Corruption in a Model of Vertical Linkage between Formal and Informal Credit Sources and Credit Subsidy Policy

Chaudhuri, Sarbajit and Ghosh Dastidar, Krishnendu

University of Calcutta

15 May 2009

Corruption in a Model of Vertical Linkage between Formal and Informal Credit Sources and Credit Subsidy Policy

Sarbajit Chaudhuri
University of Calcutta

Krishnendu Ghosh Dastidar
Jawaharlal Nehru University*

May, 2009

Abstract

The present paper develops a model of vertical linkage between the formal and informal credit markets highlighting the presence of corruption in the distribution of formal credit. The existing moneylender, the bank official and the new moneylenders move sequentially and the existing moneylender acts as a Stackelberg leader and unilaterally decides on the informal interest rate. The analysis distinguishes between two different ways of designing a credit subsidy policy. If a credit subsidy policy is undertaken through an increase in the supply of institutional credit it is likely to increase the competitiveness in the informal credit market and lower the informal sector interest rate under reasonable parametric restrictions. Any change in the formal sector interest rate has no effect. An anticorruption measure, on the contrary, may be counterproductive and raise the interest rate in the informal credit market.

Keywords- formal/informal credit markets, interest rates *Journal of Economic Literature Classification number* -O16, O17

1 Introduction

Credit available to the farmers in the less developed economies can be divided broadly into two categories: formal and informal. Formal (or institutional) credit comes from banks, cooperative credit

*S. Chaudhuri's address is Department of Economics, University of Calcutta, B.T. Road, Kolkata 7000, India. Email: sarbach@yahoo.com. K.G. Dastidar's address is CESP, School of Social Sciences, Jawaharlal Nehru University, New Delhi 110067, India. Email:kgd12@yahoo.com. The authors gratefully acknowledge the grant from UGC-DRS Scheme of Department of Economics, University of Calcutta for supporting their research. The authors are indebted to Sarmila Banerjee and Soumyen Sikdar for their encouragement and intellectual support.

societies, etc. while traditional village moneylenders, traders and landlords are the main sources of informal credit. Since the informal-sector lenders, especially the moneylenders, charge exorbitantly high interest rates, conventional thinking on financial sector reforms favoured an expansion of the formal credit sources (for instance, opening of more bank branches).

It was thought that this would achieve a reduction in the interest rates faced by the farmers. However, this has not happened in practice. Among the possible reasons pointed out by empirical research is the problem of corruption among the formal sector credit officials (see, for instance, Sarap (1991)[1]. At the theoretical level, Chaudhuri and Gupta (1996) and Gupta and Chaudhuri (1997) show that if there is corruption in the distribution of formal credit, a credit subsidy policy may raise the informal interest rate.

Recently economists have discussed an alternative[2] type of reform: forging a vertical linkage between the formal and the informal credit sources under which formal credit is given to informal sector-lenders who supply credit to the farmers. Under this policy, the informal sector lenders act as financial intermediaries between the formal credit agency and the final borrowers of credit. This type of policy has actually been experimented with some success in Philippines (see Umali (1990)).

There is some theoretical literature on the economic effects of building such a vertical linkage. Hoff and Stiglitz (1996) show that extending formal credit to the informal lenders paves the way for the entry of new lenders in the informal credit market which in turn, makes loan recovery from the farmers more difficult and leads to an increase in the cost of loan administration for every lender. The informal sector interest rates may go up instead of falling. Bose (1998) has argued that the policy of vertical linkage may fail to deliver the goods in a situation where the informal sector lenders have asymmetric information regarding the borrowers' ability to repay loans and competition between them determines the interest rate in the informal credit market. If in such a situation a credit subsidy policy is undertaken, as the paper argues, it would enable the better-informed informal sector lender to attract better borrowers with low probability of default towards him and leave borrowers with high default probability for the other. As a consequence, the second lender may not find it profitable to continue the lending operation and may finally leave the credit market. In such a situation, the borrowing terms in the informal credit market will deteriorate.

[1] Also see Bedback (1986), Bell (1990) and Braverman and Guasch (1986) in this context.

[2] Another approach may be to actually design credit institutions at the micro level that will take advantage of local information in innovative ways. The leading example of small-scale lending or micro-finance is the Grameen Bank of Bangladesh.

Floro and Ray (1997) have shown that a rise in the credit flow to the informal sector reduces informal interest rates and increases informal credit supply to the farmers only if the informal lenders compete among themselves. If they collude, this will no longer be the case.

Surprisingly however, the effect of the presence of corruption (among formal sector officials) on the workability of the vertical linkage has not so far been analyzed in the literature. In this paper we attempt to undertake this exercise. In order to focus on this problem we shall abstract from the other problems of vertical linkage mentioned in the preceding paragraph.

In the empirical literature mentioned earlier it has been observed that in the absence of vertical linkage, both formal and informal credit sources are limited in number in a given village. We shall model this situation by assuming that there is only one formal credit source (a bank) and only one moneylender[3] before the vertical linkage is forged. When the bank offers to refinance the informal money-lending, new moneylenders enter the picture. The central monetary authority of the economy seeks to increase the degree of competitiveness of the informal credit market and, therefore, permits formal credit supply to new moneylenders only. The bank official is corrupt and takes a bribe from the new moneylenders to disburse formal credit. The preexisting moneylender is assumed to play a dominant role in informal interest rate determination. The bribing rate, the number of new moneylenders who actually receive the credit from the bank and the informal interest rate are determined in a game between the dominant moneylender, the bank official and the fringe moneylenders. We will consider a three-stage game theoretic model to analyse this scenario.

There is a rural credit market with a single formal credit agency (a bank). The bank official is given the task of distributing a given amount of bank credit to people who would relend the money to the farmers of the village. This program vertically links the formal and the informal credit markets. The dominant moneylender supplies credit to farmers out of his own resources.

[3] Empirically the moneylender is not the only source of informal credit. Traders, landlords (large farmers), friends and relatives, etc., often give loans to the farmers. So the assumption that the moneylender is the only source of informal credit may look objectionable when the moneylender charges a high interest and the others charge low interest rates. Bardhan and Rudra (1978) and Rudra (1982) point out that the traders and landlords offer interlinked credit contracts at very low interest rates. But the empirical analysis of Sarap (1991) supplies some weak defenses of this assumption. Firstly, small and marginal farmers take nearly 80% of informal credits from the moneylenders (see his table 2.5). Secondly, the rates of interest charged by the traders, friends and relatives, etc., to the small and marginal farmers are also very high and close to the moneylender's interest rate (see his tables 5.2 and 5.6). Also the All India Debt and Investment Survey (Reserve Bank of India, 1981) shows that even in 1981, the moneylenders' share of informal credit (16.1%) is higher than the combined share of the landlords and the traders (12%).

When the bank official invites the loan applications, new informal moneylenders enter the picture. The bank credit is the only source of loanable funds for the new moneylenders. We assume that there is a very large number of potential new money lenders.

Our basic model is as follows. Here, in the first stage of the game the dominant money lender unilaterally determines the informal interest rate. In the second stage of the game, the bank official decides both on the bribing rate and the number of fringe moneylenders to whom the credit will be disbursed. In our model there is a probability that the bank official will get caught and if he gets caught he has to pay a fine. This probability is a strictly increasing function of the bribing rate. Finally, in the third stage of the game, each fringe moneylender (who has been selected for the credit) determines the amount of formal credit that he would apply for. There is no asymmetric information between the formal and the informal sector lenders, regarding the fringe moneylenders' ability to repay loans. They are assumed to be price followers[4] and charge exactly the same interest rate as set by the dominant moneylender.

We shall discuss two alternative ways of formulating a credit subsidy policy. A credit subsidy policy may be undertaken either through (a) an increase in the volume of formal credit supplied to the borrowers or through (b) a change in the rate of interest charged on the formal credit. Our main concern is with the effects of these policies on the informal interest rate since it is a lowering of this interest rate that constitutes the principal objective of a credit subsidization policy. The analysis of the present paper shows that if a credit subsidy is undertaken via the first route (an increase in the volume of formal credit supplied to the borrowers), it is able to lower the informal sector interest rate under some reasonable conditions. The other route (a change in the rate of interest charged on this type of credit) has no effect on the informal sector interest rate. We also show that in some cases an anticorruption measure (like increase in the fine if the official gets caught) may be counterproductive and lead to an increase in the informal sector rate of interest. The earlier papers in this area (Hoff and Stiglitz (1996), Bose (1998) and Floro and Ray (1997))

[4] The new moneylenders could not previously enter the informal credit market because of their high opportunity costs of credit vis-à-vis the preexisting moneylender. Now when vertical linkage between formal and credit markets is forged, each of them receives a given amount of formal credit at the subsidized interest rate which enables them to make some positive profits from money-lending but cannot set their own interest rates individually or collectively. This is because if any one charges a lower interest rate than what the dominant moneylender charges, he is only going to suffer because of his limited amount of funds. On the contrary, if he charges a higher interest rate vis-à-vis the rate fixed by the preexisting moneylender, no borrower would borrow from him and hence the assumption.

have not made such a comparative analysis between these two alternative ways of financing a credit subsidy policy, which is quite important from the point of view of policy making. Our result is significant because the earlier papers dealing with corruption in the distribution of formal credit (Chaudhuri and Gupta (1996) and Gupta and Chaudhuri (1997)) have predicted a credit subsidy policy to be counterproductive.

2 The Model

There is a rural credit market with a single formal credit agency (a bank). The bank official is given the task of distributing a given amount, $\overline{C}$, of bank credit to people who would relend the money to the farmers of the village. Let N denote the *very large* number of homogeneous new moneylenders applying for bank credit. But how many of them, n, would ultimately get the formal credit is decided by the bank official. The bank officer demands a bribe z per unit of bank credit given to the fringe moneylenders. This amount is withheld as 'cut money' from the bank credit at the time of disbursal.

There are three stages of the game. In the first stage, the dominant moneylender determines the informal interest, i, as he knows the behavioural patterns of the bank official and the fringe moneylenders. In the second stage of the game the bank official decides on the bribing rate, z, and the number of new moneylenders, n who actually get the credit. In the final stage of the game, each fringe moneylender determines the amount of formal credit that he would apply for. The amount of formal credit that each new moneylender receives, C^F , is also determined in the process.

We now turn to analyze the behaviour and payoff function of the different economic agents in this extended model.

Fringe moneylenders We start with the fringe moneylenders who move in the third stage. If a fringe money lender is formally approved of C amount of credit, the amount that he actually gets in hand is $C(1-z)$ as an amount zC is to be paid as bribe to the bank official. He can now use this amount i.e. $(1-z)C$ to disburse as a loan and earn an interest rate of i on it. Let r be the formal interest rate, and $f(x)$ be the cost of loan enforcement. It's given that $f(0)=0$. Also $f'(x)>0$ and $f''(x)>0$ for all $x>0$. Since this person has been formally approved of C amount of credit, he has to pay back $(1+r)C$ to the bank.

The income of each fringe moneylender is therefore

$$Y^F = [(1+i)(1-z) - (1+r)]\,C - f\,(C\,(1-z))\,.$$

We assume that the reservation income of each moneylender is zero. We now proceed to the bank official.

The bank official We now proceed to analyse the behaviour of the bank official who moves in the second stage. Let C^F be the formal credit received by each of the n fringe moneylenders in the third stage. Let $P(z)$ be the probability of that the bank official gets caught if he takes a bribe. $P(.)$ satisfies the following properties. (i) $P(0) = 0$, (ii) $P'(z) > 0 \quad \forall z > 0$ and (iii) $P'(z)$ is strictly monotonic in the interval $(0, 1]$. That is, either $P''(z) < 0 \; \forall z > 0$ or $P''(z) > 0 \; \forall z > 0$. K is the fixed money value of penalty in the case of detection of the bribery. The bank official is assumed to be risk neutral and his expected income is

$$Y^O = nzC^F - P(z)\,K.$$

It may be noted that the bank official while choosing z and n must see to it that $Y^F \geq 0$ (the reservation income constraint of each fringe money lender) and $\overline{C} \geq nC^F$ (the credit constraint that he himself faces).

The dominant moneylender The dominant moneylender moves in the first stage. Let g be the opportunity interest rate of the dominant money lender. $F(i)$ is the aggregate demand function for credit by the ultimate borrowers (farmers). We assume $F'(.) < 0$ and $F''(.) \leq 0$. Note that $n(1-z)\,C^F$ is the aggregate supply of actual formal credit (after bribe has been paid) going to the fringe moneylenders. Since this amount is supplied to the farmers as loans, the net demand of credit function faced by the dominant moneylender is $F(i) - n(1-z)\,C^F$. Hence, the income of the dominant moneylender is

$$Y^M = (i-g)\left[F(i) - n(1-z)\,C^F\right].$$

We also assume that the dominant moneylender has no cost of enforcing loan repayment. This can be justified by the hierarchical structure of a rural society where the dominant moneylender enjoys enormous clout.

2.1 Solving for the three stage game

2.1.1 Third stage

The fringe money lender moves and chooses $C \geq 0$ to maximise

$$Y^F = [(1+i)(1-z) - (1+r)]\, C - f\left(C(1-z)\right).$$

The first and second order conditions for maximisation are as follows.

$$\begin{aligned} Y_C^F &= \frac{\partial Y^F}{\partial C} = (1+i)(1-z) - (1+r) - f'\left(C(1-z)\right)(1-z) = 0 - -(1) \\ \text{and } Y_{CC}^F &= \frac{\partial^2 Y^F}{\partial C^2} = -f''\left(C(1-z)\right)(1-z)^2 < 0 - - - (1a) \end{aligned}$$

Note that the second order condition $\left(Y_{CC}^F < 0\right)$ is always satisfied since $f''(.) > 0$. Solving (1) and ($1a$) we get C^F. Note that if $(1+i)(1-z) - (1+r) < 0$ then $C^F = 0$. Also, $C^F > 0 \Longrightarrow (1+i)(1-z) - (1+r) > 0$. Therefore

$$Y^F = [(1+i)(1-z) - (1+r)]\, C^F - f\left(C^F(1-z)\right) > 0 \implies (1+i)(1-z) - (1+r) > 0 - - - - (2)$$

From (1) we get that if $C^F > 0$ then

$$(1+i)(1-z) - (1+r) = f'\left(C^F(1-z)\right)(1-z).$$

That is, if $C^F > 0$ we get that (from (1))

$$\begin{aligned} C^F &= \frac{1}{1-z} f'^{-1}\left(1 + i - \frac{1+r}{1-z}\right) - - - (3) \\ \text{Note that } C_r^F &= \frac{\partial C^F}{\partial r} < 0 \text{ (since } f''(.) > 0) - - - -(3a) \\ \text{and the sign of } C_z^F &= \frac{\partial C^F}{\partial z} \text{ is ambiguous.} - - - - (3b) \end{aligned}$$

2.1.2 Second stage

We now fold the game backwards and solve the second stage. In this stage the bank official moves and chooses z and $n \leq N$ to maximise Y^O subject to $Y^F \geq 0$ and $\overline{C} \geq nC^F$. Using (2) it may be noted that the official maximises

$$\begin{aligned} Y^O &= nzC^F - P(z)K \\ s.t.\ g^1(z,n) &= -Y^F \leq 0 \\ g^2(z,n) &= nC^F - \overline{C} \leq 0 \\ \text{and } g^3(z,n) &= n - N \leq 0 \end{aligned}$$

The relevant Lagrangian is

$$L = nzC^F - P(z)K + \lambda_1 Y^F + \lambda_2\left(\overline{C} - nC^F\right) + \lambda_3(N - n)$$

In an interior equilibrium, the 1OCs and the complementary slackness conditions are as follows.

$$\begin{aligned} L_z &= \frac{\partial L}{\partial z} = nC^F + nzC_z^F - P'(z)K + \lambda_1 Y_z^F - n\lambda_2 C_z^F = 0 - - - - (4a) \\ L_n &= \frac{\partial L}{\partial n} = zC^F - \lambda_2 C^F - \lambda_3 = 0 - - - - (4b) \\ L_{\lambda_1} &= \frac{\partial L}{\partial \lambda_1} = Y^F \geq 0 - - - - (4c) \\ \lambda_1\left(\frac{\partial L}{\partial \lambda_1}\right) &= \lambda_1 Y^F = 0 - - - - (4d) \\ L_{\lambda_2} &= \frac{\partial L}{\partial \lambda_2} = \overline{C} - nC^F \geq 0 - - - - (4e) \\ \lambda_2\left(\frac{\partial L}{\partial \lambda_2}\right) &= \lambda_2\left(\overline{C} - nC^F\right) = 0 - - - - (4f) \\ L_{\lambda_3} &= \frac{\partial L}{\partial \lambda_3} = N - n \geq 0 - - - - - (4g) \\ \lambda_3 \frac{\partial L}{\partial \lambda_3} &= \lambda_3(N - n) = 0 - - - - (4h) \end{aligned}$$

Note that in any non-trivial equilibrium $Y^F > 0$ and this implies (from 4d) that $\lambda_1 = 0$. Since we have assumed that N is very large, in equilibrium $n < N$. This means $\lambda_3 = 0$ (from 4h).

In equilibrium $\overline{C} - nC^F = 0$. This is because of the following reason. If $\overline{C} - nC^F > 0$ then the official can increase his payoff simply by increasing n. Therefore, $\overline{C} - nC^F > 0$ cannot arise in equilibrium. Hence, the *binding constraint* is the second constraint (which is $g^2(.)$). Note that

$$\begin{aligned} g_z^2 &= \frac{\partial g^2(.)}{\partial z} = nC_z^F \text{ and} \\ g_n^2 &= \frac{\partial g^2(.)}{\partial n} = C^F. \end{aligned}$$

Therefore the second order condition for the maximisation is as follows.

$$\det \begin{vmatrix} L_{zz} & L_{zn} & -g_z^2 \\ L_{nz} & L_{nn} & -g_n^2 \\ -g_z^2 & -g_n^2 & 0 \end{vmatrix} > 0$$

Then using the fact that $\lambda_1 = 0 = \lambda_3$ and that $g^2(.) = 0$ in equilibrium, we get the following from (4a) to (4h).

$$\begin{aligned} nC^F + n(z - \lambda_2) C_z^F - P'(z) K &= 0 - - - - (5a) \\ (z - \lambda_2) C^F &= 0 - - - - (5b) \\ \overline{C} &= nC^F - - - (5c) \end{aligned}$$

From (5a) to (5c) we can solve for z, λ_2 and n. That is, we will get z and n as functions of i (which has been chosen by the existing moneylender in the first stage), $\overline{C}$ and r. Note that $\overline{C}$ and r are given exogenously.

From (5b) we get that $z - \lambda_2 = 0$, since $C^F > 0$ (in any non-trivial equilibrium) . This implies (from 5a and 5c)

$$\overline{C} - P'(z) K = 0 - - - - (6).$$

Since $P'(.)$ is a strictly monotonic function, we have in equilibrium

$$z = P'^{-1}\left(\frac{\overline{C}}{K}\right) - - - - (7).$$

Hence we have

$$\begin{aligned} z_i &= \frac{\partial z}{\partial i} = 0 - - - - - (8a) \\ z_r &= \frac{\partial z}{\partial r} = 0 - - - - (8b) \\ z_{\overline{C}} &= \frac{\partial z}{\partial \overline{C}} = \frac{1}{KP''\left(P'^{-1}\left(\frac{\overline{C}}{K}\right)\right)} = \frac{1}{KP''(z)} - - - - (8c) \\ \text{and } z_K &= \frac{\partial z}{\partial K} = -\frac{\overline{C}}{K^2 P''(z)} - - - - (8d). \end{aligned}$$

2.1.3 First stage

We now solve the first stage. In this stage the dominant moneylender chooses i to maximise

$$Y^M = (i-g)\left[F(i) - n(1-z)C^F\right].$$

Note that from the second stage equilibrium condition we know that $z = z\left(i, \overline{C}, r\right)$ and $nC^F = \overline{C}$. The dominant moneylender will take this into account (like a Stackelberg leader) to maximise

$$Y^M = (i-g)\left[F(i) - (1-z)\overline{C}\right].$$

The conditions for maximisation are as follows. We use (8a), (8b) and (8c) to derive them.

$$\begin{aligned} Y_i^M &= \frac{\partial Y^M}{\partial i} = (i-g)F'(i) + F(i) - \overline{C}(1-z) = 0 - - - (9a) \\ \text{and } Y_{ii}^M &= \frac{\partial^2 Y^M}{\partial i^2} = (i-g)F''(i) + 2F'(i) < 0 - -(9b). \end{aligned}$$

Note that (9b) is always satisfied since we have assumed that $F'(.) < 0$ and $F''(.) \leq 0$.

Subgame Perfect equilibrium Note that in our model the parameters are $\overline{C}$, K, r and g. From (5c), (7) and (9a) we can compute the subgame perfect equilibrium values of i, z and n (i^{eqm}, z^{eqm} and n^{eqm} respectively). Plugging in the values of i^{eqm} and z^{eqm} in (3) we will get the equilibrium value of C^F.

By using (8a), (8b) and (8c) and (9a) we get the following.

$$\begin{aligned} Y_{ir}^M &= \overline{C}\left[(i-g)z_{ir} + z_r\right] = 0 - - - -(10a) \\ Y_{i\overline{C}}^M &= -(1-z) + \overline{C}z_{\overline{C}} = -(1-z) + \frac{\overline{C}}{KP''(z)} - - - -(10b) \\ \text{and } Y_{iK}^M &= \overline{C}z_K = -\frac{\overline{C}^2}{K^2P''(z)} - - - -(10c) \end{aligned}$$

Also note that

$$\begin{aligned} \frac{di^{eqm}}{dr} &= -\frac{Y_{ir}^M}{Y_{ii}^M} - - - -(11a) \\ \frac{di^{eqm}}{d\overline{C}} &= -\frac{Y_{i\overline{C}}^M}{Y_{ii}^M} - - - -(11b) \\ \text{and } \frac{di^{eqm}}{dK} &= -\frac{Y_{iK}^M}{Y_{ii}^M} - - - -(11c). \end{aligned}$$

In any non-trivial equilibrium where $C^F > 0$ and $z \in (0,1)$ we get the following result.

Proposition 1 *(i)* $\frac{\partial i^{eqm}}{\partial r} = 0$. *(ii) If* $P''(.) < 0$ *then* $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$.

Proof (i) Note $Y_{ii}^M < 0$ (9b) and $Y_{ir}^M = 0$ (10a). Hence from (11a) we get that $\frac{\partial i^{eqm}}{\partial r} = 0$.

(ii) Since $Y_{ii}^M < 0$ using (11b) we get that $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$ iff $Y_{i\overline{C}}^M < 0$. Since in equilibrium $z \in (0,1)$, we have $-(1-z) < 0$. From (10b) note that if $P''(.) < 0$ then $Y_{i\overline{C}}^M < 0$. Therefore if $P''(.) < 0$ then $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$.

Corollary 1 *If* $P''(.) > 0$ *then* $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$ *provided* <u>*either*</u> K *is large enough compared to* $\overline{C}$ <u>*or*</u> $P''(z)$ *is large enough (i.e.* $P(z)$ *is sufficiently convex)..*

Proof If $P''(.) > 0$ then $\frac{\overline{C}}{KP''(z)} > 0$. However, if K is large enough compared to $\overline{C}$ then $\frac{\overline{C}}{K}$ is sufficiently small. Since $z < 1$, $-(1-z) < 0$, and so we get that $Y_{i\overline{C}}^M = -(1-z) + \frac{\overline{C}}{KP''(z)} < 0$ for a sufficiently large K. For such a K we have $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$. Similarly if $P''(z)$ is large enough then $Y_{i\overline{C}}^M = -(1-z) + \frac{\overline{C}}{KP''(z)} < 0$. This in turn implies that $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$.■

Proposition 2 $\frac{di^{eqm}}{dK} > 0$ *if* $P''(.) < 0$ *and* $\frac{di^{eqm}}{dK} < 0$ *if* $P''(.) > 0$.

Proof Since $Y_{ii}^M < 0$ the above result follows straight from (10c) and (11c).■

Comment We now try to provide some intuition behind propositions 1, 2 and corollary 1. If r decreases z does not change as equation (7) does not contain r. This means that the effective amount of formal credit injected into the system, $\overline{C}(1-z)$ remains unaffected which in turn implies that the informal interest rate, i, in the new equilibrium will remain unchanged.

An increase in $\overline{C}$, on the contrary, changes z. But the direction of change must depend on the curvature of the $P(.)$ function. If $P''(.) < 0$ the bribing rate, z decreases and this implies that $\overline{C}(1-z)$ rises. This lowers the demand for informal credit of the dominant moneylender that forces him to lower the informal interest rate, i. If $P''(.) > 0$, z rises. However, either if K is sufficiently large relative to $\overline{C}$ or if $P(.)$ is sufficiently convex the increase in z is small (relative to the increase in $\overline{C}$) so that $\overline{C}(1-z)$ rises. In this situation also i falls as the existing moneylender's demand for informal credit falls.

If the government resorts to anticorruption measure in the form of an increase in K, $P'(z)$ has to fall (see equation 6). Consequently, z must change. It increases (decreases) if $P''(.) < (>) 0$

which in turn implies a reduction (rise) in $\overline{C}\,(1-z)$. As a consequence, the demand for informal credit of the dominant moneylender rises (falls) which allows him to raise (lower) the informal interest rate, i.

We now proceed to provide a few remarks on n^{eqm} (the number of money lenders who actually get the credit in equilibrium). From (5c) we get that $n^{eqm} = \frac{\overline{C}}{C^F}$.

$$\begin{aligned} \text{Therefore } \frac{dn^{eqm}}{dr} &= -\frac{\frac{dC^F}{dr}}{\left(C^F\right)^2} ----(12a) \\ \text{and } \frac{dn^{eqm}}{d\overline{C}} &= \frac{1}{\left(C^F\right)^2}\left[C^F - \overline{C}\frac{dC^F}{d\overline{C}}\right] ----(12b) \end{aligned}$$

Since $z_r = 0$ (from 8b) and $C^F = \frac{1}{1-z} f'^{-1}\left(1+i-\frac{1+r}{1-z}\right)$ (from 3) and $f''(.) > 0$ we get that $\frac{dC^F}{dr} < 0$.

$$\text{Therefore } \frac{dn^{eqm}}{dr} = -\frac{\frac{dC^F}{dr}}{\left(C^F\right)^2} > 0 \;\; ----(13).$$

Note that $\frac{dz^{eqm}}{d\overline{C}} = z_{\overline{C}}$. From (3) we have

$$\frac{dC^F}{d\overline{C}} = \frac{1}{(1-z)^2}\left[\begin{array}{c} (1-z)\,\frac{1}{f''\left(1+i-\frac{1+r}{1-z}\right)}\left(\frac{di^{eqm}}{d\overline{C}} - z_{\overline{C}}\frac{1+r}{(1-z^{eqm})^2}\right) \\ +f'^{-1}\left(1+i-\frac{1+r}{1-z}\right) z_{\overline{C}} \end{array}\right] ----(14).$$

Therefore from (12b) and (14) it is clear that the sign of $\frac{dn^{eqm}}{d\overline{C}}$ is ambiguous. We summarise this result in terms of the following proposition.

Proposition 3 *n^{eqm} always rises with r. However, the effect of an increase in $\overline{C}$ on n^{eqm} is ambiguous.*

Comment It may be noted that while the effect of increasing $\overline{C}$ on i^{eqm} is ambiguous, with reasonable restrictions on the parameters it is possible to have a scenario where n^{eqm} increases with $\overline{C}$. This will be shown in an example given below.

3 An example

Let us have the following.

$$\begin{aligned} f(x) &= \frac{1}{2}x^2,\ P(z) = z^{\alpha} \text{ where } \alpha > 0 \text{ and } \alpha \neq 1, \\ F(i) &= 100 - i \text{ and } g = 0. \end{aligned}$$

Note that $P'(z) = \alpha z^{\alpha-1} > 0$ for all $z > 0$. $P''(z) = \alpha(\alpha-1)z^{\alpha-2}$. Hence if $\alpha \in (0,1)$ then $P''(z) < 0$ and if $\alpha \in (1,\infty)$ then $P''(z) > 0$. This means all the assumptions of our model are satisfied in the example.

Using (3) we get

$$C^F(i,z,r) = \frac{(1+i)(1-z) - (1+r)}{(1-z)^2} \quad ----(16)$$

Routine computation shows that in our example

$$\begin{aligned} z^{eqm} &= \left(\frac{\overline{C}}{\alpha K}\right)^{\frac{1}{\alpha-1}} \quad ----(17a) \\ i^{eqm} &= \frac{1}{2}\left[100 - \overline{C}\left(1 - \left(\frac{\overline{C}}{\alpha K}\right)^{\frac{1}{\alpha-1}}\right)\right] \quad ----(17b) \\ \text{and } n^{eqm} &= \frac{\overline{C}\left(1 - \left(\frac{\overline{C}}{\alpha K}\right)^{\frac{1}{\alpha-1}}\right)^2}{\left[1 + \frac{1}{2}\left\{100 - \overline{C}\left(1 - \left(\frac{\overline{C}}{\alpha K}\right)^{\frac{1}{\alpha-1}}\right)\right\}\right]\left[1 - \left(\frac{\overline{C}}{\alpha K}\right)^{\frac{1}{\alpha-1}}\right] - (1+r)} \quad ----(17c). \end{aligned}$$

Note that

$$\frac{di^{eqm}}{d\overline{C}} = \frac{1}{2}\left[-1 + \left(\frac{\overline{C}}{\alpha K}\right)^{\frac{1}{\alpha-1}}\left(\frac{\alpha}{\alpha-1}\right)\right] \quad ----(18).$$

If $\alpha \in (0,1)$ then $P''(z) < 0$ and $\frac{di^{eqm}}{d\overline{C}} < 0$ (check proposition 1).

To illustrate the case of $\alpha > 1$ (i.e $P''(.) > 0$) we take $\alpha = 2$. For this particular value of α, we have

$$\frac{di^{eqm}}{d\overline{C}} = \frac{1}{2}\left[-1 + \frac{\overline{C}}{K}\right] < 0 \text{ iff } K > \overline{C}.$$

The above shows that there are reasonable parametric restrictions which satisfy conditions of corollary 1.

To check that it is possible for n^{eqm} to increase with $\overline{C}$ we try with two possible values of α.

If $\alpha = \frac{1}{2}$ (which implies $P''(z) < 0$) then from (17c)

$$n^{eqm} = \frac{\overline{C}\left(1 - \left(\frac{2\overline{C}}{K}\right)^{-2}\right)^2}{\left[1 + \frac{1}{2}\left\{100 - \overline{C}\left(1 - \left(\frac{2\overline{C}}{K}\right)^{-2}\right)\right\}\right]\left[1 - \left(\frac{2\overline{C}}{K}\right)^{-2}\right] - (1+r)} - - - - (19).$$

In this particular case

$$\frac{\partial n^{eqm}}{\partial \overline{C}} = 16\left(K^2 - 4\overline{C}^2\right)\frac{-800\overline{C}^4 + 12K^2\overline{C}^2 + 16r\overline{C}^4 + 51K^4 + 12K^2\overline{C}^2 r}{\left(-1600\overline{C}^3 + 408K^2\overline{C} + 16\overline{C}^4 - 8K^2\overline{C}^2 + K^4 + 32\overline{C}^3 r\right)^2} - - - - (19a).$$

Note that if $\frac{K}{\overline{C}} \geq 2$ then $K^2 - 4\overline{C}^2 \geq 0$ and $K^4 \geq 16\overline{C}^4 \Longrightarrow 51K^4 \geq 816\overline{C}^4 > 800\overline{C}^4$. Using this in the above equation $(19a)$ we get that n^{eqm} rises with $\overline{C}$ (when $\alpha = \frac{1}{2}$).

To check for the case where $P''(z) > 0$ we take $\alpha = 2$. For this case

$$n^{eqm} = \frac{\overline{C}\left(1 - \frac{\overline{C}}{2K}\right)^2}{\left[1 + \frac{1}{2}\left\{100 - \overline{C}\left(1 - \frac{\overline{C}}{2K}\right)\right\}\right]\left[1 - \frac{\overline{C}}{2K}\right] - (1+r)} - - - - (20)$$

Here we have

$$\begin{aligned}\frac{\partial n^{eqm}}{\partial \overline{C}} &= 16\left(2K - \overline{C}\right)K\frac{100K^2 - 150\overline{C}K - 2K^2 r + 51\overline{C}^2 + 3K\overline{C}r}{\left(-400K^2 + 204\overline{C}K + 4K^2\overline{C} - 4\overline{C}^2K + \overline{C}^3 + 8K^2 r\right)^2} \\ &= 16K^2\left(2K - \overline{C}\right)\frac{\left(2K - 3\overline{C}\right)(50 - r) + 51\overline{C}^2}{\left(-400K^2 + 204\overline{C}K + 4K^2\overline{C} - 4\overline{C}^2K + \overline{C}^3 + 8K^2 r\right)^2} - - - - (20a).\end{aligned}$$

Note that since r is the formal sector rate of interest it is reasonable to suppose that $r < 50$ (i.e. formal sector rate of interest is less than 5000%). From $(20a)$ we get that if $K > \frac{3}{2}\overline{C}$ then $\frac{\partial n^{eqm}}{\partial \overline{C}} > 0$.

Our example clearly illustrates the main results derived in our paper.

4 Conclusion

Forging of vertical linkage between formal and informal credit markets is projected as an alternative to the existing credit policy where the formal credit market aims at displacing the informal credit market horizontally. We have developed a model of vertical linkage between the two credit markets emphasizing the presence of corruption in the distribution of formal credit. Earlier works in this area e.g. Bose (1998), Floro and Ray (1997) and Hoff and Stiglitz (1997) have not dealt with this important aspect. In this model the existing moneylender, the bank official and the new moneylenders move sequentially and the existing moneylender acts as a Stackelberg leader and unilaterally decides on the informal interest rate as he knows the behaviour patterns of the other players. The analysis distinguishes between two different ways of designing a credit subsidy policy. It can be achieved either by (i) an increase in the volume of formal credit supplied to the new lenders while keeping the formal interest rate at a reasonable rate or by (ii) a decrease in the rate of interest charged on formal credit, without changing the total supply of formal credit. The earlier papers in the theoretical literature did not make any such distinction. We have found that if a credit subsidy policy is undertaken via the first route it is likely to increase the competitiveness in the informal credit market and lower the informal interest rate under reasonable conditions. On the contrary, a credit subsidy policy through a reduction in the formal interest rate not only fails to bring down the informal interest rate but also lower the number of new informal sector lenders receiving formal credit. Besides, anticorruption measure may be counterproductive and raise the informal interest rate. We, therefore, advocate the adoption of a credit subsidy policy through provision of more and more institutional credit over time keeping the formal interest rate at a reasonable level.

References

1. Bardhan, P.K. and A. Rudra (1978), "Interlinkage of Land, Labour, and Credit Relations: An Analysis of Village Survey Data in East India", Economic and Political Weekly 13, 367-84.

2. Bedbak, H. (1986), "Institutional Financing for Priority Sector: An Empirical Assessment of Delay and Analysis of Attitudes of Agencies Towards Loanees," Indian Cooperative Review 24, 65-76.

3. Bose, P. (1998): 'Formal-informal sector interaction in rural credit markets', *Journal of Development Economics* 56, 265-80.

4. Braverman,A., and J. L. Guasch (1986), "Rural Credit Markets and Institutions in Developing Countries: Lessons for Policy Analysis from Practice and Modern Theory," World Development, 14, No. 10, 1253-67.

5. Chaudhuri, S., and M. R. Gupta (1996), "Delayed Formal Credit, Bribing and the Informal Credit Market in Agriculture: A Theoretical Analysis," Journal of Development Economics 51, 433-449.

6. Floro, M. S., and D Ray (1997), "Vertical Links Between Formal and Informal Financial Institutions," Review of Development Economics 1, 34-56.

7. Gupta, M. R., and S. Chaudhuri (1997), "Formal Credit, Corruption and the Informal Credit Market in Agriculture: a Theoretical Analysis", Economica 64, 331-43.

8. Hoff, K., and J. Stiglitz (1997), "Moneylenders and Bankers: Price-Increasing Subsidies in a Monopolistically Competitive Market," Journal of Development Economics 52, 429-62.

9. Reserve Bank of India, 1981, "All India Rural Debt and Investment Survey 1981".

10. Rudra, A. (1982), "Indian Agricultural Economics: Myths and Realities". Allied Publishers, New Delhi.

11. Sarap, K., (1991), "Interlinked Agrarian Markets in Rural India". Sage Publications, New Delhi.

12. Umali, D. (1990), "The Structure and Price Performance of the Philippine Rice Marketing System". Ph.D. dissertation, Stanford University.