An Economic Framework for Understanding Micro-Credit in Developing Countries

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Abstract

To reduce vulnerability and food insecurity this paper investigates the economics of micro-credit. We provide a model that shows how a micro-credit market based on trust can co-exist with a commercial collateral-based market. This model is developed in detail and certain propositions are supported using dominant strategies in a trust-honour game based on the prisoner's dilemma. From a policy point of view the theoretical model indicates that trust-based lending, coupled with certain incentives, can go far in supporting growth opportunities in developing countries. It is argued that development policy should be flexible enough to permit trust-based micro-lending to the poor, regardless of how counter-intuitive this must appear to the conventional wisdom.

1. Micro Lending and Economic Development

The vulnerabilities of peoples in developing countries to economic subterfuge are both persistent and degrading. The direct consequence is that hundreds of millions of households, mostly in rural areas, suffer from chronic economic hardship, and languish in a perpetual state of poverty and food insecurity. The root causes of economic suffrage are many but it is well understood that the most vulnerable of populations, those in a persistent poverty trap, are those who lack physical and financial resources. By physical resources it is meant the economic resources, land, buildings, inputs etc from which livelihoods are derived, and by financial capital it is meant the capital with which to acquire the physical resources. The stock of physical resources and the financial wherewithal to acquire those resources are inextricably linked. To many the root cause of the poverty trap is not the constraint on physical resources but the financial constraints or credit constraints that prohibit the acquisition of those resources to poverty-escaping scale.

Until the past 20 or so years credit has been rationed to the poor because it is believed that the poor are not creditworthy, have limited or no collateral, and do not generate sufficient income with which to repay a loan. This applies not only to the acquisition of fixed resources such as land and buildings which could contribute to economies of size, but the purchase of variable inputs (seed, feed, fertilizer) which could enhance economies of scale. Given the ill-effects of credit constraints it is no wonder that these constraints, above all hold the greatest shadow price, and the more vulnerable the household the greater this shadow price will be.

More recently the traditional view of credit worthiness has been challenged. Nowhere has this been more apparent than the activities of Bangladesh's Grameen Bank that in 1978 started providing micro credit to poor households in rural areas. The escalation of micro-credit and micro-finance institutions (MFI) throughout the developing world has resulted in a burst of growth in some rural communities providing benefits in terms of rural entrepreneurship, growth, income enhancement, poverty reduction and increased food security and livelihoods(see reviews by Hartarska and Holtmann, 2006; Meyer and Nagarajan 2006 and Zeller 2006). While it is understood that micro-credit provides a counter-model for a non-collateral economy that is juxtaposed to the collateral based credit-rationing model of say Stiglitz and Weiss(1981), little formality has been given to Micro-Credit. The purpose of this paper is to provide such a

framework. In this paper we use as a starting point the principles of Grameen-type lending since this type of no-collateral lending, together with incentive mechanisms such as self help groups that embolden trust, has proved to be in many instances adopted and successful.

2. Economics and Trust

Yunus (1999) argues that the poor are creditworthy because they are trustworthy. Yet the role of trust in an economic system is not well understood and the idea that trust can substitute for the conventional metrics of profitability, liquidity, leverage and repayment capacity found in conventional credit scoring or risk rating models (e.g. Turvey 1991; Turvey and Brown 1990) is foreign to the conventional lender. For this reason the conventional economic models, including the lending models of Stiglitz and Weiss have excluded vulnerable populations. But why should trust-based micro-lending work? Is trust induced by economic circumstance, or are incentives to make one trustworthy required to induce trust, suggesting that one is innately trustworthy? Or is trust simply innate? Consider the rational description provided by James (2002) that is deciding on whether agent A should trust another agent B, the economic approach is for A to investigate the incentives that B has either to honour or dishonour the trust offered by A. If B has an incentive to be trustworthy then A will trust B. Rabin (1993) considers a “fairness equilibrium” in which people like to help those who are helping them but are willing to hurt those that do not, even if the cost of the latter exceeds all possible benefits. James (2002) argues that such thinking assumes that all agents are rational utility maximizers, and that people are honest only to the extent that the appearance of honesty or honesty itself pays more than dishonesty. In other words, one is trustworthy if he does not have the incentive to exploit others.

This is of course a depressing view of human behaviour, but it is endemic. The use of credit scoring models for example assumes dishonesty first; only experience brings about trust. And the economic justification for this presumption is that inherent in any economy some numbers of unidentifiable individuals, the vast minority, are for whatever reason dishonest. There is also evidence that trust-based economies outperform other economies in terms of economic growth (Fukuyama 1995;Beugelsdijk et al 2004) and trust plays an integral part in the reduction of transactions costs (Chiles and McMackin 1996). In terms of credit the number of loan defaults or arrearages will far exceed the number of dishonest players for it is true that an honest person, by circumstance rather than sloth, may at one time or another be unable to meet

the obligation. The problem is that what is ultimately observed is the default ex post rather than the probability of default ex ante.

But in repeated experiments such as the Grameen Bank lending based on trust appears to work. To a large extent this may be based on the use of self help groups which act as a collective to enforce trust. The recurring question, from an economic point of view, is how and why this works. It appears perhaps that there are two separate but not mutually exclusive games at play. First, if the borrower is a group then there is a game of mutual enforcement within the group to ensure equal effort. Thus the group becomes trustworthy. Second there is the game between the borrower (individual or group) and the lender (an NGO or MFI).

The game within the group is a simple one based lightly on the prisoner's dilemma. Here a group member can take action to reduce effort (the free rider effect) but must consciously absorb the fact that the remaining members can individually or as a group take an opposing action against him. Kindle and Lazear (1992) introduce a 'Peer Pressure" function that integrates with utility to affect behaviour. Here the function $P\left(e_i; e_j, e_k, ..., e_n, a_i, a_j, a_k, ..., a_n\right)$ captures the pressure that is felt by participant i, which depends on his own effort, e_i, and the efforts of others, $e_k, ..., e_n$, as well as the joint actions that he and group members can take $a_i, a_j, a_k, ..., a_n$. There are *n* separate games played out, each with imperfect information about the actions of the remaining members of the group or the collective action of the group itself. If agent *i* is dishonest the collective response of the group could do more harm than good. The same applies to all agents. Consequently none will reveal themselves and the group will act as one. In other words, it may be the case that all group members are dishonest and would enjoy a free ride, but in the absence of information about other members' intentions, all individuals behave with honesty and the group becomes trustworthy (James 2002).

Now consider the game between a lender and a borrower. Unless the group members conspire, the lender will look upon the group more favorably than an individual. Consider the following lender-borrower version of the trust-honor game.

		Borrower	
		Honour	Exploit
Lender	Trust	$iD, C(D)-(1+i)D,$	$-D(1+i), C(D)$
	Distrust	$0, C(0)-C(D)<0$	$0,0$

Figure 1: Prisoner's Dilemma Payoff Matrix to Trust -Honesty Game

If the lender trusts the borrower and the borrower is honourable then a loan is made raising consumption of the borrower by $C(D)-(1+i)D$ and returning revenue to the lender of iD. If the borrower is dishonest and is wanting to exploit the trust and not repay the loan, then the lender loses principal plus interest, $D(1+i)$, while the borrower benefits to the gross value of $C(D)$. If the lender distrusts the borrower then no loan is offered resulting in no gain or loss to the lender but an opportunity cost to the borrower of $C(0)-C(D)<0$. The final pair is 0,0 for the distrust-exploit pair.

The borrower has a dominating strategy trust-exploit. If $\frac{C(D)}{D}-1=i$ then gains in trust-honour are equal and the lender then has no dominant strategy. In this situation, the lender having knowledge of the borrower's exploitive possibility will make no loan and a Nash equilibrium occurs at distrust-exploit. If $\frac{C(D)}{D}-1<i$, then the lender has a dominating strategy in honour-trust. But this also means that if the borrower exploits the trust the lender has more to lose. Again the Nash equilibrium is distrust-exploit. Ultimately, what this suggests is that in the presence of exploitive nature by a borrower no loans would be made.

But in micro credit loans are made, which suggests that to many pairs, trust-honour is a Nash equilibrium. How can this be? The trust-honour game provides no incentive for good behaviour. For example, if the lender knew that the borrower would not default then clearly trust-honour is an equilibrium. But borrowers represent an adversely selected group so there is no way that an exploiter can be identified a priori. Consequently the lender will provide the incentive that if the borrower honours the obligation then there will be a second opportunity to borrow, but if there is default then all opportunity for future borrowing cedes. In this case the trust-honour cell will accumulate over two periods as $\left(2iD, C(2D)-(1+i)2D\right)$ whereas the remaining cells will remain as is. The borrower's exploit choice will dominate the honour choice

under the lender's trust only if $i > \frac{C(2D) - C(D)}{2D} - 1$. In other words if the lender is non-exploitative in interest rates then the likelihood of default diminishes and trust-honour is a Nash equilibrium. Obviously if the borrower incorporates the loss of all future borrowings then for some T it will be true that $i < \frac{C(TD) - C(D)}{TD} - 1$ and again trust-honour becomes a Nash equilibrium. Interestingly if we consider two individuals such that $C_i(D) > C_j(D)$ then the incentives for i to exploit the trust of the lender will be lower than j. It is on this basis that we proceed with the model of the micro-credit market.

3. A Micro-Credit Equilibrium

To keep the model simple we stick to the two major assumptions implied by the Grameen Model. These are a) that the poor place a higher value on money than the rich and b) that the poor have a higher probability of loan repayment than the rich. We define the loan value function as a measure of utility $V(\omega)$ where the dependent variable is measured as a % and the independent variable is measured as income, ω. The value function can be viewed as a schedule representing a willingness to pay for credit and it is assumed, quite reasonably, that $V'(\omega) < 0$; that is the value placed on the next dollar available, and hence the willingness to pay for that next dollar, is decreasing in income. In other words, the poor are willing to pay a higher interest rate than the rich. The supply of funds is measured by the loan default function $L(\omega)$ as an increasing function of income (e.g. $L'(\omega) > 0$) with the dependent variable representing a percentage cost (expectation) of loss and the independent variable is again income. This function is unusual and is based on the premise, as expressed by Yunus, that the poor are more trustworthy than the rich. However, since most applications of micro-credit involve the poor with little or no collateral, much of the lending decisions of micro-credit revolve around trust. Hence, $L(\omega)$ can be viewed as a schedule for the trust in repayment and assumes that in the absence of collateral that the rich are more likely to default than the poor.

The general form of welfare is given by

(1) $W = \max \int_0^{\omega^*} \left[V(\omega) - L(\omega) \right] d\omega$

Where ω^* represents the barrier between $\left[V(\omega) - L(\omega) \right] \geq 0$ and $\left[V(\omega) - L(\omega) \right] < 0$. We further define

(2) $V(\omega) = A\omega^{-\beta_1}$

And

(3) $L(\omega) = B\omega^{\beta_2}$

Where β_1 is the marginal value of the next dollar of income and β_2 is the marginal propensity to default. Equation (2) can be viewed as a *vulnerability* schedule in that it places a much higher value on the marginal dollar for the poor, while a low value is given to the rich. Equation (3) in contrast might be viewed as a *corruptibility* schedule which associates greater moral hazard of loan default and bad debts with the rich rather than the poor.

The slopes of V() and L() measure the rate of change in V or L as income increases. Thus

$$\frac{\partial V(\omega)}{\partial \omega} = -\beta_1 A\omega^{-\beta_1 - 1} < 0$$

$$\frac{\partial^2 V(\omega)}{\partial \omega^2} = \beta_1 (\beta_1 + 1) A\omega^{-\beta_1 - 2} > 0$$

And

$$\frac{\partial L(\omega)}{\partial \omega} = B\beta_2 \omega^{\beta_2 - 1} > 0$$

$$\frac{\partial^2 L(\omega)}{\partial \omega^2} = B(\beta_2 - 1)\beta_2 \omega^{\beta_2 - 2} \begin{cases} > 0 & \beta_2 > 1 \\ = 0 & \beta_2 = 1 \\ < 0 & \beta_2 < 1 \end{cases}$$

In other words we characterize vulnerability as a decreasing function of income that decreases at an increasing rate. This suggests that the poorer one becomes in terms of income the greater the value of money.

The L () function is always increasing. In other words the model assumes a corruptible population in which higher income leads to a lower value of money and hence with less 'respect' for money a higher chance of default. This is of course a broad generalization and should not suggest that the wealthy will default as a matter of course but rather that the propensity to default will be higher for the wealthy. The slope of the default curve is determined by the elasticity. If $\beta_2 > 1$ then the function increases at an increasing rate. In the figures we present this is the assumption made. However if $\beta_2 = 1$ the default function is constant indicating that the propensity to default is linearly related to income. Finally if $\beta_2 < 1$ the propensity to default is, on margin, higher for lower income people than higher income people. Higher income people will still default more than lower income people but the increase in the propensity to default gets incrementally smaller as income rises.

The coefficients β_1 and β_2 represent the respective elasticities, or the percentage change in V() or L() with respect to a percentage change in income. In other words if β_1 is 0.5 then a 1% increase in income will reduce the utility value of money by 0.5% and if β_2 is 0.5 then a 1% increase in income will increase the propensity to default by 0.5%.

The welfare maximizing level of income is given by the intersection of the value and loan default curves $V(\omega) = L(\omega)$ Or

(4) $A\omega^{-\beta_1} = B\omega^{\beta_2}$.

From (4) the level of income that maximizes welfare is given by

(5) $\omega^* = \left[\frac{A}{B}\right]^{\frac{1}{\beta_1+\beta_2}}$

According to the rule, any loans below ω^* will be made using micro credit while loans above ω^* will be denied and the borrower will be required to seek credit elsewhere.

Comparative statics yield

$$(6) \qquad \frac{\partial \omega^*}{\partial \beta_1} = \frac{\partial \omega^*}{\partial \beta_2} = -\frac{\omega^* \ln\left(\frac{A}{B}\right)}{\left(\beta_1 + \beta_2\right)^2} < 0 .$$

In other words if the marginal value of money increases the wealth threshold decreases. Likewise if the marginal propensity to default increases the wealth threshold decreases. The results in (6) hold because the derivatives are anchored by A and B. However, if A changes then

$$(7) \qquad \frac{\partial \omega^*}{\partial A} = \frac{\omega^*}{\left(\beta_1 + \beta_2\right) A} > 0$$

And if B changes

$$(8) \qquad \frac{\partial \omega^*}{\partial B} = -\frac{\omega^*}{\left(\beta_1 + \beta_2\right) B} < 0 .$$

The welfare maximizing interest rate to be charged on loans is found by substituting (5) into (2).

$$(9) \qquad V^* = V\left(\omega^*\right) = A\left[\frac{A}{B}\right]^{\frac{-\beta_1}{\beta_1+\beta_2}}$$

We refer to this rate, at least theoretically, as the Grameen rate because it applies to all loan applicants below ω^*.

However, there are a number of variants of this model. The interest rate charged in (9) is not determined by market rates but by the value to the holder so it may well be that $V^* > r$ where r is the commercial loan rate. Suppose further that a government observing the spread between the micro-credit rate and the commercial rate decides to impose by fiat a maximum rate on micro loans so that $V^* > r^* \geq r$. At r* ,

$$(10) \qquad \omega(r^*) = \left[\frac{r^*}{A}\right]^{-\frac{1}{\beta_1}} > \omega^*$$

So that the threshold for loans widens, more loans are accepted, and loan risks increase. That is

$$(11) \qquad L\left(\omega(r^*)\right) = B\left[\frac{r^*}{A}\right]^{-\frac{\beta_2}{\beta_1}} > L\left(\omega^*\right)$$

The basic structure is illustrated in Figure 2 with the borrower's valuation curve V(), downward sloping and the lender's loss curve L() increasing. The equilibrium is at ω^* and V*. To the

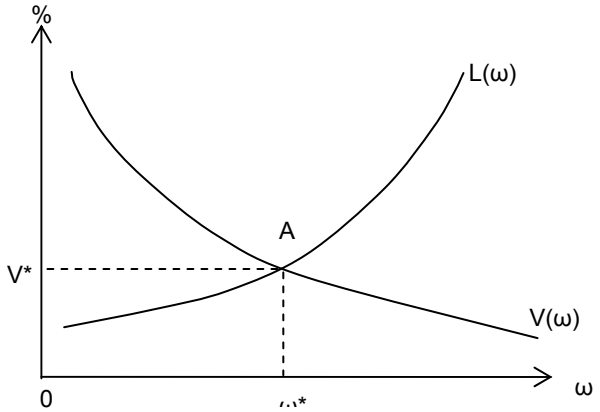

Figure 2 General model of micro credit market

right of ω^*, L()>V() indicating that losses exceed the willingness to pay. Hence loans to the right of ω^* are denied micro-credit loans and forced into the commercial market. Loans to the left of ω^* are considered for micro-credit at the rate V*. In this model V* applies to all micro-credit loans regardless of how poor the borrowers are. The social benefits to the poor are defined by

the area above V* and below the V() schedule, while benefits to the NGO or MFI that provides these loans is measured by the area below V* and above L().

There are three artifacts of the model that require theoretical foundation. First, the value function $V(\omega)$ is decreasing in ω, Second, $L(\omega)$ is increasing in ω and third an equilibrium at ω^* exists below which micro credit is made and above which micro credit is denied.

For the first proposition we apply expected utility defined over the variables C, D, ω; $U\left(C\left(\omega(D)\right)\right)$ and applying the quotient rule get

$$(12) \quad \frac{\partial U(\ )}{\partial C(\ )}\frac{\partial C(\ )}{\partial \omega(\ )}\frac{\partial \omega(\ )}{\partial D(\ )} > 0 \rightarrow \frac{\partial V(\ )}{\partial \omega(\ )}\frac{\partial \omega(\ )}{\partial D(\ )} < 0 \ .$$

The first part of (12) holds by monotonicity of the utility function whereas the second part emerges from the convexity of utility. Here, $\frac{\partial V(\ )}{\partial \omega(\ )} < 0$ represents the change in the marginal utility $\frac{\partial U(\ )}{\partial C(\ )}\frac{\partial C(\ )}{\partial \omega(\ )} > 0$, and $\frac{\partial \omega(\ )}{\partial D(\ )} > 0$ by assumption of the leveraging effect of credit.

The second proposition is more difficult. First assume two individuals with different income endowments such that $\omega_i < \omega_j$. We further assume a point of satiation in consumption exists such that the marginal benefit of additional consumption units leveraged by an additional unit of debt is zero, i.e. $\frac{\partial C_k(D^*)}{\partial D} = 0 \rightarrow C_{\max}$. A consumption relation $\frac{\partial C_i(D)}{\partial D} > \frac{\partial C_j(D)}{\partial D}$ states that the marginal increase in consumption of a poor individual will be higher than the marginal increase in consumption of the wealthier individual. By concavity of the consumption function it must be true that $C_j > C_i$ and $C_{\max} - C_j < C_{\max} - C_i$. We introduce the concept of a reneging temptation and define the following function $\Gamma\left(C_{\max} - C_k\right)$ and its shape

by $\frac{\partial \Gamma(\ )}{\partial (C_{\max} - C_k)} < 0$. In other words, the smaller the value of $C_{\max} - C_k$, the greater will be the temptation to default. Thus, when considering the dominating trust-exploit strategy in Table 1 (e.g. $(-D(1+i), C(D))$) then we can state that because $C_j > C_i$, then the rich agent j will have a greater propensity to exploit than the poorer agent i.

We can take this a step further by assuming that T, the number of periods for which future micro-loans will be desired decreases as ω increases. In other words $T = T(\omega)$, $\frac{\partial T}{\partial \omega} \leq 0$ and $\frac{\partial^2 T}{\partial \omega^2} \begin{cases} < 0 \\ = 0 \\ > 0 \end{cases}$ are reasonable properties of the game that suggest not only the existence of a reneging temptation but also its various forms. In terms of Figure 1, as ω increases, the welfare benefits from micro-credit decrease quite rapidly (i.e. $\lim_{\omega \to \omega^*} V(\omega) - L(\omega) \to 0$) and $T(\omega) \to 0$.

Interestingly, if there is no information passed between the micro-credit market and the commercial market (beyond ω^*) then most surely the reneging temptation will be high. However if credit reports are passed from the micro-credit market to the commercial market then most likely the reneging temptation will be diminished.

Finally, the value function $V(\omega)$ is decreasing in ω, $L(\omega)$ is increasing in ω then an equilibrium at ω^* exists below which micro credit is made and above which micro credit is denied.

4. Preliminary Findings Assessment of Rural Credit Cooperatives in China

In this section we examine rural credit in China as it relates to efforts by the Rural Credit Cooperatives to provide micro-credit to rural farms and households.

Rural Credit Cooperatives (RCCs) in China are regulated formal financial institutes which provide micro credit to farmers. Basically RCCs classify farmers in their precincts by different credit levels firstly and then according to the credit level decide upon the sum of loans given to farmers in range ￥1000 to ￥20000. Considering sustainability and profitability, RCCs usually prefer to choose those farmers who are in the middle class in terms of income as principal clients. Farmers with lower income have great difficulty in obtaining loans from RCC. Moreover, loans only can be used in producing rather than consuming. More generally, the Chinese central government sets a regulated policy for micro credit lending and the interest rate on RCC loans is considerably lower than the rate offered by MFIs or NGOs and can not be exceeded. A ceiling limitation on the lending rate legislated is set but RCC rates can fluctuate within a scale under the ceiling limitation.

This is illustrated in Figure 3 which maps onto figure 1 the RCC Rate Schedule. Note that the RCC discriminates between borrowers, with higher rates charged to the poor, Note also that the RCC rate is everywhere below the MFI rate defined by point A. Several things are suggested by this market. First because the RCC offers a lower rate it is attractive to borrowers between ω^* and ω_1. If the RCC views income as a metric it will prefer these loans and incur losses. In fact, under the model assumptions the RCC will profit only for loans below ω_2. The policy implications are important. First, by offering low interest micro credit loans the RCC is crowding out micro-credit from NGOs or MFIs who, by recognizing risk will charge a higher rate.

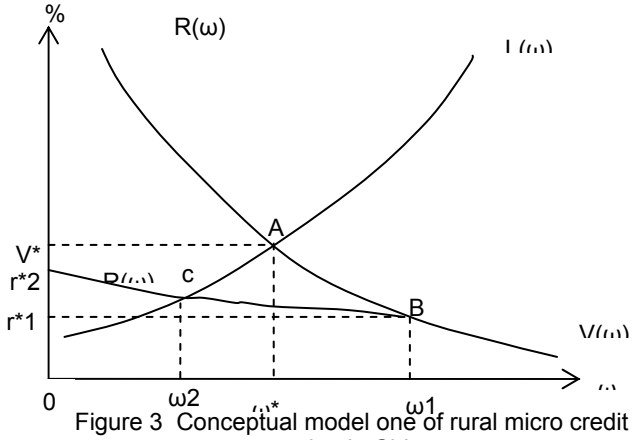

Figure 3 Conceptual model one of rural micro credit market in China

A variant of figure 3 is provided in figure 4. Here, the upper end of the flexible rates allowed exceeds the equilibrium rate of the MFI/NGO. Here we find incomplete crowding out. The RCC crowds out the MFI to the right of ω_3. To the left of ω_3 borrowers would prefer the lower MFI rate suggesting that even in the presence of a central credit policy in China, there is some room for MFIs and NGOs to make micro credit loans.

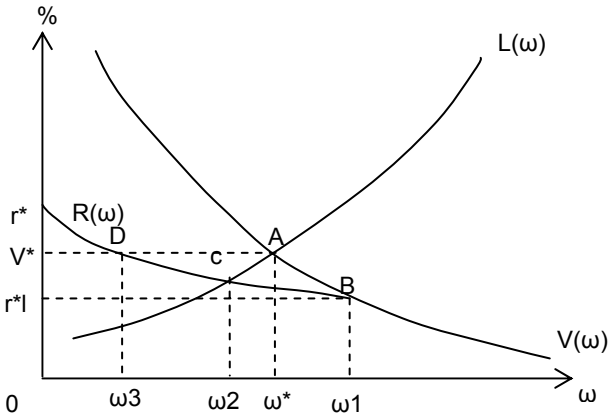

Figure 4 Conceptual model two of rural micro credit market in China

Unfortunately, this is not what is observed in China. An examination of the history of micro-credit suggests a market more closely resembled by Figure 5.

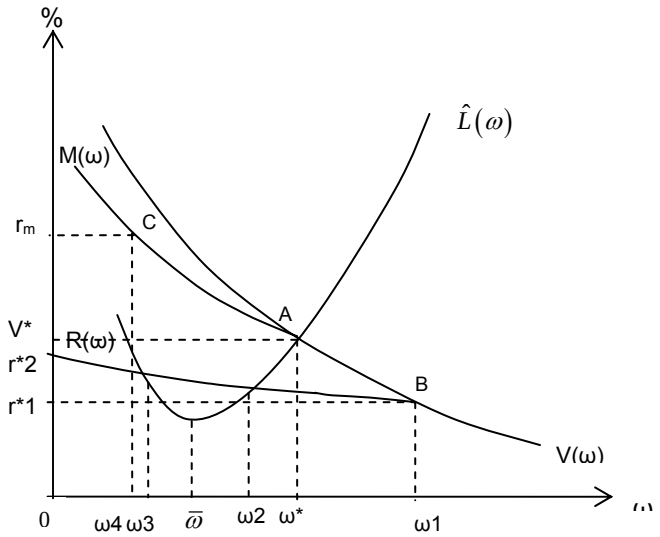

Figure 5 Expanded model of rural micro credit market in China

In Figure 5 the L() curve bends back at lower income levels. This need not be associated with trust, but simply a consequence of farmers not having the economic wherewithal to repay

loans according to a conventional schedule. As a result neither MFIs nor NGOs will lend below ω_4 and the RCC will not provide micro-credit below ω_3. The market for MFI loans is limited only to the range of income between ω_3 and ω_4. Borrowers below ω_4 are in fact credit rationed.

In the absence of credit below ω_4 there exists a market for informal lending through money lenders who are more willing to exploit through usurious rates the willingness of the poor to pay high rates. The money lender schedule is described in Figure 3 by the curve $M(\omega)$ and rates to the poor will exceed r_m. Money lenders are crowded out of the market by either the RCC or the MFI/NGO at incomes to the right of ω_4.

5. Conclusions and Further Work

Our approach is pedagogical but the model provides an economic structure to micro-credit that is fundamentally different from the collateral-based models of lending. The model can be used to describe a number of different micro-credit scenarios. For example (2) and (3) illustrate how the Grameen Bank operates its micro loans in Bangladesh. In other jurisdictions such as in China, the Central Policy is to offer low interest rate micro-credit to farmers. These rates are below the MFI rate. The consequence is that the Rural Credit Cooperatives that administer the loans accept some loans that would otherwise be untrustworthy and hence the default rate amongst many credit cooperatives in China is high (lower trust loans). In addition the Central rate is below the MFI rate so the number of NGO's or MFI's in China is lower than in other countries. China's cooperative banking system has not fully endorsed either the self-help group model or the notion of trust as a form of capital. Thus in China, the very poor are credit-constrained from the micro-credit market. In India, MFI's such as BASIX have made headway into micro-credit and other forms of finance. However, commercial banks are also involved in micro-credit and both are largely promoted by rural development NGO's. Unlike China, the micro-credit lenders in India, largely through the use of self-help groups, lend fundamentally on trust and are focused largely on the poor in rural areas. One variant of the model explains how an MFI can co-exist with subsidized credit from Government banks. Here, the MFI does not micro-lend to the very poor. This created a void which was filled by Government bank lending. The

model also shows how the emergence of micro-credit has affected informal lending and usury rates from money lenders.

We believe that a credit framework based on trust rather than assets can be used to explain, from an economic point of view, much of what is observed in micro-credit lending in agriculture. The pedagogy of the model should be of broad interest to development economists studying micro-credit and agricultural finance scholars studying alternative lending models.

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