR, LR \tag{1}$$

where K_t is the total amount of capital produced. L_t and $T_{i,t}$ represent amount of loan taken from banks and from households (H_t) and moneylenders ($M_{i,t}$) respectively in period t. All of them are assumed to be in real terms.

Stage 2: In this stage firms convert their capital into a consumption good. In our model we assume return on the i^{th} firm's project is a random outcome. All projects yield the same return. When the firms are successful irrespective of their type, they achieve a ψ_t percent more output above mean level. Output is zero when they fail. Only difference is in their rate of success. We defined the firms with higher success rate as the low risk firms (LR) and firms with lower rate of success as the high risk firms (HR). With corresponding rate of success (ϕ_i) the expected production can be written as:

$$E_t[f(k_t)] = \gamma_{i,t}[Ak_t^m] \tag{2}$$

where,

$$\gamma_{i,t} = \phi_i(1 + \psi_t) \tag{3}$$

The equation of motion for capital takes the following form:

$$k_{t+1} \;\; = \;\; (1 - \delta)k_t + i_t \tag{4}$$

where i_t is investment and k_t is the per capita capital stock in period t. We assume no technological difference between these two types of firms. Given the above production functions the profit functions for the ith firm, (π_i) can be written as:

$$E[\Pi_{i,t}] = \begin{cases} \gamma_{i,t}A(L_{i,t})^m - (1 + l_{i,t})L_{i,t} & \text{when gets formal sector loan} \\ \gamma_{i,t}A(T_{i,t})^m - (1 + h_{i,t})T_{i,t} & \text{when does not get formal loan} \end{cases} \tag{5}$$

where i = High risk (HR) or, Low risk (LR), $L_{i,t}$ and $T_{i,t}$ are the amount of loans taken from formal and informal sectors respectively by the i^{th} firm in period t.

Maximizing profit for the i^{th} firm with respect to $L_{i,t}$ and $T_{i,t}$, we get the corresponding unconstrained demand functions as follows:

For i^{th} firm:

$$L_{i,t}^{D*} = \left(\frac{\gamma_{i,t} Am}{1 + l_{i,t}}\right)^{\frac{1}{1-m}} \text{ when loan is available from formal sector} \tag{6}$$

$$T_{i,t}^{D*} = \left(\frac{\gamma_{i,t} Am}{1 + h_{i,t}}\right)^{\frac{1}{1-m}} \text{ when loan is not available from formal sector} \tag{7}$$

And since $\phi_{LR} > \phi_{HR}$, therefore, between the two types of firms

$$\gamma_{LR,t} > \gamma_{HR,t} \tag{8}$$

Now from the above equations, we can say that, $\gamma_{LR,t}$ being greater than $\gamma_{HR,t}$ due to higher value of ϕ_{LR}, the demand for loan of the low risk firms is greater than that of the high risk firms at any price. But since the value of ϕ_i for different groups are unknown to the banks, banks can not differentiate between the firms on the basis of differences in demand.

2.2 Banks

We address the bank's problem by assuming that there are two possible types of regimes.

2.2.1 Credit Rationing Regime:

In this regime we assume that banks are price takers both in the loan market as well as in the deposit and stock markets. They have a uniform loan rate, $\overline{l_t}$, predetermined by the central bank. In this situation banks face a pooled demand from both types of firms. Let us assume that the proportion of high risk firms be ρ and that of low risk firms be $(1-\rho)$. Since banks do not have this information and the information regarding the type of each firms , banks ration credit. They decide to cater a fraction of the market demand and this fraction is endogenously determined so as to maximize profit. Through rationing banks turn down some of the borrowers' demand for loan even if the borrowers are willing to pay the price as well as the non price element.

Let us assume that the banks supply only α fraction of loan demanded under credit rationing regime. If the firm is rationed out then it goes to the informal market. So, with probability $(1-\alpha)$, firms go to the informal market to get loans. This implies that, if the total demand for loan revealed is L_t^{FD} in the formal sector, then banks supply only αL_t^{FD}. The pool will be identical because the high demand firms (low risk) will take the guise of the low demand firms for the formal loan. In this way high demand firms can reap the benefit of certain amount of surplus by operating on the lower demand curve in the guise of low demand firms. They fulfil their extra demand from the informal market supply. Let us consider

$$L_t^D = \rho\left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} + (1-\rho)\left(\frac{\gamma_{LR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} \tag{9}$$

be the actual demand generated from both high risk and low risk firms. But total demand revealed in the formal market from the identical pool will be

$$\begin{aligned} L_t^{FD} &= \rho\left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} + (1-\rho)\left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} \\ \text{or,}\quad L_t^{FD} &= \left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} \end{aligned}$$

In that case, total supply of formal loan will be

$$L_t^{FS} = \alpha\left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} \tag{10}$$

Now, the part of total demand for loan that is hidden to the banks by the low risk firms to maintain an identical pool is

$$L_t^D - L_t^{FD} = \rho\left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} + (1-\rho)\left(\frac{\gamma_{LR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} - \left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} \tag{11}$$

$$= (1-\rho)\left[\left(\frac{\gamma_{LR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} - \left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}}\right] \tag{12}$$

This makes a spill over of total demand for informal loan as

$$T_{i,t} = (1-\alpha)\left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} + (1-\rho)\left[\left(\frac{\gamma_{LR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}} - \left(\frac{\gamma_{HR,t}Am}{1+\overline{l_t}}\right)^{\frac{1}{1-m}}\right] \tag{13}$$

where $\sum T_{i,t}$ is the total demand for informal loan. If we assume η as the proportion of high risk firms in the informal demand mix then demand from the high risk firms that goes to the moneylenders is

$$M_{HR,t} = \eta(1-\alpha)\left(\frac{\gamma_{HR,t}Am}{1+\overline{l}_t}\right)^{\frac{1}{1-m}} \tag{14}$$

Now, suppose households having a capacity constraint, cater only a fraction, λ of the less risky firms at a very low (in the equilibrium it is zero) interest rate. In that case supply of household sector loan will be

$$H_{LR,t} = \lambda\left(Am\right)^{\frac{1}{1-m}}\left[\gamma_{HR,t}^{\frac{1}{1-m}}(\rho+\eta\alpha-\eta-\alpha)+(1-\rho)\gamma_{LR,t}^{\frac{1}{1-m}}\right] \tag{15}$$

and rest of the demand from residual low risk firms goes to the moneylenders. Therefore, demand for moneylenders loan from low risk firms will be

$$M_{LR,t} = (1-\lambda)\left(\frac{Am}{1+h_{LR,t}}\right)^{\frac{1}{1-m}}\left[\gamma_{HR,t}^{\frac{1}{1-m}}(\rho+\eta\alpha-\eta-\alpha)+(1-\rho)\gamma_{LR,t}^{\frac{1}{1-m}}\right] \tag{16}$$

Notice that the value of λ is endogenously chosen from our model although households resources are given. The reason behind λ being endogenous is the endogenous demand for households loan. Before we set up banks' profit maximizing problem under credit rationing regime, we want to assume that

i. there is no reserve requirement for the banks. So, they can convert their entire deposit and stock into loan.

ii. banks choose the proportion of demand for loan to be catered, α endogenously, based on the available funds with them in order to make zero profit in the long run.

In that case, banks' profit maximization problem can be written as

$$\max_{L_t,\alpha} E_t[\Pi_t^B] = \alpha\phi_{HR}(\overline{l}_t)L_t^D - (W_t)(D_t+S_t) \tag{17}$$

$$\text{S. T. } L_t^D \geq D_t + S_t \tag{18}$$

Solving for α^* from the zero profit condition, we get

$$\alpha^* = \frac{W_t}{\overline{l}_t\phi_{HR}} \tag{19}$$

Given the fixed share of households loan, this optimum value of α then decides the share of informal loans under credit rationing.

2.2.2 Self-Revelation Regime:

Self revelation regime is proposed as an alternative to credit rationing in order to compare relative efficiencies under different regimes. In this regime we assume that banks operate under monopolistic competition where they set prices for differentiated loans. In this case, banks intend to disburse loan to different types of investment projects at different rates instead of single prime lending rate. Loans are intended to be differentiated on the basis of the associated degree of risk. But the problem that arises due to incomplete information in this regard is the inseparability of riskier projects from the projects with low risk. Banks have asymmetric information on each individual's type. In this situation banks can use some kind of incentive mechanism based on demand such that each firm self-selects itself. We adopted direct revelation principle in our model from Myerson (1979). Under asymmetric information, Myerson defined that revelation mechanism leads to a Bayesian Nash equilibrium under induced communication game. According to Myerson, among different Bayesian equilibria under a mediation plan, truth telling becomes Bayesian Nash if and only if it is incentive compatible. This equilibrium is also called the incentive compatible equilibrium (Gibbons (1992)).

To set up the bank's maximization problem under this regime we use the following information gathered from firms' maximization problem, given their type. Between two types of firms in our model,

1. high risk firms with lower demand coefficient, γ_{HR}, operate on a lower demand curve. In this case, banks set the price in such a way so that it can take way all the surplus from high risk firms. Therefore, for the high risk firms with low demand and a probability of success, ϕ_{HR}, participation constraint is binding - i.e,

$$E_t[R_{HR,t}] = \phi_{HR} L_{HR,t}(l_{HR,t}) \tag{20}$$

   where, $E_t R_{HR,t}$ is the banks' expected total revenue from the high risk firms.

2. low risk firms with higher demand coefficient, $(\gamma_{LR,t})$, should operate on a higher demand curve. But they have incentive to operate on the lower demand curve because,

by doing so, they can enjoy a surplus. This creates an adverse selection problem. Therefore, under self selection regime, the low risk firms with higher demand should be bounded by the incentive constraint.

Under revelation regime, the borrowers will reveal their type only if, at least, their previous payoff is assured. To do that banks have to know the actual surplus the low risk firms were enjoying. As we see from the two firms demand functions that the willingness to pay for the high risk firm for any given level of loan is

$$1 + l_{HR,t} = \frac{\gamma_{HR,t} Am}{(L_{HR,t})^{1-m}} \tag{21}$$

and that for the low risk firm is

$$1 + l_{LR,t} = \frac{\gamma_{LR,t} Am}{(L_{HR,t})^{1-m}} \tag{22}$$

These above two equations imply that the less riskier firm has a $\frac{\gamma_{LR,T} - \gamma_{HR,t}}{L_{HR,t}^{1-m}}$ times higher willingness to pay for the same amount of loan. In this case, the amount of surplus the low risk or high demand firms enjoy from $L_{HR,t}$ unit of loan is

$$Q_t = \left[\frac{\gamma_{LR,t} Am}{(L_{HR,t})^{1-m}} - \frac{\gamma_{HR,t} Am}{(L_{HR,t})^{1-m}} \right] L_{HR,t} \tag{23}$$

Or,

$$= AmL_{HR,t}^{m} (\gamma_{LR,t} - \gamma_{HR,t}). \tag{24}$$

where Q_t is total surplus. Therefore, the incentive constraint for the high demand or low risk firms to self select themselves is

$$E_t[R_{LR,t}] = \phi_{LR} L_{LR,t}(l_{LR,t}) - AmL_{HR,t}^{m} (\gamma_{LR,t} - \gamma_{HR,t}) \tag{25}$$

where $E_t[R_{LR,t}]$ is the expected revenue from low risk firms, $L_{LR,t}$ and $L_{HR,t}$ are the loan amount for low risk and high risk firms and $l_{LR,t}$ is the loan rate for low risk firms. ϕ_{LR} is the success rate of the low risk firms. To induce the firms with high demand to disclose their type, banks under such communication game with mediation, can promise to return the surplus they were enjoying. This way banks can motivate the less riskier firms to demand for

$L_{LR,t}$ amount instead of $L_{HR,t}$. Now with ρ as the fraction of high risk firms and $(1-\rho)$ as the fraction of low risk firms, assumed earlier in firm's problem, banks' profit maximization problem can be written as :

$$\max_{L_{LR,t},L_{HR,t}} E_t\Pi_t^B = \rho E_t(R_{HR,t}) + (1-\rho)E_t(R_{LR,t}) - r_t(D_t + S_t) \tag{26}$$

$$\text{S.T. } E_t R_{LR,t} = \phi_{LR} L_{LR,t}(l_{LR,t}) - Amk_{ht}^{1-m} L_{HR,t}^m(\gamma_{LR,t} - \gamma_{HR,t}) \tag{27}$$

$$E_t R_{HR,t} = \phi_{HR} L_{HR,t}(l_{HR,t}) \tag{28}$$

$$D_t + S_t = \rho L_{HR,t} + (1-\rho)L_{LR,t} \tag{29}$$

From the F.O.Cs w.r.t $L_{HR,t}$ and $L_{LR,t}$ we get :

$$l_{HR,t}^* = \frac{W_t}{\phi_{HR}} + \frac{(1-\rho)}{\rho\phi_{HR}} \frac{Am^2(\gamma_{LR,t} - \gamma_{HR,t})}{(L_{HR,t})^{1-m}} \tag{30}$$

$$l_{LR,t}^* = \frac{W_t}{\phi_{LR}} \tag{31}$$

Notice that the surplus under such pricing mechanism can be considered as cost irrespective of success of the low risk firms.

These F.O.Cs show that for low risk firms with higher demand co-efficient, banks' marginal benefit is inversely related to their probability of success. For the firms with no risk, it becomes exactly equal to bank's marginal cost under certainty. Where as, for the high risk firms, banks' marginal benefit is greater than their marginal cost by a positive amount. This extra amount can be considered as the premium that banks charge to the high risk firms to hedge against their vulnerability in order to default.

One important assumption to make this mechanism work is that banks do not breach the ex ante contract at the end of the contract period. If they do so then self revelation mechanism does not hold. This assumption is rational because when all the banks are operating under revelation regime then by cheating ex post, the violator comes back to rationing equilibrium. But in that case, only high risk firms will come to this bank because low risk firms do not have any incentive to come back to this bank by leaving lower rate of interest being offered by other banks. This will decrease the violator bank's expected pay

off. Therefore, when this self selection is reached by firms under revelation mechanism no bank will have a tendency to breach the contract.

2.3 Households

In our model we assume that there are large number of identical households who maximize their life time utility from consumption and total lending by them as well as by the formal sector. Total volume of formal and households loan gives households positive utility because higher coverage by them leads a lower dependence of their relative or friends firms on money lenders. The representative household solves the following maximization problem [3] :

$$V = \max_{C_t, H_{LR,t}, D_t, S_t} \sum_{t=0}^{\infty} \beta^t \frac{\left(C_t + \frac{(\overline{L}_t + H_{LR,t})^e}{e}\right)^{1-\sigma} - 1}{1-\sigma} \tag{32}$$

S. T. :

$$\begin{aligned} C_t + D_t + S_t + H_{LR,t} \leq I_t + (1 + h_{LR,t-1}) H_{LR,t-1} \\ + (1 + W_{t-1})(D_{t-1} + S_{t-1}) \end{aligned} \tag{33}$$

where D_t denotes the quantity of goods deposited with the bank at time t, S_t is the real amount of stock purchased, C_t is the real consumption and I_t is the wage income from one unit of labor offered. $H_{LR,t}$ is the amount of household sector loan and $h_{LR,t}$ is the low risk informal sector loan rate in real terms, e is the elasticity of substitution between consumption and loan. $\overline{L}_t$ is the amount of loan supplied by the formal sector and W_t is the weighted average cost of capital ($WACC$) or the risk adjusted per unit cost of deposit and stock at time t [4]. The discount factor β lies in the open unit interval, $0 \leq \beta \leq 1$. The constant elasticity of substitution parameter σ is strictly positive. In our case we assume $\sigma = 1$.

Then the Euler equations are :

[3] The utility function we consider here is used by Uzawa (1968), Epstein (1983), Mendoza (1991) and others. For explanation see Mendoza (1991).

[4] Details about the estimation procedure are given in the Calibration section.

$$D_t : \frac{I_t + (1+h_{LR,t})H_{LR,t} + (1+W_t)(D_t+S_t) + \frac{(\overline{L}_{t+1}+H_{LR,t+1})^e}{e} - D_{t+1} - S_{t+1} - H_{t+1}}{I_{t-1} + (1+h_{LR,t-1})H_{LR,t-1} + (1+W_{t-1})(D_{t-1}+S_{t-1}) + \frac{(\overline{L}_t+H_{LR,t})^e}{e} - D_t - S_t - H_t} = \beta(1+W_t) \tag{34}$$

$$S_t : \frac{I_t + (1+h_{LR,t})H_{LR,t} + (1+W_t)(D_t+S_t) + \frac{(\overline{L}_{t+1}+H_{LR,t+1})^e}{e} - D_{t+1} - S_{t+1} - H_{t+1}}{I_{t-1} + (1+h_{LR,t-1})H_{LR,t-1} + (1+W_{t-1})(D_{t-1}+S_{t-1}) + \frac{(\overline{L}_t+H_{LR,t})^e}{e} - D_t - S_t - H_t} = \beta(1+W_t) \tag{35}$$

$$H_{LR,t} : \frac{I_t + (1+h_{LR,t})H_{LR,t} + (1+W_t)(D_t+S_t) + \frac{(\overline{L}_{t+1}+H_{LR,t+1})^e}{e} - D_{t+1} - S_{t+1} - H_{t+1}}{I_{t-1} + (1+h_{LR,t-1})H_{LR,t-1} + (1+W_{t-1})(D_{t-1}+S_{t-1}) + \frac{(\overline{L}_t+H_{LR,t})^e}{e} - D_t - S_t - H_t} = \frac{\beta(1+h_{LR,t})}{(\overline{L}_t+H_t)^{-(1-e)} - 1} \tag{36}$$

2.4 Informal Moneylenders

Informal moneylenders (henceforth moneylenders) are risk neutral. Money lenders are price setters and decide the price according to the degree of risk. Since the informal market experiences separating equilibrium (Fig-2) between households loan and moneylenders' loan, and a fraction of low risk firms goes to the households after being rejected by the formal sector, the money lenders are left with the pool of residual high and low risk firms. Money lenders do not have prior information regarding firms' type. But since they operate under a small jurisdiction they can glean this information by incurring certain cost. We assume moneylenders has certain market power in setting the price so that they can keep a margin of profit over their cost. This acts as rent of the moneylenders. Given this backdrop, moneylenders maximize their expected profit in the following way:

$$\begin{aligned} \max_{M_{HR,t}, M_{LR,t}} E_t\pi_{m,t} =& \phi_{HR}(1-\alpha)\eta h_{HR,t}M_{HR,t} + \phi_{LR}(1-\alpha)(1-\eta)(1-\lambda)h_{LR,t}M_{LRt} \\ & - (c_{LR}M_{LRt} + c_{HR}M_{HRt}) \end{aligned} \tag{37}$$

where $M_{i,t}$ is the loan amount offered by the money lenders, ϕ_i is the success rate and c_i is the cost coefficient of the ith type of firm in the informal sector.

F.O.C with respect to $M_{HR,t}$ and $M_{LR,t}$:

$$M_{HR,t} \quad : \quad h_{HR,t} = \frac{c_{HR}}{(1-\alpha)\eta\phi_{HR}} \tag{38}$$

$$M_{LR,t} \quad : \quad h_{LR,t} = \frac{c_{LR}}{(1-\eta)(1-\alpha)(1-\lambda)\phi_{LR}} \tag{39}$$

After solving the optimization problems of each decision makers from our model, given their respective constraints, the following equilibrium conditions lead us to the steady state values of each parameter of our model.

3 Equilibrium

An equilibrium in this model economy is a sequence of prices $\{sp_t, W_t, l_{LR,t}, l_{HR,t}, h_{LR,t}, h_{HR,t}\}_{t=0}^{\infty}$, allocations, $\{C_t, i_{kt}\}_{t=0}^{\infty}$, stock of financial assets, $\{D_t, S_t, H_t, M_{LR,t}, M_{HR,t}, L_{HR,t}, L_{LR,t}\}_{t=0}^{\infty}$, and policy variables $\left\{r_t, \bar{l}_t\right\}_{t=0}^{\infty}$, such that :

1. The allocations and stocks of financial assets solve the household's date t maximization problem, Equation (32), given prices and policy variables.

2. The real allocations solve the firm's date t profit maximization problem, Equation (5), given prices and policy variables.

3. The stock of financial assets solve informal money lender's maximization problem, Equation (37), given prices and policy variable.

4. The stock of financial assets solve the bank's date t profit maximization problem, Equation (17), under credit rationing and, Equation (26), under self revelation regime, given prices and policy variables.

5. The loanable funds market equilibrium condition under credit rationing: $L_t^D = L_t + T_t$ where $T_t = \lambda(1-\eta)(1-\alpha)H_t + (1-\lambda)(1-\eta)(1-\alpha)M_{LRt} + \eta(1-\alpha)M_{HRt}$ and $L_t = \alpha(D_t + S_t)$.

6. Goods market equilibrium condition satisfies $C_t + i_t = f(k_t)$ for all t.

3.1 A. Steady State Equilibrium under Credit Rationing Regime

To evaluate the steady state equilibrium we use the solutions to the maximization problems of households, banks, firms and the informal moneylenders together with the equilibrium conditions. Along this path we assume no growth in the economy. The economy is characterized by the following equations:

1. Given the households and formal sector loan, the elasticity of substitution, e, between household consumption (C^{ss}) and loan amount (H_{LR}^{ss}) has been calculated from Equation (35) and (36). Considering inter temporal consumption is constant, Equation (36)

reduces to

$$H^{ss} + \overline{L}^{ss} = (1+\beta))^{\frac{1}{e-1}} \tag{40}$$

By taking log of both the sides we estimate the value of e. [5]

2. Equating households loan supply from Equation (35), (36) with demand, Equation (15), from firms we find the value of λ, i.e, proportion of low risk loan that households supplies under credit rationing.

$$\lambda = \frac{(\frac{1+W}{2+W})^{\frac{1}{1-e}} - \overline{L}}{\left((Am\gamma_{HR})^{\frac{1}{1-m}}(\rho - \frac{W^{ss}}{\overline{l}\phi_{HR}}(1-\eta) - \eta) + (1-\rho)(Am\gamma_{LR})^{\frac{1}{1-m}}\right)} \tag{41}$$

3. From Equation (19) we get the optimum value of α, the proportion of demand for formal loan being catered by banks under credit rationing. With this value, Equation (10) gives us the total supply of formal loan by banks as

$$L^{ss} = \left(\frac{\gamma_{HR}Am}{1+\overline{l^{ss}}}\right)^{\frac{1}{1-m}} \frac{W^{ss}}{\overline{l^{ss}}\phi_{HR}} \tag{42}$$

4. From Equation (14) and (38), we get demand for moneylender's loan by high risk firms

$$M^{ss}_{HR} = \eta(1 - \frac{W^{ss}}{\overline{l^{ss}}\phi_{HR}}) \left(\frac{\gamma_{HR}Am}{1+h_{HR,t}}\right)^{\frac{1}{1-m}} \tag{43}$$

Since the money lenders supply the entire amount therefore, this is the optimum value of high risk moneylenders' loan.

5. From Equation (16)and (39), we get money lender's supply of low risk loan

$$M^{ss}_{LR} = (1-\lambda)\left((\frac{Am\gamma_{HR}}{1+h_{LR}})^{\frac{1}{1-m}}(\rho - \frac{W^{ss}}{\overline{l}\phi_{HR}}(1-\eta) - \eta) + (1-\rho)(Am\gamma_{LR})^{\frac{1}{1-m}}\right) \tag{44}$$

6. Capital accumulation under this regime is

$$k^{ss} = L^{ss} + (1-\alpha)\eta M^{ss}_{HR} + \lambda H^{ss} + (1-\alpha)(1-\lambda)(1-\eta)M^{ss}_{LR} \tag{45}$$

[5] To make our model compatible with available data we solve for the particular value of e such that the equilibrium household sector loan rate turns out to be zero.

3.2 B. Steady State Equilibrium under Self-Revelation Regime

To evaluate the steady state equilibrium under this regime we use the solutions to the maximization problems of households, banks and firms together with the equilibrium conditions. In this regime banks can identify different types of firms using truth telling incentive mechanism and can decide the corresponding prices for each type of firms. Due to banks total coverage, there will be no households or moneylenders' loan in the equilibrium. Along this path also we assume no growth in the economy. The economy is characterized by the following equations:

1. By equating high risk firms' willingness to pay from Equation (21) with banks' willingness to accept, Equation (30), we get the optimum value of high risk loan supplied

$$L_{HR}^{ss} = \left(\frac{Am(\gamma_{HR}\rho\phi_{HR} - m(1-\rho)(\gamma_{LR}-\gamma_{HR})}{\rho(\phi_{HR}+W^{ss})}\right)^{\frac{1}{1-m}} \tag{46}$$

2. By equating low risk firms' willingness to pay from Equation (22) with banks' willingness to accept, Equation (31), we get the optimum value of low risk loan supplied

$$L_{LR}^{ss} = \left(\frac{\phi_{LR}\gamma_{LR}Am}{\phi_{LR}+W^{ss}}\right)^{\frac{1}{1-m}} \tag{47}$$

3. By using the optimum high risk loan amount in Equation (30), we get the optimum loan rate for high risk loan

$$l_{HR}^{ss} = \frac{\gamma_{HR}\rho W^{ss} + m(1-\rho)(\gamma_{LR}-\gamma_{HR})}{\gamma_{HR}\rho\phi_{HR} - m(1-\rho)(\gamma_{LR}-\gamma_{HR})} \tag{48}$$

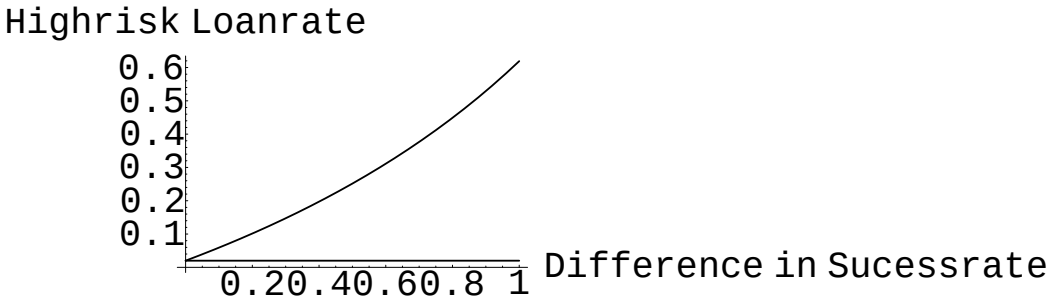
4. From Equation (30) we get the low risk loan rate,

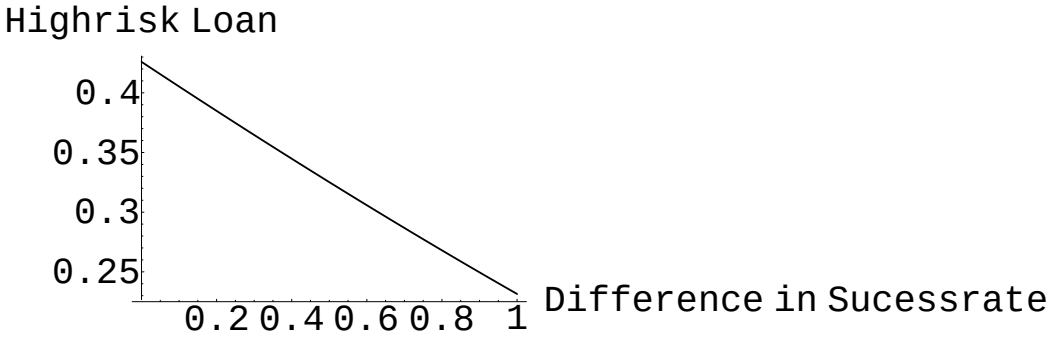
$$l_{LR}^{ss} = \frac{W^{ss}}{\phi_{LR}} \tag{49}$$

5. Capital accumulation under this regime is

$$k^{ss} = \rho L_{HR}^{ss} + (1-\rho)L_{LR}^{ss} \tag{50}$$

Figure 1: **Variation in High Risk Loan Rate and Amount of Loan Across Different Values of Difference in Success Rate**





Note that, from Equation (46) to (49), high risk loan volume depends on their corresponding success rate, ϕ_{HR} as well as their proportion, ρ. Therefore, an decrease in proportion of high risk firm or their success rate, ϕ_{HR},

- decreases the high risk loan volume,
- increases the loan rate for the high risk firms (Fig. 1). This happens because high risk firms' marginal benefit is higher than bank's marginal cost. Therefore, even if banks charge higher loan rate for the high risk firms, it does not affect the social welfare inversely so long it is below their willingness to pay.

Another important outcome in this regard, is that when the low risk loan volume or rate is independent of the influence of high risk firms, the high risk loan rate or the loan amount depends on the difference in success rate or the proportion of low risk firms. Larger proportion of low risk firms or their higher success rate decrease the high risk loan volume or increase the loan rate (Fig. 1).

4 Calibration

To quantitatively assess this model economy we need to find the parameter values. Most of the parameter values we directly estimated from equilibrium relations of our model while other parameter values we either used directly or estimated from the available data in the following way.

4.1 Parameter values estimated from micro data

To quantify our model we used a sample of 700 rural agricultural households. All the information are collected annually for a span of three years 1997-2000 from different states of India. Data has been collected by Agro-economic Research Centers and Units, Ministry of Agriculture, Government of India. The use of agricultural loans does not lead to any loss of generality in the context of India. According to *All India Debt and Investment Survey* (AIDIS), 48th Round, the household borrowing and repayments during the period 7.1.91

to 6.30.92[6] suggest that 116 million of rural households and 42 million of urban households borrowed money from different formal and informal lending institutions. This indicates 74 percent of total borrowers belong to rural sector while only 26 per cent are the urban households. The break up of total amount of cash borrowing shows Re. 1349.8 billion is borrowed by rural households that constitutes 63 percent of the total borrowing. Rest 37 per cent i.e., 791.8 billion goes to urban sector.

4.1.1 Parameter values calculated using econometric model

To calculate the technological parameters presented in table 1.a, we used the available sample data collected by Agro-economic Research Centers and Units, Ministry of Agriculture, Government of India.

Estimations of the following parameters are done in the following way:

i. m = capital share : We first found out the labor share from available data on National Income Accounting and then deducted it from total real GDP at factor cost[7] to find capital share in production.

ii. ψ = Percentage gain in production over mean level when the project is successful: We first regressed the log of real value of production on the log of different inputs and implements used. Percent deviation of actual from the estimated real production is considered as the expected gain for each firms. Since there is no technological differences assumed between high risk and low risk firms therefore, this expected gain is considered to be same for all types of firms.

iii. A = Technology parameter: The intercept value of the following model of real value of output on capital inputs gives us the value of A:

[6]NSSO conducts this household level debt and investment survey every ten years and data for the year 1991-92 is the latest available data. Total 9052 villages and 5560 urban units were surveyed by the NSSO. Actual number of households surveyed was 36425 in the rural sector and 20606 in the urban sector

[7]Source: Key Indicators of Developing Asian and Pacific Countries, ADB,pp.185: *http* : *//www.adb.org/documents/economic*$_u$*pdates/ind/*

$log(output) = 2.14 + \alpha_1 * log(Capital^*) + \alpha_2 * log(Land^*)$ with $R^2 = .47$.[8]

Table 1.a: Different Parameters and their Corresponding Estimated Values

Parameters	Description	Value
ψ	Percentage gain in output when successful	.81
A	Technological parameter	2.14
m	Share of capital in production	.24

Table 1.b: Investment, Some Policy Parameters and their Corresponding Values

Parameters	Description	Value
π	Inflation rate	.087
r	Real deposit rate	.096*
p_s	Real rate of return on securities	.028*
W	Weighted Average of cost of capital	.020
i	Private investment	.135*

We also used different macro economic indicators like inflation rate, real deposit rate, real rate of return on securities and investment for the years from 1970 to 2000 from Sirai (2002). The estimated averages are given in the following table-1.b. The Weighted Average Cost of Capital, W, in the above table is estimated using capital asset pricing model (CAPM) in the following way:

$$W_{t-1} = \frac{r_{t-1}D_{t-1}}{(D_{t-1} + S_{t-1})} + \frac{p_{s,t-1}S_{t-1}}{(D_{t-1} + S_{t-1})} \tag{51}$$

where,

$$p_{s,t-1} = r_{t-1} + [E(r_{mt}) - r_{t-1}]\mu \tag{52}$$

and,

$$\mu = \frac{\text{Cov}(S_{t-1}, r_{mt})}{\text{Var}(r_{mt})} \tag{53}$$

where r_{t-1} is deposit rate in period $t-1$, $p_{s,t-1}$ is price of securities, $E[r_{m,t}]$ is the expected market price in period t.

[8]'*' indicates level of significance at less than 1 percent

4.1.2 Parameter values obtained from Discriminant Analysis:

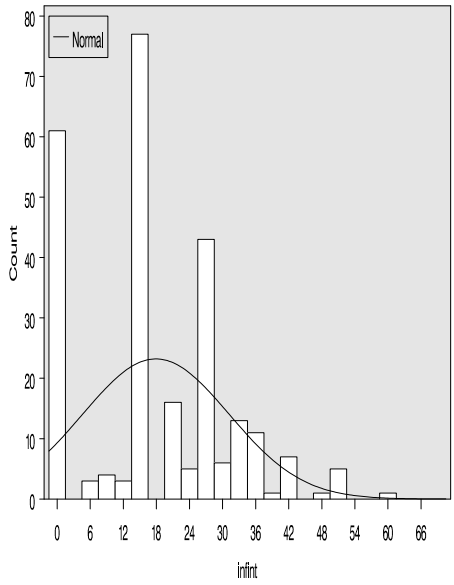
We started with the separating equilibrium in the informal sector based on the available data (Fig. 2, Table 2) According to Fig.-2, the distribution of borrowers with respect to informal interest rates has a tri-modal distribution. The first mode is at zero percent real interest rate while the other two modes correspond to 15 and 27 percent. We assume that separation of zero percent interest rate from the other rates represents the separation of households low risk loans to their friends or family members from moneylenders loan. The definition of low risk loans are based on the following hypotheses in this regard :

- The borrowers with diversified sources of income are low risk.
- High risk borrowers use more child labor as compared to low risk borrowers as a shock absorbing device.
- High risk firms have higher probability of default.

Table 2: Number of Borrowers Across Different Rates of Interest in the Informal Market

Inf. Int.rate	Freq	Percent	Cum. Freq.	Cum. Percent
0	61	23.74	61	23.74
$0-5$	0	0	61	23.74
$5-10$	7	2.72	68	26.46
$10-17$	80	31.13	148	57.59
$17-19$	0	0	148	57.59
$19-25$	20	7.78	168	65.37
$25-30$	48	18.68	216	84.05
$30-42$	34	13.23	250	97.28
$42-46$	0	0	250	97.28
$46-70$	7	2.72	257	100

Figure 2: **Frequency Distribution of Number of Borrowers in the Informal Market Across Different Rates of Interest**



The results in table-3 validate our hypothesis regarding the definition of low risk firms. Moreover, all loans being offered at zero percent interest rates are households loan, is justified from the fact that moneylenders charge an exorbitantly higher interest rates and it cannot be zero.

Due to households resource constraint moneylenders face a mix of high and low risk firms. Moneylenders do not have information about firms' type. But having a smaller jurisdiction compared to banks money lenders can get this information by incurring certain cost. Therefore, from the pool of moneylenders' loan, low risk firms cannot be separated costlessly and hence, this information is unknown to the moneylender at the beginning. Based on the separation of borrowers in the informal market between households and moneylenders loan, and considering household borrowers as low risk borrowers, we created a binary variable as $y = 0$ when real interest rate is 0 and $y = 1$ otherwise. y=0 represents low risk firms. With respect to that we used the observed behaviorial pattern of some variables in the informal sector like percentage child labor used, percentage income from trade and services (i.e, other than agriculture) and percentage household members engaged in agriculture, to divide the formal sector borrowers through discriminant analysis (table 3).

Table 3: Mean Estimated Values of Certain Indicator Variables Across High Risk and Low Risk Firms

Variables	High risk	Low risk
Percent of firms	.54	.46
percent child labor used	.38	.06
Percent income from secondary sources	.03	.30
Percent household members engaged in agriculture	.84	.39
Default rate in formal sector	.21	.12
Default rate in informal sector	.29	.15
Average default rate in both the sector	.22	.15

After we divided our sample firms into two groups - high risk and low risk, we find out the mean values of the following parameters.

Table 3.a: Parameters Values Obtained from Discriminant Analysis

Parameters	Description	Value
ϕ_{LR}	Success rate of the low risk firms	.86
ϕ_{HR}	Success rate of the high risk firms	.78
γ_{HR}	Demand coefficient for high risk firms	1.41
γ_{LR}	Demand coefficient for low risk firms	1.56
ρ	Proportion of high risk firms	.54
x	Proportion of high risk firms in the formal market	.72
η	Proportion of high risk firms in the informal market	.38

i. ρ = Proportion of high risk firms among the total borrowers.

ii. ϕ_{HR} = success rate of the high risk firms.

iii. ϕ_{LR} = success rate of the low risk firms.

iv. γ_{LR} = Demand coefficient for low risk firms.

v. γ_{HR} = Demand coefficient for high risk firms.

vi. η = The proportion of high risk firms in the informal market.

vii. x = Proportion of high risk firms in the formal market .

4.2 Equilibrium values of parameters estimated from the model

Table 4.a represents the behaviorial parameters used in the baseline computational experiments. We calculated the value of β from the available data. σ is assumed to be 1.

Table 4.a: Behavioral Parameters and their Corresponding Values

Parameters	Description	Value
β	Inter temporal discount factor	.98
σ	Degree of risk aversion	1
e	Elasticity of substitution between household consumption and loan	.39

Following variables in table 4.b have been calculated from the model:

i. The percentage of low risk firms in the rejected pool from formal sector and getting loan from households, λ, is obtained from Equation (41). Note that λ is dependent on the value of the elasticity of substitution between households consumption and loan parameter, e.

ii. Moneylenders' information cost coefficients for low risk and high risk loans, c_{LR} and c_{HR}, are estimated from our model using Equations (14), (16), (38) and (39).

iii. The equilibrium value of proportion of loan demand supplied by formal market under credit rationing regime, α, is estimated from maximizing bank's optimization problem under credit rationing from Equation (19).

iv. The equilibrium value of high and low risk loan rate, l_i, is estimated from Equation (48) and (49) for revelation regime. Under credit rationing it is the average value estimated from the data for the period 1970 to 2000.

v. The equilibrium value of high and low risk loan, L_i, is estimated from our model using Equation (46) and (47).

vi. The equilibrium value of amount of informal moneylenders' loan, M_i, has been estimated from model using Equation (14), (16), (19), (43) and (44).

Table 4.b: Equilibrium Values of Differentiated Loan Rates and Optimum Amount of Loans Under Different Regimes

		Under Credit Rationing		Under Self Selection	
Parameter	Description	High risk	Low risk	High risk	Low risk
α	Fraction of credit rationing	.484	.484	-	-
λ	Proportion of low risk households loan	-	.08	-	-
l^{ss}	Bank loan rate	.053	.053	.055	.023
h^{ss}	Informal sector loan rate	.270	.150	-	-
c_i	Cost coefficient for moneylenders loan	.042	.038	-	-
L^{ss}	Amount of bank loan	.216	.084	.608	.724
H^{ss}	Amount of household sector loan	-	.020	-	-
M^{ss}	Amount of moneylenders' loan	.120	.232	-	-
k^{ss}	Capital formation	.240	.155	.328	.333

vii. The equilibrium value of capital accumulation, k, has also been estimated as follows:

- Rationing: $k_{HR} = L_{HR} + (1-\alpha)\eta M_{HR}$ and $k_{LR} = L_{LR}\lambda(1-\alpha)(1-\eta)H + (1-\lambda)(1-\alpha)(1-\eta)$

- Revelation: $k = \rho L_{HR} + (1-\rho)L_{LR}$

4.3 Social Welfare under the two regimes:

In this section we compare the social welfare implications of both the regimes with respect to consumption equivalence. We also estimated the respective social welfare for each regime. In the following equation we assume that a ξ times change in consumption in the credit rationing regime makes utility in both the regimes equivalent to each other. From the following equation

$$\sum_{t=0}^{\infty} \beta^t \frac{\left(\xi C_{CR,t} + \frac{(\overline{L}_t + H_{LR,t})^e}{e}\right)^{1-\sigma} - 1}{1-\sigma} = \sum_{t=0}^{\infty} \beta^t \frac{\left(C_{SS,t} + \frac{(\overline{L}_t + H_{LR,t})^e}{e}\right)^{1-\sigma} - 1}{1-\sigma} \tag{54}$$

where, ξ is the consumption equivalence co-efficient. The following Table-4.c represents the values of different indicator variables and consumption equivalence co-efficient under two

different regimes. The equilibrium value of ξ is estimated to be 1.63 indicating a significant difference in consumption between these two regimes.

Table 4.c : Equilibrium Values of Real Variables

Parameters	Description	CR	SS
C	Consumption	.865	.872
$L = D + S$	Deposit plus Stock	.300	.661
H	Households Loan	.02	-
$L + H$	Formal plus HH Loan	.320	.661
i	Investment	.135	.135
I	Households periodic fixed income	.859	.859
ξ	Consumption Equivalence Co-efficient	-	1.63
SW	Social Welfare	19.45	23.75

The main reason behind this higher consumption equivalence with a given income and investment is the substantial increase in earnings of the households from deposits and stocks. Although under revelation regime there is no households loan but the increase in formal sector loans more than compensates this deficiency and leads to a much higher level of consumption. Social welfare increases by 23 percent if the banks stitch from credit rationing to self revelation regime.

4.4 Robustness of the Model

To estimate the equilibrium parameter values from our model under credit rationing we consider that the loan rate is predetermined by the central bank. Based on this consideration we take the average loan rate [9] to estimate two crucial parameters, α, the proportion of formal sector loan and λ, the share of households loan in the informal loan volume from our model. These two parameters are crucial in our model because ultimately, they dictate the share of formal loan, informal low and high risk loans and households loan. To check the robustness of our model we alternatively estimate the value of α and λ from the available data on 700

[9]Based on Sirai(2002) from data, we estimated the average loan rate for the period 1970 to 2000

sample households instead of estimating them from our model. Then, given these values, we estimate the equilibrium values of formal sector loan rate, formal sector loan volume, different components of informal sector loans, consumption equivalence and social welfare. Table 4.d represents the comparisons between these two alternative situations. According to this table the difference in these two alternatives is very negligible and it does not affect either the consumption equivalence or social welfare.

Table 4.d: Comparison of Values Between the Model and Sample Data

Parameter/variable	α and λ calibrated	α and λ from sample
α	.485	.502
λ	.080	.072
$\bar{l}$	.053	.051
L	.300	.305
M_{HR}	.12	.088
M_{LR}	.232	.246
k	.395	.391
ξ	1.63	1.63
SW	19.45	19.45

One of the major concern in this regard is that we can check these values only for credit rationing regime. None of the parameter values for self selection regime can be cross checked from sample data because we do not observe self selection in the Indian context. One way to test the robustness of our model in this regime is by comparing the capital accumulation (Table 4.e), consumption equivalence (Table 4.f) and social welfare (Table 4.g) under two different regimes for different values of the proportion of high risk firms, ρ, and the high risk success rates, ϕ_{HR}. We ignored the possibility of ρ=0 or, 1 because in both of these cases the group becomes homogenous with identical firms. We also ignored the values of ϕ_{HR} below .4. The reason is that for value of ϕ_{HR} lower than .38 does not satisfy zero profit condition under credit rationing even if $\alpha = 1$, given the administered loan rate and the deposit and stock prices. We choose only ρ or ϕ_{HR} because low risk loan rate being the bench mark rate and loan amount independent, these parameters are most crucial in the self revelation

regime in determining the steady state capital accumulation as well as deciding the extent of social welfare. Originally, we estimated the proportion of high risk firms and the success rates from sample data using discriminant analysis.

The following Table-4.e shows that capital accumulation declines with the increase in ρ or decrease in ϕ_{HR}.

Table 4.e: Shares of High(L_{HR}) and Low (L_{LR}) Risk Loans and Capital Accumulation(k) under Revelation Mechanism for Different Values of ρ and ϕ_{HR}

			$\rho = .1$		$\rho = .25$		$\rho = .5$		$\rho = .75$		$\rho = .99$	
ϕ_{HR}	k_{CR}	L_{LR}	L_{HR}	k	L_{HR}	k	L_{HR}	k	L_{HR}	k	L_{HR}	k
.4	.268	.73	0	.65	0	.54	.05	.39	.18	.32	.23	.28
.5	.315	.73	0	.65	0	.54	.20	.46	.29	.40	.33	.37
.6	.348	.73	0	.65	.17	.58	.34	.53	.41	.49	.43	.46
.7	.375	.73	.11	.66	.38	.64	.49	.60	.53	.58	.54	.57
.78	.395	.73	.40	.69	.55	.68	.61	.67	.63	.65	.63	.64

Note: The capital Accumulation, $k = \rho L_{HR} + (1 - \rho)L_{LR}$.

k_{CR} represents capital accumulation under credit rationing.

The most important point to underpin here is that capital accumulation is always higher under self revelation as compared to the respective capital accumulation under credit rationing regime (represented by k_{CR} in the same table). Notice that, in Table 4.e, high risk loan volume is equivalent to zero for the combination of some lower values of ρ and ϕ_{HR}. The reason is with lower success rate the demand for high risk loans becomes inefficiently low. On top of that, lower value of ρ, coupled with such lower success rate, reduces their share almost to zero. As ρ increases the share increases even if demand for individual high risk firm is very low. As the share of these low demand firms increases, capital accumulation goes down and reaches its minimum when ρ is maximum and ϕ_{HR} is minimum (k=.28 for $\rho = .9$ and $\phi = .4$, Table 4.e). But even this value of capital under self revelation regime is well above its counterpart in credit rationing regime (given in the first column in the same table). This results validate our claim that revelation mechanism leads to a higher capital accumulation path as compared to credit rationing.

Table 4.f: Total Formal Loan (L), Consumption (C) and Consumption Equivalence (ξ) Under Revelation Regime for Different Values of ρ and ϕ_{HR}

	$\rho = .1$			$\rho = .25$			$\rho = .5$			$\rho = .75$			$\rho = .99$		
ϕ_{HR}	L_t	C_t	ξ	L_t	C_t	ξ	L_t	C_t	ξ	L_t	C_t	ξ	L_t	C_t	ξ
.4	.65	.872	1.83	.54	.870	1.65	.39	.866	1.37	.32	.865	1.20	.28	.865	1.11
.5	.65	.872	1.78	.54	.870	1.61	.46	.868	1.46	.40	.867	1.34	.37	.866	1.27
.6	.65	.872	1.75	.59	.871	1.64	.53	.869	1.56	.49	.869	1.48	.46	.868	1.43
.7	.66	.872	1.73	.64	.872	1.69	.61	.871	1.64	.58	.871	1.59	.56	.87	1.56
.78	.69	.873	1.75	.68	.873	1.73	.67	.872	1.71	.65	.872	1.69	.64	.872	1.67

From the social welfare perspective, Table-4.f represents the formal sector loan volume (L^{ss}), consumption (C^{ss}) and consumption equivalence (ξ) in revelation regime under the same environment. The table reveals that L^{ss}, C^{ss} and ξ all declines monotonically. Most important finding in this regard is that even the lowest value of consumption equivalence due to the maximum share of low demand high risk firms is significantly above 1.

According to Table 4.g, social welfare with these different combinations of ρ and high risk success rates, behave in the same pattern. Table 4.g shows that social welfare decreases monotonically with the increase in ρ and decrease in ϕ_{HR}. But the lowest value of social welfare is even much higher than that under credit rationing. As we find from our result that social welfare is lowest with a value 19.2 for $\rho = .9$ and $\phi = .4$ from Table 4.g. The corresponding value under credit rationing is 18.68 is given on the same table, second column.

Table 4.g: Total Formal Loan (L), Consumption (C) and Social Welfare (SW) Under Revelation Regime for Different Values of ρ and ϕ_{HR}

		$\rho = .1$			$\rho = .25$			$\rho = .5$			$\rho = .75$			$\rho = .99$		
ϕ_{HR}	SW_{CR}	L_t	C_t	SW	L_t	C_t	SW	L_t	C_t	SW	L_t	C_t	SW	L_t	C_t	SW
.4	18.68	.65	.872	24.16	.54	.870	23.05	.39	.866	21.09	.32	.865	19.9	.28	.865	19.2
.5	19.03	.65	.872	24.16	.54	.870	23.05	.46	.868	22.07	.40	.867	21.27	.37	.866	20.76
.6	19.31	.65	.872	24.16	.59	.871	23.49	.53	.869	22.95	.49	.869	22.41	.46	.868	22.08
.7	19.56	.66	.872	24.25	.64	.872	24.03	.61	.871	23.72	.58	.871	23.41	.56	.87	23.22
.78	19.73	.69	.873	24.52	.68	.873	24.43	.67	.872	24.28	.65	.872	24.13	.64	.872	24.04

Note: SW_{CR} represents social welfare under credit rationing.

5 Conclusion

In this paper we quantify two alternative credit regimes– credit rationing in the presence of informal credit market and direct revelation. The main contribution of this paper is to show quantitatively the difference in capital accumulation between these alternative regimes under asymmetric information in a dynamic general equilibrium framework. With the consideration of heterogenous agents in the production, direct revelation mechanism can act as a separating tool costlessly and can lead to higher capital accumulation as compared to credit rationing. Our findings in this context can be presented as follows:

i. Presence of informal market not only prevents market failure by accommodating the rejected pool of borrowers but it also reduces the cost of credit rationing by providing more loans to the rejected low risk borrowers as compared to high risk borrowers. This is possible because of the availability of more information to the households sector as compared to the formal sector. This leads to a higher capital accumulation path as compared to credit rationing with no informal market.

ii. Optimum loan rate for the low risk firms, in separating equilibrium, is dependent only on their respective success rate. With a success rate equal to 1 will fix the loan rate at banks' marginal cost. Therefore, banks can consider this low risk loan rate as the bench mark rate. High risk loan rate increases when their own success rate goes down. High risk loan rate is also positively correlated with the difference of its own success rate from that of low risk firms (Fig. 1). Our findings suggest that margin in high risk loan rate over the bench mark rate increases with the increase in the difference in success rate.

iii. In the steady state under separating equilibrium, banks diversify their risk by issuing higher amount of low risk loan as compared to high risk loans. The difference increases as the gap between rate of success of the low risk firms and that of high risk firms increases (Fig. 1).

iv. Our results show that through incentive based pricing mechanism banks can set a price

for the high risk firms in such a way that they can keep a margin over their marginal cost. This extra margin can be considered as the premium for higher risk loans. As fig. 1 suggests, this premium increases with the increase in difference in the success rate of high risk firms from that of low risk firms. These upshots of our model suggest that banks can hedge against risk just by charging different interest rates and adjusting the amount they lend based on success rates. Banks do not require collateral as a sorting device as suggested by Bester (1985). And since collateral is not needed at all, Besanko-Thakor (1987) findings that, under collateral constraints banks need to ration credit - is also not necessary.

v. If we compare direct revelation regime with credit rationing our findings suggest that total supply of loan is always higher in self revelation regime as compared to credit rationing regime with informal sector.

vi. The predetermined loan rate in the credit rationing regime is set at a very high level. This rate is almost equal to the high risk loan rate under self revelation regime. This finding suggests that banks, with no information about the firms' type under credit rationing, set the interest rate much higher treating all firms as high risk firms.

vii. Capital accumulation, for any combination of proportion of high risk firms and their success rate, is higher under self revelation regime as compared to credit rationing regime even in the presence of informal market. And the difference is significant.

viii. Separation through revelation mechanism improves social welfare significantly. The significantly high value of consumption equivalence corroborates this claim. To check the robustness of our findings we estimated consumption equivalence for different proportion of high risk firms and different degrees of their success rate. Our findings in this regard suggest that for different proportion of high risk firms and success rates, the lowest possible capital accumulation, consumption equivalence and social welfare gain, under self revelation regime are much higher than their corresponding counterparts under credit rationing.

In this paper we consider no growth in the economy. One possible extension of our model would be to assume endogenous growth in the same framework and analyze the impact of credit rationing and price incentive mechanism on growth. Regarding the policy issues our model suggests that under price incentive mechanism higher price for risky loan discourages many risky firms to apply for loan. Moreover, the margin over the marginal cost of loan acts as a risk premium and therefore, there is no need for costly collateral. Second important policy relevance of our model is that price incentive mechanism not only ensures much higher social welfare from loan extension but also it ensures lower amount of loan to the risky sector as compared to low risk firms.

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