# Vertical Linkage between Formal and Informal Credit Markets, Corruption and Credit Subsidy policy: A Note

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# Vertical Linkage between Formal and Informal Credit Markets: Corruption and Credit Subsidy policy

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**Abstract**

We develop a model of vertical linkage between the formal and informal credit markets which highlights 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. However, an anticorruption measure (increase in penalty) unambiguously lowers the interest rate in the informal credit market. Finally, we examine the effects of alternative policies on the incomes of different economic agents in our model.

Keywords: Formal/informal credit markets, informal interest rate; corruption; credit subsidy policy

JEL Classification: O16, O17

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# 1 Introduction

Forging a vertical linkage between formal and informal credit markets is considered to be one of many different ways to pursue a liberalized policy in the financial markets in emerging economies. Under this policy, formal credit is supplied to the informal sector lenders with a view to enhance competition between them so that the ultimate borrowers receive credit at a reasonable interest rate. The informal sector lenders act as financial intermediaries between the formal credit agency and the final borrowers of credit. This policy has been experimented with some success in the Philippines (see Umali, 1990).

There are a few papers in the theoretical literature that analyses the economic effects of building such a vertical linkage. Some papers discuss as to why the policy may not ultimately be able to succeed. For example, Hoff and Stiglitz (1996) have argued that this policy may be counterproductive and actually raise the informal sector interest rate since 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 borrowers more difficult and this leads to an increase in the cost of loan administration for every lender. Bose (1998) has shown that the policy of vertical linkage may in fact produce adverse effects on the borrowing terms faced by the small and marginal borrowers. He considered 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, it would enable the better-informed informal sector lender to attract better borrowers with lower probability of default and consequently leave the reaming borrowers with high probability of default for the other lender. As a result, 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. Furthermore, Floro and Ray (1997) have shown that a credit flow to the lenders in the informal credit market may strengthen the ability and incentive of the informal lenders to collude among themselves, which would result in worse terms faced by the borrowers in the informal credit market. Finally, Chaudhuri and Dastidar (CD hereafter) (2011) have shown that presence of corruption in the distribution of formal credit might be another factor behind the failure of the policy of vertical linkage.

The present work is an extension of CD (2011). We develop a model of vertical linkage between the formal and informal credit markets that highlights 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. This result is different from that of the CD (2011) work. The present paper then goes on to show that any change in the formal sector interest rate has no effect on the informal interest. However, an anticorruption measure (increase in penalty) unambiguously lowers the interest rate in the informal credit market. Finally, the effects of alternative policies on the incomes of different economic agents have also been examined. These effects have not been examined in CD (2011).

## 2 The Model

We closely follow CD(2011). 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, $\overline{C}$, to people who would re-lend the money to the farmers of the village. Let $N$ denote the *very large* number of homogeneous new moneylenders applying for the 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 model.

**Fringe moneylenders** We start with the fringe moneylenders who move in the third stage. Each fringe moneylender decides the amount of formal credit that he would apply for. If a fringe money lender is formally approved of $C^F$ amount of credit, the amount that he actually gets in hand is $C^F(1-z)$ since $zC^F$ is to be paid as bribe to the bank official. He can now use this amount i.e. $(1-z)C^F$ 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 $C^F$ amount of credit, he has to pay back $(1+r)C^F$ to the bank.

The income of each fringe moneylender is therefore

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

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

**The bank official** The bank official moves in the second stage and chooses the bribing rate, $z$, and the number of new moneylenders, $n$, who actually get the credit. 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) $P'(z)>0 \ \ \forall z>0$ and (iii) $P''(z)>0 \ \forall z>0$. $K$ 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 and chooses the informal interest, $i$. 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 function of credit 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.

# 3 Solving for the three stage game

### 3.0.1 Third stage

The fringe moneylender moves and chooses $C^F \geq 0$ to maximise

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

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

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

Note that the second order condition $\left(Y^F_{CC} < 0\right)$ 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))

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

### 3.0.2 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.

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

**Remark 1** *It may be noted that the second order condition will be valid only if* $P''(.) > 0$ *(which we have assumed to be the case).*

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 $z$, $\lambda_2$ 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

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

### 3.0.3 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.

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

Also note that

$$\frac{di^{eqm}}{dr} = -\frac{Y^M_{ir}}{Y^M_{ii}} ----(11a)$$
$$\frac{di^{eqm}}{d\overline{C}} = -\frac{Y^M_{i\overline{C}}}{Y^M_{ii}} ----(11b)$$
$$\text{and } \frac{di^{eqm}}{dK} = -\frac{Y^M_{iK}}{Y^M_{ii}} ---- (11c).$$

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)* $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$ *provided* *either* $K$ *is large enough compared to* $\overline{C}$ *or* $P''(z)$ *is large enough (i.e.* $P(z)$ *is sufficiently convex). (iii)* $\frac{di^{eqm}}{dK} < 0$.

**Proof** (i) Note $Y^M_{ii} < 0$ (9b) and $Y^M_{ir} = 0$ (10a). Hence from (11a) we get that $\frac{\partial i^{eqm}}{\partial r} = 0$. (ii) Since $P''(.) > 0$ 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 $Y^M_{i\overline{C}} = -(1-z) + \frac{\overline{C}}{KP''(z)} < 0$ 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 $Y^M_{i\overline{C}} = -(1-z) + \frac{\overline{C}}{KP''(z)} < 0$. This in turn implies that $\frac{\partial i^{eqm}}{\partial \overline{C}} < 0$. (iii) Since $Y^M_{ii} < 0$ the above result follows straight from (10c) and (11c).■

**Comment** We now try to provide some intuition behind proposition 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. As $P''(.) > 0$ in a stable equilibrium, $z$ 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 decrease in a stable equilibrium. It decreases as $P''(.) > 0$, which in turn, implies a rise in $\overline{C}(1-z)$. As a consequence, the demand for informal credit of the dominant moneylender falls which compels him to lower the informal interest rate, $i$.

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

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

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 $\frac{dC^F}{dr} < 0$.

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

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 2** *$n^{eqm}$ 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 later.

We now provide some comparative static results. It may be noted that $r$, $\overline{C}$ and $K$ are the parameters of our model. The results are as follows. From the discussions above and using (8a-8d) we obtain:

$$\frac{dY^F}{dr} = -C^F - C^F\left[(1+i) - f'(.)\right]\frac{dz}{dr} = -C^F < 0. \left(\text{note that } \frac{dz}{dr} = 0\right)$$
$$\frac{dY^F}{d\overline{C}} = -C^F(1+r)\frac{dz}{d\overline{C}} < 0. \left(\text{note that } \frac{dz}{d\overline{C}} > 0 \text{ as } P''(.) > 0\right)$$
$$\frac{dY^F}{dK} = -C^F(1+r)\frac{dz}{dK} > 0. \left(\text{ as } \frac{dz}{dK} < 0\right)$$

**Proposition 3** *(i) $Y^F$ always increases with a fall in $r$. (ii) $Y^F$ increases following an increase in $K$. (ii) $Y^F$ falls following an increase in $\overline{C}$ .*

A decrease in the formal interest rate, $r$, lowers the opportunity cost of credit of every fringe moneylender which in turn raises his net income. Besides, an increase in the gross volume of formal credit, $\overline{C}$, raises the bribing rate, $z$, charged by the bank official per unit of formal credit disbursed to the new moneylenders as $P''(.) > 0$ in the stable SPE. This affects their profitability adversely and lowers their income. Finally, an anticorruption measure on the bank official lowers $z$ and hence improves earnings of the fringe moneylenders.

Differentiating the expression for $Y^M$ and using equations (8a-8d) we get the following:

$$\begin{aligned}\frac{dY^M}{dr} &= (i-g)\,\overline{C}\frac{dz}{dr} = 0 \\ \frac{dY^M}{d\overline{C}} &= -(i-g)\left(\frac{d(1-z)\,\overline{C}}{d\overline{C}}\right) < 0. \quad \left(\begin{array}{c}\text{Note that } \frac{d(1-z)\overline{C}}{d\overline{C}} > 0 \text{ if } K \text{ is sufficiently large} \\ \text{relative to } \overline{C} \text{ or if } P(.) \text{ is sufficiently convex.}\end{array}\right) \\ \frac{dY^M}{dK} &= (i-g)\,\overline{C}\frac{dz}{dK} < 0.\end{aligned}$$

**Proposition 4** *(i) A change in $r$ cannot affect $Y^M$. (ii) An increase in $\overline{C}$ lowers $Y^M$ in a stable equilibrium. (iii) A rise in $K$ lowers $Y^M$.*

A credit subsidy policy in terms of a reduction in the formal interest rate cannot affect the income of the dominant moneylender as it does not change the bribing rate. On the other hand, although an increase in $\overline{C}$ raises the bribing rate, it may also lead to an increase in the net volume of formal credit, $\overline{C}(1-z)$, injected into the system, provided $K$ is sufficiently large relative to $\overline{C}$ and/or $P(.)$ is sufficiently convex. If this happens, the aggregate demand for informal credit of the moneylender falls and this affects his profitably adversely. Furthermore, an increase in $K$ lowers the official's bribing rate which in turn raises the net volume of formal credit injected into the system. The dominant moneylender in such a situation has no alternative but to charge a lower informal interest rate that also affects his profitability unfavourably.

From the bank officer's maximisation exercise the following may also be noted.

$$\frac{dY^O}{dr} = 0, \frac{dY^O}{d\overline{C}} = z > 0 \text{ and } \frac{dY^O}{dK} = -P(.) < 0$$

Consequently, we have the following result.

**Proposition 5** *(i)* $dY^O/dr = 0$ *(ii)* $dY^O/d\overline{C} > 0$ *and (iii)* $dY^O/dK < 0$.

A credit subsidy policy, if undertaken through a reduction in the formal interest rate, cannot affect the income of the official as bribing rate he charges remains unaffected. Besides, the official has to lower the bribing rate following an anticorruption measure which in turn affects his income negatively. Finally, an increase in $\overline{C}$ enables the official to earn a higher bribe income when he behaves optimally and chooses the bribing rate.

### 3.1 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

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

Routine computation shows that in our example

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

Note that

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

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 $\alpha$, 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 $\alpha$.

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

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

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

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

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

Development economists have often expressed concerns regarding the efficacy of the policy of forging a vertical linkage between the formal and informal credit markets in achieving its primary objective to enhance competition and improve the borrowing terms faced by the small and marginal farmers. It has been shown in the literature that such a policy may indeed be counterproductive under asymmetric information among informal sector lenders. In this context, we analyse some of the issues that have not been adequately examined in the earlier works. We show that *even without any asymmetric information problems*, *this policy may not succeed in the presence of corruption in the distribution of formal credit*. We also show that any change in the formal sector interest rate has no effect on the informal interest rate while an anticorruption measure (increase in penalty) unambiguously lowers the interest rate in the informal credit market. Finally, we also examine the effects of alternative policies on the incomes of different economic agents.

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