Formal and Informal Sector Credit Institutions and Interlinkage

Abstract

Nationalized banks in poor countries often ration rural credit. This creates demand for loans from monopolistic landlord/moneylenders who often interlink credit and product contracts allowing the latter to extract more of the tenant's consumer surplus. In the presence of asymmetric information such arrangements can be inefficient. We find that increasing the fixed credit allocation to the rural sector at a subsidized rate does not reduce that inefficiency. The entire benefit of the subsidy is extracted by the moneylender. An alternative policy of providing credit at subsidized rates but in a flexible manner is more effective in reducing the inefficiency.

JEL Classification: D82, O12, L14.

Keywords: Credit markets, Adverse Selection, Formal Sector, Informal Sector, Interlinked contracts.

Introduction

An interlinked transaction is one where two or more interdependent exchanges are simultaneously agreed upon. Thus, when a landlord agrees to take on a client at a fixed rent and also agrees to provide him with credit at a certain rate of interest, he is entering into an interlinked deal. Interlinkages among rural markets are widely observed in developing countries. Such interlinkages assume economic significance when the prices of the commodities transacted through interlinked markets differ from what their prices would have been if they had not been interlinked. Two markets that are often interlinked are the rural land and credit markets. Braverman and Stiglitz (1982) is one of the seminal papers analyzing the nature of interlinked transactions in rural areas. Also see Basu (1983, 1987) for interesting discussions of the subject. Hoff, Braverman and Stiglitz (1993) provide a comprehensive review of the literature. There is also considerable controversy regarding the impact of intelinking on the informal sector interest rates. Some have argued that interlinking will lead to very high interest rates while others have claimed that interest rates will be very low. See Gangopadhyay and Sengupta (1986, 1987).

In this paper we develop a model of interlinkage in the land and credit markets where a landlord who leases out land to tenants in return for rental/share payments also offers credit to the tenant and charges interest. We assume that there is a formal sector (nationalized banks) providing cheap credit but that credit is rationed so that at the prevailing formal sector interest rates there is an excess demand for credit. In fact each tenant can borrow only a fixed amount at a fixed formal rate of interest which makes the supply curve of funds coming from the formal sector a vertical straight line once the credit limit is reached. It is clear that interlinkage affords the landlord two separate means of extracting the tenant's consumer surplus - one through the rental/share payment and the other through the interest charged. We introduce adverse selection in this model by assuming heterogeneity of tenant types in the sense that the tenants differ in their skill levels and the landlord has only prior beliefs about the tenant's type. We show how the landlord will charge different rates of interest to different types of tenants. Specifically we show that the highest type tenant is charged the same interest rate as the moneylender's opportunity cost with succeeding higher rates for lower types. We also look at the efficiency implications of formal credit and how some of the inefficiency arising out of the lender's incomplete information about the borrower's type can be alleviated by making the supply of credit from the formal sector flexible i.e. making the supply curve a positively sloping function of the interest rate rather than a vertical line.

Section 2 presents the model and some results. Section 3 introduces the idea of flexible credit from the formal sector. In Section 4 we study the behavior of landlord when he faces elastic credit from the formal sector. Section 5 concludes.

The Model

Consider a landlord who owns a tract of land which he wishes to lease out. The landlord can lease his land to tenants in return for some kind of remuneration. In addition the landlord also has large reserves of money or other liquid assets, which can be loaned to tenants if demand arises. Let ρ be the gross opportunity cost of providing loans for the landlord. The tenants need credit to buy factors required for production. To keep matters simple let us assume that output is a function of the amount of investment in the production process. Output also depends on the productivity of the agent. An agent with higher productivity will be able to produce more output with the same amount of investment, than an agent with lower productivity. Output therefore can be written as,

$$Y_j = f(\theta_j; M) + \epsilon, \qquad \#$$

for $j = L, H$. L and H stand for the low type and the high type agents respectively. M denotes the

amount of investment in the production process. ϵ is a random variable with continuous distribution over some interval $[\underline{\epsilon}, \bar{\epsilon}]$ denoted by G with $E(\epsilon) = 0$ for $j = L, H$ footnote . This random realization of the state of nature does not allow the landlord to infer the amount of investment undertaken from the observed output.

Assumption 1: *The production function is strictly increasing and concave with respect to investment for all types of tenants. It satisfies standard Inada conditions. In addition* $f'_H(\theta_H; M) > f'_L(\theta_L; M)$, *for all* $M > 0$, *where* f' *denotes the partial derivative of the production function with respect to investment.*

The assumption above captures the notion that for any given level of investment the high type tenant is more productive that the low type. Without any loss of generality suppose that tenants of both types do not possess any wealth for production. Their abilities to provide collateral for loans are also identical. Tenants can borrow from banks (called formal credit) or from the landlord (called informal credit). We assume that the banks supply credit at a very low rate of interest. Let us denote this gross rate of interest by *r*. However, there is only a small amount of credit available from the banks. Formal credit thus falls short of the total credit demanded by the tenants. Hence the tenants of all types are forced to go to the landlord for additional loans. The landlord, aware of this rationed formal credit, can act as a monopolist and charge any rate of interest for the informal credit that maximizes profit. It has been noted that in such situations it may be profitable for the landlord to inter-link the two types of contracts; the terms on which he rents his land and the rate of interest he charges on his loans.(See Tirole, 1988)

Assumption 2: *Tenants derive utility from wealth according to* $U(.)$, *which is same for tenants of both types. Utility is assumed to be monotonically increasing and a strictly concave function of wealth, i.e.,* $U'(.) > 0$ *and* $U''(.) < 0$.

A contract offered by the landlord is a triple (α_j, β_j, I_j) where α_j is the amount of rental payment charged by the landlord to the *j*th agent, (1-β_j) is his share in the output and I_j is the gross interest rate charged on loans. These amounts are decided before any production activity. The actual payments are made after the production takes place. We assume that contracts offered by the landlord to the tenant are linear. The largest majority of tenancy contracts tend to be linear. So the set of contracts that we consider are such that the pay-off to the landlord can be written as $\alpha + (1 - \beta)f(.,.)$ such that the economic characterization of the contracts is the following:

- for a fixed rental contract, set $\alpha > 0$, $\beta = 1$,
- for a pure sharecropping contract, set $\alpha \geq 0$, $\beta \in (0, 1)$,
- for a pure wage contract, set $\alpha < 0$, $\beta = 0$.

A mixed contract would involve both a fixed rental payment as well as an output share.

The landlord offers a menu of contracts to the tenant and the tenant picks the optimal contract depending on his type. In addition the landlord also has to undertake monitoring of the tenants to prevent them from reneging on their debt. For simplicity, assume that the landlord can monitor tenants costlessly. However, the allocation of credit into investment in the production process cannot be perfectly observed by the landlord because of the random realization of ϵ. The tenant could decide to use the credit available for some activity which does not affect output but makes working conditions more pleasant for himself. This activity provides the tenant with pure private benefit. The tenant has to decide how to allocate the credit he gets from all possible sources into investment(*M*) and pure private benefit (*b*).

Let c_j be the amount of credit provided by the landlord to the *j*th agent. Suppose that the amount of formal sector credit forthcoming is $N\ \bar{F}$ which is divided equally among N borrowers. Thus each tenant receives at most $\bar{F}$ amount of credit from the formal sector. Given an interest rate *I* announced by the principal the tenant maximizes the following problem:

$$\max_{\{c,\,b,\,M,\,F\}} \quad E\{U[\beta f(\theta_j; M) - \alpha - Ic - rF + b]\},$$

$$\text{subject to } 0 \leq F \leq \bar{F} \text{ and } M = F + c - b.$$

Solution to this problem gives us the demand function for credit and the allocation of credit into investment and pure private benefit. If the productivity of investment is too low then it may be the case that after borrowing from the formal sector the tenant will not borrow from the landlord. The following assumption ensures that there will always be some residual demand for credit from the tenants as long as proper incentives exist.

Assumption 3: $f'_j(\theta_j; \bar{F}) > r$ *for* $j = H, L$.

The credit demand function derived from above can be written as:

$$EU'(.)[\beta f'_j(.) - I] = 0 \qquad \Rightarrow c_j \begin{cases} = \Phi_j(I, \beta) - \bar{F} + b \text{ if } I \geq r \\ = \Phi_j(I, \beta) + b \qquad \text{if } I < r \end{cases}$$

where $\Phi_j(I)$ is a decreasing function of I. We may also note that $\Phi_H(I) > \Phi_L(I)$ which gives us the desired single crossing property. Also, we will assume that $I \geq r$ in rest of our analysis. This is to capture the notion that formal sector credit is highly subsidized and hence rationed. Now let us focus our attention to the amount of credit allocated for investment and for pure private benefit. From Assumption 1 as long as $\beta > 0$, i.e. the tenant has some share in output, investment in production will be strictly positive. The optimal allocation of credit into investment and pure private benefit is given by the solution to the following equation:

$$\beta f'_j(\theta_j; c + F - b) = 1.$$

If $\beta f'_j(\theta_j; c + F) > 1$ then $b = 0$. As long as the marginal product of investment and tenant's share in output does not become too low the tenant will find it profitable to invest in production rather than in pure private benefit. We are going to show that the interest rate charged to tenant will always be greater than one, and as long as $\beta > 0$, the entire credit is going to be invested in production. Given the interest rate announced by landlord, the indirect utility function of the tenant can be written as:

$$V_j(\alpha, \beta, I, \bar{F}) = E\{U[\beta f(\theta_j; \Phi(I, \beta)) + \epsilon - \alpha - I\Phi_j(I, \beta) + (I - r)\bar{F}]\},$$

where $V_j()$ has following properties which we shall call [**P1**]:

$$\frac{\partial V_j(\alpha, \beta, I, \bar{F})}{\partial I} = EU'(.)[-\Phi_j(I, \beta) + \bar{F}],$$

$$\frac{\partial V_j(\alpha, \beta, I, \bar{F})}{\partial \bar{F}} = EU'(.)[I - r],$$

$$\frac{\partial V_j(\alpha, \beta, I, \bar{F})}{\partial \alpha} = -EU'(.),$$

$$\frac{\partial V_j(\alpha, \beta, I, \bar{F})}{\partial \beta} = EU'(.)f(\theta_j; .).$$

Let p be the proportion of high type tenants in the population. The principal's problem therefore can be written as

$$\max_{\{\alpha_j,\beta_j,I_j\}} \; p[\alpha_H + (1-\beta_H)Y_H + (I_H - \rho)(\Phi_H(I_H) - \bar{F})]$$
$$+ (1-p)[\alpha_L + (1-\beta_L)Y_L + (I_L - \rho)(\Phi_L(I_L) - \bar{F})],$$

subject to

$$V_L(\alpha_L, \beta_L, I_L, \bar{F}) \geq 0 \qquad (IR_L),$$

$$V_H(\alpha_H, \beta_H, I_H, \bar{F}) \geq 0 \qquad (IR_H),$$

$$V_L(\alpha_L, \beta_L, I_L, \bar{F}) \geq V_L(\alpha_H, \beta_H, I_H, \bar{F}) \qquad (IC_L),$$

$$V_H(\alpha_H, \beta_H, I_H, \bar{F}) \geq V_H(\alpha_L, \beta_L, I_L, \bar{F}) \qquad (IC_H).$$

IR_j and IC_j refer to the Individual Rationality and Incentive Compatibility constraints for j = L, H respectively. It is also assumed that the landlord has huge supply of credit available so that optimal allocation of credit among various types of agents does not bind at optimum. Using our single crossing property it is easy to show that at optimum only (IR_L) and (IC_H) will be bind. We will omit a formal proof of this statement. The proof is simple and follows along the lines of Laffont and Tirole (1993) pp. 55-58.

Proposition 1: *The amount of loan given to the high type tenant by the landlord is optimal and the rate of interest charged to the high type tenant is equal to the landlord's opportunity cost ρ. The amount of loan given to the low type agent is sub-optimal and the interest rate charged to the low type is higher than ρ.*

Proof: See the appendix. [End Proof]

Let us denote the contract offered by the landlord as $\{(\bar{\alpha}_H, \bar{I}_H); (\bar{\alpha}_L, \bar{I}_L)\}$. From proposition 1, we know

$$\bar{I}_H = \rho \text{ and } \bar{I}_L - \rho = -\frac{p}{(1-p)\Phi_L'(I_L)}[\Phi_H(\bar{I}_L) - \Phi_L(\bar{I}_L)].$$

This tells us that if the demand of the low type tenant is close to the demand of the high type, then the difference in the two rates of interest will be lower. Also, if the proportion of the high type tenant in the population is very high then the landlord may not provide any credit to the low type agent, i.e. set $\bar{I}_L$ to prohibitive levels. The rental payments are determined by the (IR_L) and (IC_H) constraints. The low type is charged a rate of interest greater than ρ. Hence the amount of credit given to the low type agent is sub-optimal. The landlord in order to separate among tenants of different types sets the interest rate higher for the low type tenant. This enables the landlord to extract maximum surplus from the contract.

Proposition 2: *The interest rate charged to the agents is independent of the amount of credit provided by the formal sector($\bar{F}$). In addition the utility of the landlord is increasing in $\bar{F}$ and the gain in landlord's utility is by $(\rho - r)$.*

Proof: See the appendix. [End Proof]

We may think of the difference between the landlord's opportunity cost and formal sector interest rate as the amount of credit subsidy. From the proof of Proposition 1 it immediately follows that the interest rate charged to the different types of agents are independent of $\bar{F}$. In addition an increase in $\bar{F}$ increases the surplus of the low-type tenant which can be extracted by the landlord through the rental payment α_L. Hence an increase in formal sector credit allocation does not help in

removing the inefficiency of the informal sector credit but just benefits the informal sector moneylender.

Proposition 3: *There exists a pure sharecropping contract for both types of tenants such that the landlord and the tenant's welfare are unaffected*.

Proof: Consider the original optimal contract $\{(\bar{\alpha}_H, \bar{I}_H); (\bar{\alpha}_L, \bar{I}_L)\}$ where the landlord offers a pure fixed-rent contract. The landlord could reduce the interest rate charged to both agents by a small amount say $I_L' = \bar{I}_L - \omega_1$ and $I_H' = \bar{I}_H - \omega_2$ where ω_1 and ω_2 are some small positive numbers. Then the landlord could choose β_H' and β_L' so that it solves $\beta_j f(\theta_j; M) = I_j'$. In doing so the total demand for credit would be unaffected and hence the ability of the landlord to extract surplus would also remain the same. The landlord would then choose α_j' so that (IR_L) and (IC_H) constraints bind.

[End Proof]

Hence there exists a continuum of optimal contracts some of which are pure sharecropping contracts. However in the present setup the landlord does not have a strong preference for either of them and hence the optimal contract observed would depend on institutional factors such as social norms.

Flexible Formal Credit

Suppose that the nationalized banks now provide credit in a more flexible manner. They take into account market considerations before setting the interest rate. However, their cost of providing credit has to be met if these banks are to be sustainable.

Let there be a large number(N) of borrowers in the market. The banks are not able to separate between various types of borrowers. This may be either due to their inefficiency, competition, or legal restrictions. When a borrower comes to the bank for loans, the bank charges him a rate of interest depending on the size of the loan. Let us call this gross rate of interest r^s. Banks also have to undertake monitoring of the borrowers to prevent strategic bankruptcy. As in standard debt contracts it will turn out that banks will choose to monitor when a borrower claims bankruptcy. Let the per unit cost of monitoring be denoted by η. Let $\pi(F)$ denote the bank's subjective probability of default on loans. We assume that $\pi'(F) > 0$, which means that banks believe that the probability of default is higher on loans of larger size. In the banking literature it has been noted that as the amount of money borrowed increases there is a greater incentive to default on loans. Hence when banks cannot monitor their borrowers they limit the amount of lending to an individual. (See Gale and Hellwig, 1985, for instance). In the case of agrarian economies too such a trend has been observed. Sarap(1991) in his study of the credit markets in the Indian state of Orissa, notes that the large borrowers in the rural credit markets have the most dismal credit record. Table 1 footnote provides a good example of this trend. In the two classes of land holding which are considered to be fairly high by the local standards, we find that in the 10.01 acres & above category the percentage of defaulters (no. of defaulters/ no. of borrowers) is remarkably higher. One might argue that this percentage is higher because these borrowers borrowed large sums of money which was beyond their means to repay. However it should be noted that these borrower's land holdings are much higher and hence they are more insulated from idiosyncratic risks. The average amount of overdue loan and the percentage of the default is also much higher.

Table 1

1in	1in	1in	1in
1in	1in	1in	1in
1in	1in	1in	1in

Suppose r^d is the rate of interest that the banks have to pay to their depositors. Then the zero profit condition for banks can be written as

$$r^d F = (1 - \pi(F))r^s F - \pi(F)\eta F \, . \qquad \#$$

For simplicity we are assuming that in the event of the borrower defaulting on his loan, the bank's payoff is zero . The zero profit condition gives us the supply function of credit from the banks. We can alternatively write this condition as

$$\delta(F, r^d, \eta) = r^s = \frac{r^d + \eta\pi(F)}{1 - \pi(F)} \, . \qquad \#$$

Given the deposit rate and the cost of monitoring, the rate of interest charged on a loan is increasing in the size of the loan since,

$$\delta'(F) = \frac{(r^d + \eta)\pi'(F)}{[1 - \pi(F)]^2} > 0 \, . \qquad \#$$

We assume that cost of borrowing small amount of loans is sufficiently close to zero. Hence if the landlord wants to prevent agents from borrowing from banks he will have to provide credit at almost zero rate of interest. Notice however that $\pi(F)$ is the probability of default on a loan from the banks point of view. This probability of default is the average default rate given that there are both high and low type borrowers in the market, and that the banks are not able to separate among borrowers of various types. Hence the cost of borrowing for the high type agent is too high. So there will still be some scope for the landlord to provide credit to tenants and write interlinked contracts.

If a tenant is borrowing from the bank as well as from landlord then it must be the case that $\delta(F, r^d, \eta) = I_j \; ; j = H, L$. Given the demand function for credit it follows that,

$$\delta(F, r^d, \mu) = I_j = \beta_j f_j'(\theta_j; c_j + F) \; ; \qquad j = H, L. \qquad \#$$

However, credit supply from the banks is no longer inelastic. Tenants are able to substitute between loans provided by the landlord and the bank, provided they are willing to pay the required rate of interest. This degree of substitutability can be measured by carrying out the following exercise. Inverting the function $\delta()$ we get

$$F = \tau(I_j) \; ; \qquad j = H, L, \qquad \#$$

where $\tau(.)$ is an increasing function of I_j. $\tau(.)$ measures the substitutability between the two kinds of credit. In order to understand the meaning of $\tau(.)$, suppose that the landlord decides to raise his rate of interest. Given the demand for credit of the tenants, the amount of loan that the tenant takes from the landlord falls and he tries to take as much loan as he can from the banks. However, as he tries to borrow more from the bank, the bank also charges him a higher interest rate. This process goes on until the bank interest rate and the landlords interest rates are the same and the tenant is indifferent between the two sources of credit. Therefore, the amount of credit taken from bank goes up by $\tau(.)$

as a result of this increase in landlord's rate of interest.

Therefore, demand for informal sector credit is given by

$$c_j = \Phi_j(I_j, \beta_j) - \tau(I_j);$$

and the indirect utility functions of the tenants are

$$V_j(\alpha, \beta, I) = E\{U[\beta_j f(\theta_j; \Phi_j(I_j, \beta_j)) - \alpha - I\Phi_j(I_j, \beta_j)]; \qquad j = L, H,$$

with the following properties which we shall call [**P2**]:

$$\frac{\partial V_j(\alpha, \beta, I)}{\partial I} = EU'(.)(-\Phi_j(I_j, \beta_j)),$$
$$\frac{\partial V_j(\alpha, \beta, I)}{\partial \alpha} = -EU'(.),$$
$$\frac{\partial V_j(\alpha, \beta, I)}{\partial \beta} = EU'(.)f(\theta_j; .).$$

[P2] implies that the single crossing property is still satisfied.

The Principal's problem again

Now the landlord when making his decision on the menu of contracts, has to take into account the feedback effect it will have on the formal credit market. If he charges too high a rate of interest on his loans then tenants would go to the banks for credit. In the previous case where the supply of formal credit was fixed the landlord was a de facto monopolist in the informal credit market. With flexible supply of credit from the formal sector any changes that he makes to the credit provided to a tenant has a resultant effect on the formal sector equilibrium credit which is given by $\tau(I_j), j = L, H$.

The landlord has the option of charging the monopoly interest rate which would be "very high". However as we know from the industrial organization literature (see Tirole, 1988) the landlord can actually increase his pay-off by asking for a two-part tariff instead of charging the monopoly interest rate. Interlinking the land and credit markets allows him to do so. He can now charge a much lower rate of interest and then extract the entire consumer surplus from the tenant through the fixed rental payment. But making the supply of formal credit flexible reduces the monopoly power of the landlord. The landlords problem is still to maximize his expected wealth subject to (IR_L), (IR_H), (IC_L) and (IC_H). However now his optimal contract choice has a feedback from the formal sector credit, which means that we can no longer ignore the possibility of sharecropping contracts. We can now state the following proposition.

Proposition 4 *The optimal contract offered to the high type tenant is a sharecropping contract where the interest rate charged to high type of tenant is lower than the interest rates charged when the supply of formal sector credit was fixed. The amount of investment by the high type tenant solves* $f'_H(\theta_H; M^*_H) = \rho$.

Proof: See the appendix. [End Proof]

The amount of investment by the high type agent remains unaffected even after flexible credit supply from formal sector. It should be noted that the high type agent was receiving optimal credit when the credit supply from formal sector was fixed. However in order to compete against the formal sector banks the landlord charges a lower rate of interest and offers a pure sharecropping contract to blunt the edge of formal sector credit footnote . The following proposition however highlights the improvement in efficiency due to flexible formal sector credit.

Proposition 5 *The amount of investment by the low type tenant is higher with flexible formal credit.*

Proof: See the appendix. [End Proof]

Making the formal sector credit flexible results in the landlord reducing the interest charged to both types of the tenants. While the landlord is still free to extract the tenant's surplus through the mechanism of the fixed rent, still the lower interest rate would result in a higher amount of credit being taken by low type tenant. Since output is a function of the amount of credit, this implies that output would be higher as a result.

The landlord has a comparative advantage over banks in the sense that it can monitor tenants costlessly and induce tenants to separate, something that banks cannot. However threat of competition from banks when formal sector credit is flexible forces the landlord to exploit this advantage and the result is a gain in efficiency in form of more credit being provided to the low type tenant. The landlord offers sharecropping contract to both types of tenants to gain some of the benefit of credit from formal sector and also bears part of the risk.

Conclusion

In this paper we have looked at the interaction between formal and informal sector credit institutions in the presence of interlinkage. We allow the landlord to write interlinked contracts where he can specify both an amount of credit (interest rate) as well as a fixed-rent and a share in output. This gives the landlord two different means with which to extract the tenant's surplus. We find that when the formal sector is rationed, the landlord does provide optimal credit to the high type tenant but provides sub-optimal credit to the low type. In this situation, where there is a fixed amount of credit forthcoming from the formal sector the landlord/moneylender is a monopolist facing the residual demand for credit coming form the tenants. And as a monopolist he uses an interlinked contract as a two-part tariff with a flat rental fee and an interest rate in order to maximize his return. In fact in this set-up increasing the amount of fixed credit that is available from the formal sector has the perverse effect of simply increasing the utility of the landlord without affecting the utility of the tenants. We also show that one way of reducing the landlord/moneylender's monopoly power would be to make the supply of credit from the formal sector a positively sloping function of the interest rate. So even if the formal sector subsidizes the availability of credit, providing more credit at higher interest rates has the effect that now the monopolist landlord/moneylender in setting his interest rate has to consider the feedback effect on the formal sector. We show that with flexible formal credit, the amount of credit given by the landlord to both types of the tenant is higher than in the case where formal credit is fixed.

Our paper has policy implications for the design of credit policy in emerging economies and provides directions for future research in the area.

Appendix

Proof of Proposition 1

Using the single crossing property, the lagrangian for the optimization problem of the principal can be written as

$$\begin{aligned}\pounds = {} & p[\alpha_H + (1-\beta_H)Y_H + (I_H - \rho)(\Phi_H(I_H) - \bar{F})] + \\ & (1-p)[\alpha_L + (1-\beta_L)Y_L + (I_L - \rho)(\Phi_L(I_L) - \bar{F})] \\ & + \lambda V_L(\alpha_L, I_L, \bar{F}) + \mu[V_H(\alpha_H, I_H, \bar{F}) - V_H(\alpha_L, I_L, \bar{F})] .\end{aligned}$$

First order condition with respect to α_L, α_H using properties [**P1**]yields,

$$(1-p) - \lambda[\int U'(.)dG(\epsilon)] + \mu[\int U'(.)dG(\epsilon)] = 0, \qquad \#$$

and

$$p - \mu[\int U'(.)dG(\epsilon)] = 0. \qquad \#$$

Using (7) and (8) we get,

$$\mu = \frac{p}{EU'(.)} . \qquad \#$$

$$\lambda = \frac{1}{EU'(.)} . \qquad \#$$

First order condition with respect to I_H, after necessary manipulation yields,

$$\bar{I}_H = \rho, \qquad \#$$

and first order condition with respect to I_L after necessary manipulation yields,

$$\bar{I}_L - \rho = -\frac{p}{(1-p)\Phi_L'(I_L)}[\Phi_H(\bar{I}_L) - \Phi_L(\bar{I}_L)]. \qquad \#$$

Since, $\Phi_H(.) > \Phi_L(.)$, and $\Phi_L'(.) < 0$ it follows that $\bar{I}_L > \rho$.

In the optimal solution to this maximization problem it is not possible to pin down the values of α and β separately. One can solve either for the fixed rental payment or the share parameter. Hence our Proposition 3. qed **Proof of Proposition 2**

From the optimality conditions of the previous proposition it follows that a change in $\bar{F}$ will have no impact on the interest rate offered to the agents of both types. Using envelope theorem we get that change in the landlords utility due to a change in $\bar{F}$ is,

$$-p(I_H - \rho) - (1-p)(I_L - \rho) + \lambda U'(.)(I_L - r) + \mu U'(.)(I_H - I_L).$$

Substituting for λ and μ we get that the gain in utility is $(\rho - r)$. qed **Proof of Proposition 4**

The Lagrangian for the optimization problem of the principal can now be written as

$$\begin{aligned} £ = {} & p[\alpha_H + (1-\beta_H)Y_H + (I_H - \rho)(\Phi_H(I_H, \beta_H) - \tau(I_H))] + \\ & (1-p)[\alpha_L + (1-\beta_L)Y_L + (I_L - \rho)(\Phi_L(I_L, \beta_L) - \tau(I_L))] \\ & + \lambda V_L(\alpha_L, \beta_L, I_L) + \mu[V_H(\alpha_H, \beta_H, I_H) - V_H(\alpha_L, \beta_L, I_L)]. \end{aligned}$$

First order conditions with respect to α_H and α_L yield same expression for λ and μ as (9) and (10). Differentiating the Lagranginan with respect to I_H and using property [**P2**] we get,

$$f_H' - \rho = \frac{(I_H - \rho)\tau'(I_H)\beta_H}{\Phi_H'(I_H)} + \frac{\tau(I_H)\beta_H}{\Phi_H'(I_H)} ,$$

and first order condition with respect to β_H yields

$$(f_H' - \rho)\frac{-I_H\Phi_H'(I_H)}{\beta_H^2} = 0 .$$

Therefore in an optimal contract $f_H'(\theta_H; M_H^*) = \rho$. This implies interest rate charged to the high type tenant satisfies $I_H^* + \tau(I_H^*)/\tau'(I_H^*) = \rho$, which means that the interest rate charged to him is lower than ρ. The share of tenant in output $\beta_H^* = \frac{I_H^*}{\rho}$. qed

Proof of Proposition 5

Let us recall that the credit supply and investment by the low type tenant when the formal sector credit was fixed was given by the solution to the following equation:

$$[f_L'(\theta_L, \bar{M}_L) - \rho] = -\frac{p\ \bar{\beta}_L}{(1-p)\Phi_L'(\bar{I}_L)}[\Phi_H(\bar{I}_L) - \Phi_L(\bar{I}_L)]\,. \qquad \#$$

In the new problem faced by the landlord the first order condition with respect to I_L gives us

$$[f_L'(\theta_L, M_L) - \rho] - \left(\frac{f_L' - \rho\beta_L}{\Phi_L'(I_L)}\right)\tau'(I_L) - \left(\frac{\beta_L}{\Phi_L'(I_L)}\right)\tau(I_L) \qquad \#$$

$$= -\frac{p\beta_L}{(1-p)\Phi_L'(I_L)}[\Phi_H(I_L) - \Phi_L(I_L)]\,.$$

Notice the left hand side expression now has two additional positive expressions. Hence the solution to this expression will yield $M_L^* > \bar{M}_L$ which proves our assertion that the amount of investment by the low type agent is higher with flexible formal credit. qed

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