Credit Rationing in Developing Countries:

An Overview of the Theory

Parikshit Ghosh
University Of British Columbia

Dilip Mookherjee
Boston University

Debraj Ray
New York University

December 1999

To be published in Dilip Mookherjee and Debraj Ray (eds), *A Reader in Development Economics*, London: Blackwell (2000).

1 Introduction

Credit is essential in poor rural economies in a variety of ways. It is required to finance working capital and investment in fixed capital, particularly among farmers too poor to accumulate much saving. It is an important instrument for smoothing consumption, in a context where incomes typically experience large seasonal fluctuations. Moreover, unusual events such as illnesses or weddings often create a pressing need to borrow. Apart from the intrinsic benefit of being able to weather such shocks, availability of credit reduces reluctance to adopt technologies that raise both mean levels and riskiness of incomes.[1] The credit market thus affects output, investment, technology choices and inequality.

A significant fraction of credit transactions in underdeveloped countries still takes place in the informal sector, in spite of serious government efforts to channel credit directly via its own banks, or by regulating commercial banks.[2] This is largely because poorer farmers lack sufficient assets to put up as collateral—a usual prerequisite for borrowing from banks.[3] Numerous case studies and empirical analyses in a variety of countries have revealed that informal credit markets often display patterns and features not commonly found in institutional lending: (i) loans are often advanced on the basis of oral agreements rather than written contracts, with little or no collateral, making default a seemingly attractive option (ii) the credit market is usually highly segmented, marked by long-term exclusive relationships and repeat lending (iii) interest rates are much higher on average than bank interest rates, and also show significant dispersion, presenting *apparent* arbitrage opportunities (iv) there is frequent interlinkage with other markets, such as land, labor or crop (v) significant credit rationing, whereby borrowers are unable to borrow all they want, or some loan applicants are unable to borrow at all.

There are a number of different theoretical approaches that attempt to explain some or all of these features. Though differing in specific mechanisms proposed, they share a common general theme: that the world of informal credit is one of missing markets, asymmetric information, and incentive problems. There are a number of broad strands in the literature, focusing respectively on adverse selection (hidden information), moral hazard (hidden action), and contract enforcement problems. This article provides a sample of the latter two approaches, and argues that they are fundamentally similar in terms of their underlying logic and policy implications. These models have appeared

[1]Rosenzweig and Binswanger (1993) for instance show the effect of weather uncertainty on divergence between cropping choices of poor and rich farmers in Indian ICRISAT villages, which presumably owes to differential risk attitudes induced partly by differences in credit access.

[2]For further details, see Hoff and Stiglitz (1993).

[3]Banks, in turn, have to rely on such guarantees because the impersonal nature of institutional lending reduces the ability to select or monitor borrowers effectively.

in the work of many previous authors; our purpose is to provide a simple exposition, and identify the common underlying elements. The two theories focus respectively on involuntary and voluntary default risks, and associated borrower incentives. In the first model, defaults arise involuntarily, owing to adverse income or wealth shocks that make borrowers unable to repay their loans. The second model in contrast stresses problems with contract enforcement: borrowers may not repay their loans even if they have the means to do so. Both models explain how borrowing constraints endogenously arise in order to mitigate these incentive problems, even in the absence of exogenous restrictions on interest rate flexibility. The models also provide explanations for the features of informal credit markets listed above. Since their microfoundations are explicit — assumptions concerning underlying preferences, technology and information structure — they allow welfare and policy implications to be derived.

The adverse selection theory of credit markets originates with the paper by Stiglitz and Weiss (1981). The theory rests on two main assumptions: that lenders cannot distinguish between borrowers of different degrees of risk, and that loan contracts are subject to limited liability (i.e, if project returns are less than debt obligations, the borrower bears no responsibility to pay out of pocket). The analysis is restricted to *involuntary* default, i.e, it assumes that borrowers repay loans when they have the means to do so.

In a world with simple debt contracts between risk-neutral borrowers and lenders, the presence of limited liability of borrowers imparts a preference for risk among borrowers, and a corresponding aversion to risk among lenders. This is because limited liability on the part of borrowers implies that lenders bear all the downside risk. On the other hand, all returns above the loan repayment obligation accrues to borrowers. Raising interest rates then affects the profitability of low risk borrowers disproportionately, causing them to drop out of the applicant pool. This leads to an adverse compositional effect — higher interest rates increase the average riskiness of the applicant pool. At very high interest rates, the only applicants are borrowers who could potentially generate very high returns (but presumably with small probability). Since lenders' preferences over project risk run counter to those of borrowers, they may hold interest rates at levels below market-clearing and ration borrowers in order to achieve a better composition and lower risk in their portfolio. Excess demand in the credit market may persist even in the face of competition and flexible interest rates.

Stiglitz and Weiss' theory was designed to apply quite generally, rather than in the specific context of informal credit in developing countries. In the latter context, the theory has often been criticized for its underlying assumption that lenders are not aware of borrower characteristics.[4] The close knit character of many traditional rural societies implies that lenders possess a great deal of information about relevant bor-

[4]Other criticisms of the theory are discussed further in the Introduction to this volume.

rower characteristics, such as farming ability, size and quality of landholdings, cropping patterns and risk attitudes.[5]

However, if the distribution of returns from the investment is affected by the borrower's *actions*, observability and monitoring will be a problem even for lenders who live in close proximity. Limited liability could then increase default risk by reducing the borrower's effort in avoiding low yield states, rather than adversely affecting the composition of the loan applicant pool. This is precisely the moral hazard model, which we describe in section 2 of the paper.[6] The model illustrates the tradeoff between extraction of rents and the provision of incentives to induce a good harvest. Higher interest rates cause the problem of *debt overhang* — a highly indebted farmer has very little stake in ensuring a good harvest (i.e., remaining solvent), since the large loan repayments this outcome occasions imply that he captures only a small portion of the returns from the harvest. Keeping this in mind, lenders will be reluctant to raise interest rates beyond some level. As in the adverse selection theory, the interest rate may not rise enough to guarantee that all loan applicants secure credit, in times when loanable funds are limited. In general, the volume of credit and level of effort is less than first-best. We also show how collateral affects effort and borrower returns. Borrowers who have greater wealth to put up as collateral obtain cheaper credit, have incentives to work harder, and earn more income as a result. Existing asset inequalities within the borrowing class are projected and possibly magnified into the future by the operation of the credit market, a phenomenon that may cause the persistence of poverty.[7]

In section 3, we consider problems arising from contract enforcement, and the attendant possibility of *voluntary* default. Loan contracts in the informal sector are rarely explicitly recorded and enforced by formal legal institutions. Repayments may be induced partially via informal enforcement mechanisms based on social sanctions, coercion or threats of violence. In large part, however, compliance is ensured by the threat of reduction or elimination of access to credit in the future. The natural model to study the enforcement problem is one of repeated interactions in the credit market, which is described in Section 3. We first analyze a model of a single (monopolist) lender and a borrower, and show that in a (constrained) efficient stationary equilibrium, credit rationing arises unless the borrower has sufficient bargaining power. We then show that the same framework can be adapted to understand more realistic markets with

[5]See, however, our discussion later, as well as Aleem (1993), for arguments that the information available on borrowers is likely to decline over the course of development, due to increase in mobility and expansion of the market's domain.

[6]Versions of this model appear in Aghion and Bolton (1997), Jaffee and Russell (1976), Mookherjee (Reading [13]) and Piketty (1997).

[7]The implications of the theory for the dynamics of poverty and inequality are explored in Aghion and Bolton (1997), Mookherjee and Ray (1999) and Piketty (1997).

multiple lenders. In such scenarios, *social norms* which prescribe that defaulters be boycotted by the entire market, can give rise to equilibria that sustain positive levels of borrowing and lending. However, credit rationing remains a pervasive phenomenon. At this point, we draw the reader's attention to two different forms of quantity constraints: *micro* credit rationing, which places credit limits on borrowers (below first-best levels), and *macro* credit rationing, which randomly denies access to *any* credit to a fraction of borrowers. The second form involves asymmetric treatment of otherwise identical agents. We show that both forms of rationing might coexist, and play complementary but distinct roles. It also becomes clear that the second form of rationing gains in importance when information flow within the lending community is poor (so that defaulters have a fair chance of escaping detection).

One lesson that emerges from both the debt overhang and enforcement stories is that the distribution of bargaining power across lenders and borrowers has strong implications for the degree of credit rationing, effort levels and efficiency. The effect is similar in both cases—greater bargaining power to the lender reduces available credit and efficiency.[8]. The reason is that rent extraction motives can run counter to surplus maximization objectives beyond a certain point. The rent extractable from a marginal dollar loan or a marginal unit of effort induced may be less than the cost of funds, although the social returns might exceed it, leading to underinvestment. The implication is that social policies which empower the borrower and increase his bargaining strength are likely to increase efficiency.

2 Moral Hazard and Credit Rationing

Consider an indivisible project which requires funds of amount L to be viable. Output is binary, taking values of either Q (good harvest) or 0 (crop failure). The probability of a good harvest is $p(e)$, where e is the effort level of the agent who oversees the project. We assume that $p'(e) > 0$ and $p''(e) < 0$, the latter representing usual diminishing returns. Effort cost is given by e, and all agents are risk neutral.

First, consider the problem of a self-financed farmer. If investment takes place at all, the effort level is chosen so as to

$$\max_{e} \quad p(e).Q - e - L \tag{1}$$

[8]It must be stressed that "efficiency" in this context refers to maximization of social surplus, not constrained Pareto efficiency. The latter feature is built into our analysis by construction, since we only look at the boundary of the set of possible equilibrium payoff vectors. The result reported here is that as we move along this boundary towards higher lender payoffs and lower borrower payoffs, the sum of payoffs (total social surplus) decreases along the way. Lender profits can be increased only by creating a more than offsetting loss for the borrower.

The optimum choice e^* is described by the first-order condition:

$$p'(e^*) = \frac{1}{Q} \tag{2}$$

This is the efficient, or first-best level of effort, which forms the benchmark against which all subsequent results will be compared.

Now consider a debt-financed farmer. Let $R = (1+i)L$ denote total debt, where i is the interest rate. To introduce moral hazard, we assume that e is not verifiable by third parties, hence not contractible. Furthermore, there is limited liability: the borrower faces no obligations in the event of a crop failure (outcomes are verifiable, although effort is not). However, we allow for some collateral. Let w denote the value of the borrower's transferable wealth that can be put up as collateral. To make the problem interesting, assume $w < L$. The effort choice of a borrower facing a total debt R is given from:

$$\max_e \quad p(e).(Q-R) + (1-p(e)).(-w) - e \tag{3}$$

Denote the optimal choice by $\hat{e}(R, w)$, defined by the following first-order condition:

$$p'(e) = \frac{1}{Q+w-R} \tag{4}$$

Observe that $\hat{e}(R, w)$ is decreasing in R and increasing in w.[9] A higher debt burden reduces the borrower's payoff in the good state, but not in the bad state, dampening incentive to apply effort. A bigger collateral, on the other hand, imposes a stiffer penalty in the event of crop failure, thus stimulating the incentive to avoid such an outcome.

The lender's profit is given by

$$\pi = p(e)R + [1-p(e)]w - L \tag{5}$$

To find the Pareto frontier of possible payoffs, we hold the lender's expected profit at any given level π, and maximize the borrower's utility, subject to incentive compatible choice of effort level. The lender's expected profit Implicit in our formulation is the assumption that the opportunity cost of funds is zero, which is entirely innocuous and can be generalized without any problem. In determining equilibrium choices, we will treat π as given, and will later see the comparative static effects of increasing it. The special case where $\pi = 0$ represents a perfectly competitive loan market with free entry.

[9] If the size of collateral is positive, or if the borrower has some outside option, there will be a participation constraint in addition to the incentive compatibility condition described here. However, the participation constraint only places a ceiling on the interest rate, and will be non-binding if the values of collateral and outside option are low. Hence, we drop it from our analysis.

Since lenders can always choose not to lend, it makes sense to restrict attention only to cases where $\pi \geq 0$. This last condition, together with (5) (and the fact that $w < L$) immediately implies that $R > w$. Using this to compare (2) and (4), and remembering the concavity of the $p(.)$ function, we conclude that $\hat{e} < e^*$.

Proposition 1 *As long as the borrower does not have enough wealth to guarantee the full value of the loan, the effort choice will be less than first-best.*

This is the *debt overhang* problem: an indebted borrower will always work less hard on his project than one who is self-financed.

The variables determined in equilibrium are R and e. Equations (5) (the isoprofit curve) and (4) (the incentive curve) jointly determine the outcome. It is easy to check that the locus described by each is negatively sloped. If the borrower works harder, the risk of default is reduced, and R must be lower to hold down the lender's profit at the same level. On the other hand, a reduced debt burden increases the incentive to work hard.

Notice also that as we move downward along the incentive curve, the borrower's payoff is increasing. Lower debt (R) increases borrower payoff for any given choice of effort, and hence also after adjusting for optimal choice. If there are multiple intersections, only the lowest among these (the one associated with the lowest R) is compatible with Pareto efficiency. Further, the incentive curve should be steeper than the isoprofit line at the optimum point (otherwise, a small decrease in R will increase both lender profit and borrower utility). Figure 1 depicts a typical situation, point E representing the equilibrium.

We can now examine the comparative static effect of higher lender profit (π) or higher wealth (w). Figure 2 shows the effect of increasing π. The isoprofit curve shifts up; in the new resultant Pareto efficient equilibrium, the debt burden (R) increases, and so does the interest rate (since the loan size is fixed), while the effort level falls.

Proposition 2 *(Pareto efficient) equilibria in which lenders obtain higher profits involve higher debt and interest rates, but lower levels of effort. Hence, these equilibria produce lower social surplus.*

It is instructive to ask why higher rent extraction is associated with lower overall efficiency. Lenders earn more profit by increasing the interest rate, which in itself is a pure transfer. However, a greater debt burden reduces the borrower's incentive to spend effort, increasing the chance of crop failure and creating a deadweight loss. Consider two extreme cases. The case of $\pi = 0$ represents perfect competition, and this situation generates the highest level of effort among all. Notice, however, that since the debt burden still exceeds w, effort will nevertheless be less than first-best. This tells us that the source of the inefficiency is not so much monopolistic distortion created

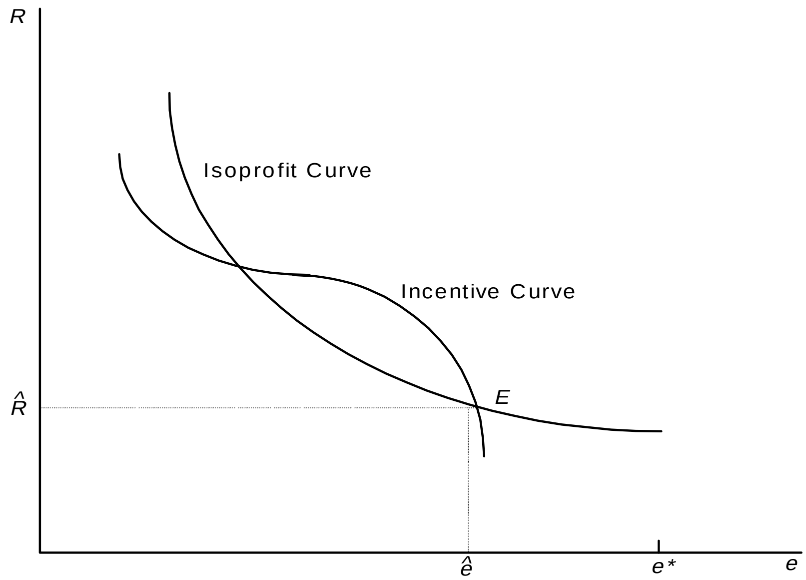

Figure 1: EQUILIBRIUM DEBT AND EFFORT IN THE CREDIT MARKET.

by the lender's market power (although that certainly exacerbates the problem), but the agency problem itself, and the distortion in incentives created by limited liability. While the borrower shares in capital gains, he bears no part of the capital losses (beyond the collateral posted). Working with other people's money is not the same as working with one's own.

The other extreme case is that of monopoly. In this case, the value of π is maximized from among all feasible and incentive compatible alternatives. In other words, the monopolistic lender will choose the point on the incentive curve that attains the highest isoprofit curve. The condition is the standard one of tangency between the two curves. This provides a ceiling on the interest rate, or debt level ($\bar{R}$), and the lender will not find it profitable to raise it above this level. In more competitive conditions, this ceiling will still apply. If, in a competitive credit market, there is excess demand for funds at $\bar{R}$, the interest rate will not rise to clear the market. We have an exact counterpart of Stiglitz-Weiss type of rationing (rationing of borrowers, or macro-rationing in our terminology) in the presence of moral hazard rather than adverse selection.[10]

[10]Stiglitz and Weiss (1981) discuss how their story can be recast as a moral hazard problem. How-

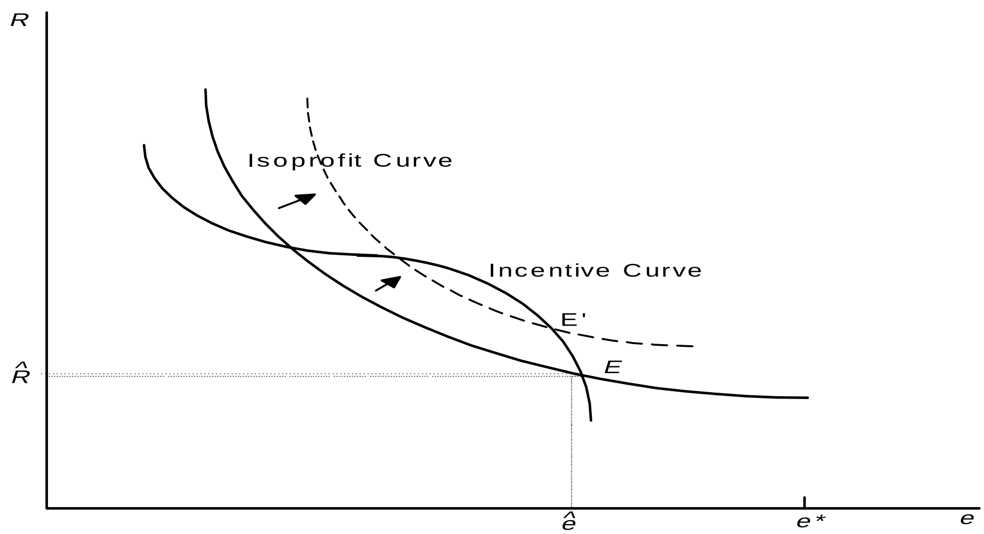

Figure 2: Effect of an Increase in the Lender's Profit.

The observation that borrower-friendly equilibria are more efficient has broad implications for social policy. Any change which reduces interest rates, or improves the bargaining power of the borrower will enhance effort and productivity. The latter involves institutional changes, such as a reallocation of property rights over relevant productive assets from lenders to borrowers, or an improvement in the latter's outside options (an issue elaborated in the Mookherjee [13] reading). Note, however, that such policy interventions cannot result in improvements in Pareto efficiency — since equilibrium contracts are by definition constrained Pareto-efficient — but result in higher levels of social surplus. In other words, they must make some agents in the economy worse off. Despite the fact that the gainers (borrowers) could potentially compensate the losers, such compensations cannot actually be paid, owing to the wealth constraints of the borrowers. Accordingly such policies will tend to be resisted by the losers, and may not actually be adopted.

Can the model also generate micro-rationing—a situation in which even those who

ever, the incentive problem suggested there is somewhat different. With limited liability, borrowers will prefer a mean preserving increase in spread in the distribution of returns. They will tend to pass up projects with secure returns, and will instead select projects with high possible returns but also high risk. An increase in the interest rate will reinforce this tendency.

succeed in obtaining credit still get too little? In other words, can there be under-investment in debt-financed projects, in addition to under-supply of effort? We cannot address the issue in this simple model, since the project has been assumed to be indivisible. However, it is easy to see that the answer will be in the affirmative if the model is extended in a natural way to allow for variable size of investment. Suppose output (when harvest is good) is $Q(L)$, an increasing concave function of the amount of loan or investment, but zero in the event of crop failure. The complementarity between effort and investment will then generate suboptimal choices on both fronts.[11]

In particular the phenomenon of nonlinear interest rates — where the interest rate depends on loan size — may arise even when the credit market is competitive. An expansion in loan size increases the debt burden, reducing the borrower's stake in success, causing default risk to increase. This may outweigh the effect of a larger scale of borrowing, making the lender worse off. In order to remain commercially viable, the larger loan must be accompanied by a different interest rate and/or level of collateral that reduces lender risk. Increases in the interest rate can make matters worse, by raising debt burdens even further. While some loan increases may thus be feasible if accompanied by higher interest rates, the lender may be unwilling to lend beyond some level of loan size at *any* interest rate.[12] Both micro and macro forms of credit rationing can therefore arise, with credit ceilings depending on the collateral that the borrower can post.

Turn now to the role of collateral in the credit market. Figure 3 captures the effect of an increase in w on equilibrium interest rates and effort choice. The incentive curve shifts to the right (there is more effort forthcoming at any R, since failure is more costly to the borrower), while the isoprofit curve shifts down (for any effort level e, since the return in the bad state is higher due to more collateral, the return in the good state, i.e, the interest charged, must be lower to keep profits the same).

Proposition 3 *An increase in the size of collateral, w, leads to a fall in the equilibrium interest rate and debt, and an increase in the effort level. For a fixed π, the borrower's expected income increases; hence, the utility possibility frontier shifts outwards.*

The intuition is fairly simple. *Ceteris paribus*, a bigger collateral increases the incentive to put in effort, since failure is now more costly to the borrower. If lender's profits are to be preserved at the same level, the interest rate must fall, because there is lower default risk. This causes less debt overhang, further reinforcing the effect on incentives. Higher effort levels increase the total surplus, but since lender's expected profits are held constant, borrowers must get more in net terms.

[11] It is easy to see that in any constrained efficient contract the loan size will be selected to maximize $p(e)Q(L) - L$.

[12] For an explicit example, see Aghion and Bolton (1997).

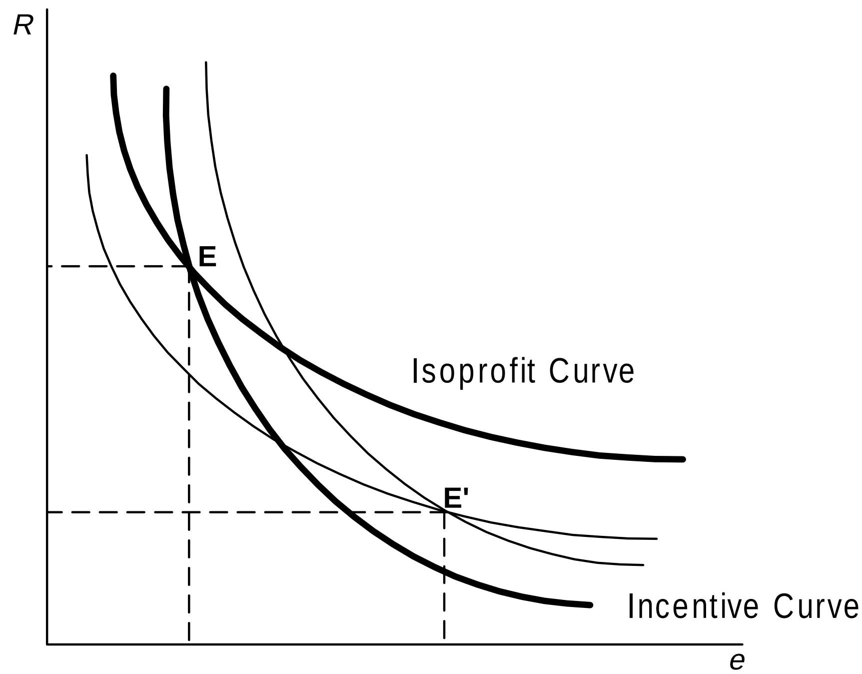

Figure 3: Effect of Higher Borrower Wealth (Collateral).

These results illustrate how interest rate dispersion might arise, even in competitive credit markets. In the presence of default risk and moral hazard, the interest rate will be closely tied to borrower characteristics such as wealth or ability to post collateral. Wealthier borrowers pose less risk for two reasons: these loans have better guarantees in case of default, plus lower default risk arising from better incentives. Hence, wealthier borrowers have access to cheaper credit. Arbitrage opportunities are illusory—the isoprofit line restricts lenders to the same profit level for different types of borrowers. The second point of interest is that the functioning of the credit market may exacerbate already existing inequalities. Those with lower wealth are doubly cursed: they not only face lower consumption potential from asset liquidation, but also lower income earning potential, owing to costlier (or restricted) access to credit. The reason is that the poor cannot credibly commit to refrain from morally hazardous behavior as effectively as the rich. This process of magnification of past inequalities through the operation of specific markets has been identified in different contexts by Dasgupta and Ray (Reading [9]) and Galor and Zeira (Reading [4]), among others.

Long-term exclusive relationships and social networks can be useful in mitigating these inefficiencies to some extent. When the lender and borrower enter a long-lived relationship, it expands the opportunity for the lender to relax limits on the borrower's current liability by extracting repayment in future successful periods (by the institution of debt), or by the threat of terminating the supply of credit (an issue further discussed in Dutta, Ray and Sengupta (1989)). A similar reason underlies the role of lending within social networks, where punishments can be imposed for loan defaults in other spheres of social interaction, and third-party community-based sanctions can be brought to bear on defaulters owing to the rapid flow of information within the community.

3 Repeated Borrowing and Enforcement

Results similar to those in the previous section can also arise from costly contract enforcement, where the principal problem faced by lenders is in preventing wilful default *ex post* by borrowers who do in fact possess the means to repay their loans. Most credit contracts in the developing world are not enforced by courts, but instead by social norms of reciprocal and third party sanctions. Contracts have to be self-enforcing, where repayment of loans rely on the self-interest of borrowers, given the future consequences of a default. In this respect the problem is akin to that of sovereign debt, where lender countries and international courts do not have the means of enforcing loan repayments by borrowing countries. Defaults are sought to be deterred solely by the threat of cutting the borrower off from future access to credit. Empirical and historical accounts of trade and credit in countries lacking a developed system of legal institutions amply document the role of such reputational mechanisms: see, for example, Clay (1997), Greif (1989, 1993, 1994), Greif, Milgrom and Weingast (1994) and McMillan and Woodruff (1996). Theoretical models of Eaton and Gersovitz (1981) and Ghosh and Ray (1996, 1999) have shown how such enforcement problems can also give rise to most of the phenomena described above: adverse incentive effects of raises in interest rates, credit rationing, long term relationships and the role of social networks.

To understand these issues, we turn our attention to the problem of *voluntary* default. In the absence of usual enforcement mechanisms (courts, collateral, etc.), compliance must be achieved through the use of dynamic incentives, i.e, from the threat of losing access to credit in the future. We use a simple infinite horizon repeated lending-borrowing game to illustrate such a mechanism, and derive its implications for rationing and efficiency in the credit market. Since bankruptcy and involuntary default are not the focus in this section, we remove any source of production uncertainty.

Each period, the borrower has access to a production technology which produces output $F(L)$, where L is the value of inputs purchased and applied. The production function satisfies standard conditions: $F^{'}(.) > 0$ and $F^{''}(.) < 0$. Suppose production takes the length of one period, and let r be the bank rate of interest (opportunity cost of funds). To set the benchmark, consider the case of a self-financed farmer. The optimum investment L^* is given from the solution to

$$\max_{L} \quad F(L) - (1+r)L \tag{6}$$

which yields the first-order-condition

$$F^{'}(L^*) = 1 + r \tag{7}$$

Next we turn to debt financed farmers. We assume that such farmers do not accumulate any savings and have to rely on the credit market to finance investment needs every period. We can allow the possibility of saving by adding a probability of crop failure.[13] This will significantly complicate the analysis by introducing inter-temporal choices, without necessarily adding much insight, so we drop it here.[14] Borrowers live for an infinite number of periods, and discount the future by a discount factor δ.

3.1 Partial Equilibrium: Single Lender

We first solve a partial equilibrium exercise. Suppose there is a single borrower and a single lender. We focus on a stationary subgame perfect equilibrium, where the lender offers a loan contract $\{L, R = (1+i)L\}$ every period, and follows the trigger strategy of never offering a loan in case of default. The defaulting borrower still has an outside option that yields a payoff v every period. For now, we treat v as exogenous. Later, we show how v can be "rationalized" as the value arising in a more general equilibrium model with many borrowers and lenders.

Of course, as with all repeated games, there are many equilibria. We characterize the Pareto frontier of all stationary equilibria, in which the same loan contract is offered at all dates.[15] All such equilibria must satisfy the incentive constraint for the borrower:

$$(1-\delta)F(L) + \delta v \leq F(L) - R, \tag{8}$$

i.e., the borrower should not benefit from defaulting on the loan: the left hand side represents the average per period long run payoff from defaulting, and the right hand side the corresponding payoff from not defaulting. In order to generate the Pareto frontier, we must maximize the borrower's per period net income, while satisfying the incentive constraint and holding the lender's profit at some fixed level z. Mathematically,

$$\max_{L,R} \quad F(L) - R \tag{9}$$

[13]This will disallow the strategy of defaulting on the first loan and rolling it over infinitely to finance investment forever after. A crop failure will cut short the process.

[14]For an intemporal model of consumption-smoothing and credit, with default risk, see Eaton and Gersovitz (1981).

[15]The assumption of stationarity is, surprisingly, not innocuous. Non-stationary equilibria can Pareto dominate equilibria which are efficient in the class of stationary equilibria. See Ghosh and Ray (2000). We confine ourselves to stationarity for simplicity and tractability.

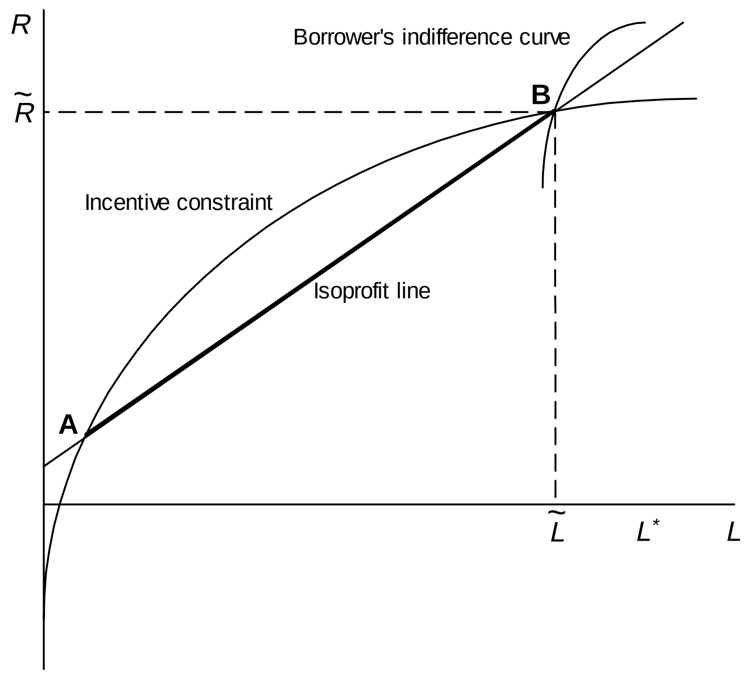

Figure 4: Optimal Solution to the Enforcement Problem.

subject to the constraints

$$R \leq \delta[F(L) - v] \tag{10}$$

$$z = R - (1 + r)L \tag{11}$$

(10) is simply the incentive constraint in (8), after rearrangement. The nature of the solution is illustrated in Figure 4. The boundary of the incentive constraint is the positively sloped, concave curve with slope $\delta F^{'}(L)$, while the lender's profit constraint (11) is represented by a straight line with slope $1 + r$. The points of intersection A and B are where both constraints bind. Clearly, the line segment AB represents the feasible set. The borrower's indifference curves are rising, concave curves with slope $F^{'}(L)$, lower indifference curves representing higher payoff. If these indifference curves attain tangency at some point on AB, it is the solution to the problem, and has the property: $L = L^*$, and $R = (1+r)L^* + z$. If not, the solution must be at the corner B. Let $\hat{L}(v, z)$ be the value of L at B, and let $\tilde{L}(v, z)$ denote the solution to the problem above (the corresponding value of R is given from (11)). The preceding discussion leads to the conclusion:

$$\tilde{L}(v, z) = \min\{L^*, \hat{L}(v, z)\} \tag{12}$$

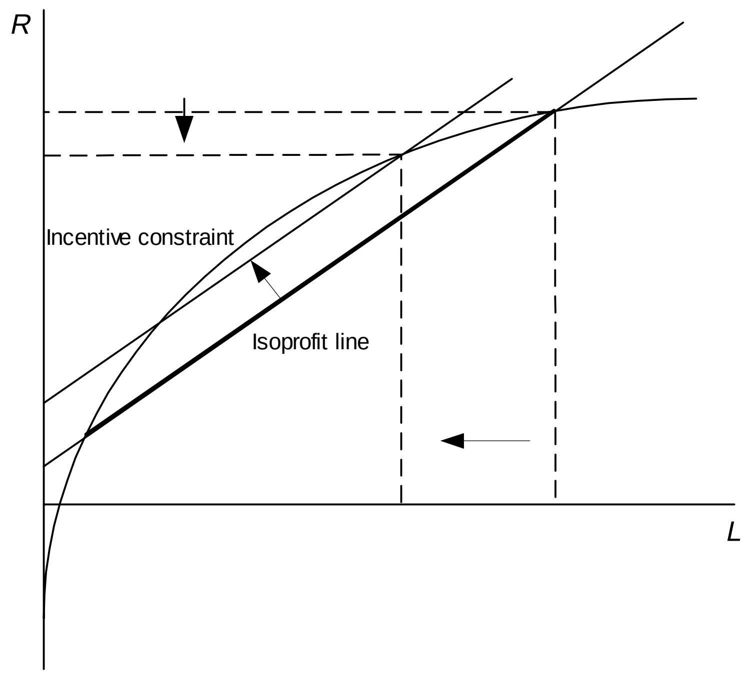

Figure 5: EFFECT OF AN INCREASE IN LENDER'S PROFIT.

If the second argument applies above (i.e, the solution is at the corner B), credit rationing will arise. We will show in a moment that this is possible. However, we first analyze the effect of a parametric shift in z (lender's equilibrium profit) or v (option value of default). If z increases (Figure 5), the iso-profit line shifts up and the point B moves to the left, i.e, $\hat{L}(z, v)$ is decreasing in z. If this is indeed the solution, then the equilibrium volume of credit is reduced and rationing becomes more acute. If the solution is interior (L^*) to begin with, a small increase in z will raise the interest rate, but will leave the loan size unaffected. Notice that the interest rate rises in the first case too, as indicated by the fact that the ray connecting point B to the origin becomes steeper.

Figure 6 illustrates the effect of increasing the borrower's outside option v. The curve representing the boundary of the incentive constraint undergoes a parallel downward shift, moving the corner point B to the left. The effect on loan sizes and interest rates is nearly similar to the case of increasing z. If $\hat{L} = L^*$ to begin with, nothing changes (since v affects only the incentive constraint, which is not binding). If $\tilde{L} = \hat{L}$, on the other hand, increasing v has the implication that the equilibrium loan size falls and the interest rate rises.

Can credit rationing arise in equilibrium? To see that the answer is in the affirma-

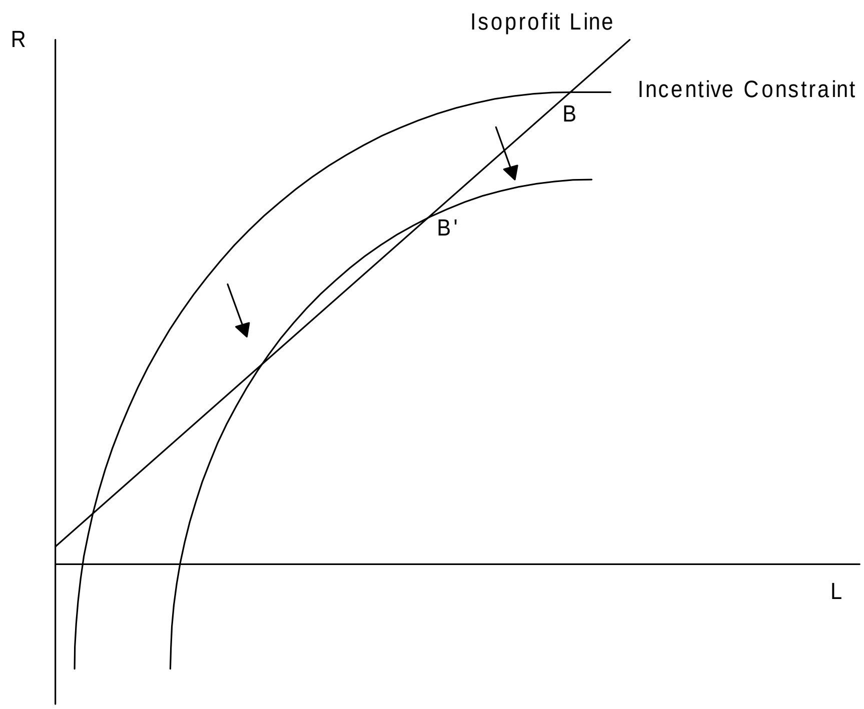

Figure 6: EFFECT OF AN INCREASE IN BORROWER'S OUTSIDE OPTION.

tive, notice that if the value of z (given v) or v (given z) is too high, the problem does not have a solution, since the iso-profit line will lie everywhere above the boundary of the incentive region. The borderline case is one where the two are tangent, i.e, when the points A and B converge to each other and the feasible set of the constrained maximization problem described above becomes a singleton. The solution must then be this single feasible point. Tangency of (11) and (10) (the latter holding with equality) implies that $\delta F^{'}(\tilde{L}) = 1 + r$ implying $\tilde{L} < L^{*}$ since $\delta < 1$ and F is concave. There is credit rationing if z (or v) is sufficiently high. Since the solution is continuous in z (or v), and given the comparative static properties of the corner solution, it follows that there will be credit rationing if either z or v (given the other) is above a critical value.

We summarize these observations in the following proposition:

Proposition 4 *There is credit rationing if z, the lender's profit (given v), or v, the borrower's outside option (given z), is above some threshold value. If rationing is present, a further increase in the lender's profit, or the borrower's outside option, leads to further rationing (i.e, a reduction in the volume of credit) as well as a rise in the interest rate.*

Notice that while changes in z move us along the Pareto frontier, shifts in v translate into a shift of the frontier itself. Equilibria which give more profit to the lender involve lower overall efficiency, because credit rationing is more severe in such equilibria. Increased bargaining power of lenders thus reduce productivity, echoing a similar result in the previous model involving involuntary default. The reason is also similar: marginal rents accruing to the lender fall below the social returns from increased lending, the difference accounted for by the incentive rents that accrue to the borrower.

3.2 General Equilibrium: Multiple Lenders

An obvious shortcoming of the model so far is that the outside option v has been assumed exogenous. In a competitive setting with multiple lenders — which fits descriptions of informal credit in many developing countries [16] — a defaulting borrower can switch to a different lender. If there is a good deal of information flow within the lending community, the defaulting borrower could face social or market sanctions (as opposed to merely individual sanction from the past lender), thus restoring the discipline.[17] However, the strength and reliability of such information networks could vary from one context to another, and is a factor that needs to be taken into account. Accordingly the strength of such networks can be treated as a parameter of the model.

Suppose that following a default, the existing credit relationship is terminated. The borrower can then approach a new lender, who checks on the borrower's past and uncovers the default with probability p (i.i.d across periods).[18] In that case, the lender refuses the loan, and the borrower approaches yet another lender, whereupon the same story repeats itself. If, on the other hand, the lender fails to uncover the default, the borrower enters into a new credit relationship with the lender. Given the assumption of a symmetric (and stationary) equilibrium, the borrower receives the same contract (L, R) as with previous lenders. Then v, the expected value of the outside option, is given by

$$v = p\delta v + (1-p)w = \frac{1-p}{1-\delta p}w. \tag{13}$$

Then we can write $v = (1-\rho)w$, where

$$\rho \equiv \frac{p(1-\delta)}{1-\delta p} \tag{14}$$

[16] See, for example, the case studies of Aleem (1993), Kranton and Swamy (1998), McMillan and Woodruff (1996) and Siamwalla et al. (1993).

[17] For a rich description of such sanctions in practice, see Udry (1994) in the context of credit markets in northern Nigeria, and Greif (1993) for an analysis of medieval overseas trade and merchant networks.

[18] Aleem (1993), McMillan and Woodruff (1996) and Siamwalla et al. (1993) document the importance of screening new borrowers among informal lenders in Pakistan, Vietnam and Thailand respectively.

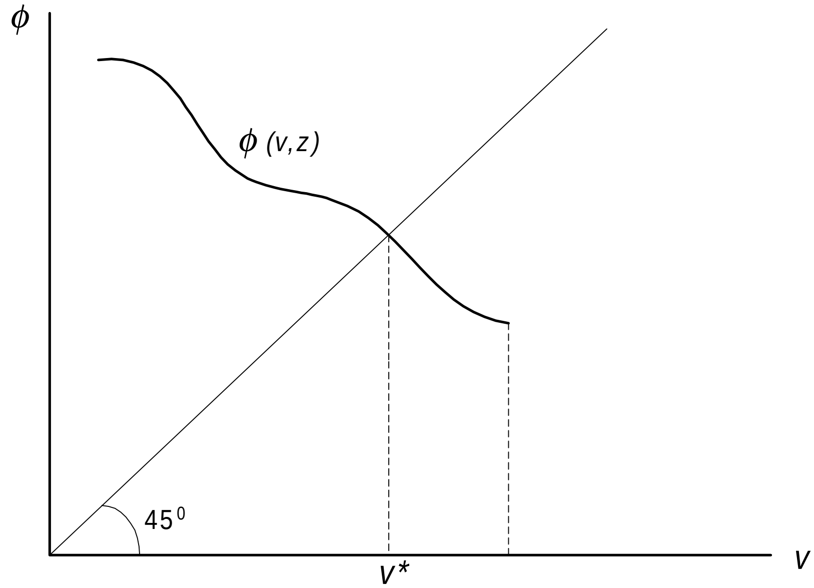

Figure 7: THE FUNCTION $\phi(v, z)$.

can be viewed as the *scarring factor*. Notice that if p gets very close to one, so that a default is always recognized, then the scarring factor converges to one as well. On the other hand, for any p strictly between zero and one, the scarring factor goes to zero as δ goes to unity, or if p itself goes to zero.

For the endogenous determination of v, we utilize our analysis of the partial equilibrium model in the previous section, to construct a function $\phi(v; z)$ whose fixed point denotes the equilibrium in this more general setting. Consider a given z and any arbitrary value of v for which the problem has a solution. The borrower's per period payoff (on the equilibrium path) in partial equilibrium is given by $w(v, z) = (1 - \delta)F(\tilde{L}(v, z)) + \delta v$.[19] If he defaults, his expected per period payoff thereafter is $(1 - \rho)w(v, z)$. The original v is "rationalized" if this latter value coincides with v (i.e, the defaulting borrower's continuation payoff is precisely what he can expect to get from the market itself after termination by his current lender). Of course, our focus is on a stationary symmetric equilibrium in which all lenders offer the same package (L, R) to borrowers in good standing. Hence, we define the following function:

$$\phi(v; z) = (1 - \rho)w(v, z) \tag{15}$$

and note that, given z, any fixed point of ϕ (with respect to v) denotes an equilibrium.

[19] This is obtained by treating (10) as binding.

Proposition 4 tells us that an exogenous increase in either v or z leads to a smaller loan size and higher interest rates, which adversely affects borrower payoffs. Hence the function $\phi(v, z)$ is decreasing in both its arguments. Further, if v is higher than some threshold $\bar{v}(z)$, the problem has no solution, and the value of $\phi(v, z)$ can be taken to be 0 in that case. Take z as given. Figure 7 shows the nature of the function ϕ: it is downward sloping, with a downward jump at $\bar{v}$. There is an unique fixed point — v^* in the diagram — if there is an intersection with 45 degree line before the point of discontinuity. Otherwise, no symmetric equilibrium exists.

We next show that if the scarring factor is sufficiently high (either the probability of detection p is high enough, or borrowers are sufficiently patient), an equilibrium usually exists. However, note first that the lower bound on the equilibrium value of v is zero, so there will be a maximal value of z (say $\bar{z}$) that is consistent with a solution existing to the problem defined in (9) through (11). Suppose z is held fixed at a value below this threshold. Then, it is easy to see from (15) that, as ρ is increased, ϕ undergoes a downward shift, the point of discontinuity remaining the same (since the function $w(v, z)$ is independent of ρ). The discontinuity disappears as $\rho \to 1$; hence we conclude that there is a threshold value ρ^* (dependent on z) such that an equilibrium exists if and only if $\rho \geq \rho^*$. The next proposition summarizes these findings.

Proposition 5 *Suppose $z \leq \bar{z}$. There is a unique equilibrium in the credit market provided ρ is greater than some threshold value ρ^*, i.e, provided either that borrowers are sufficiently patient, or the probability of detection is high enough.*

These results are fairly intuitive. A higher discount factor implies that the cost of (probabilistic) lack of access to credit in the future is more costly. A rise in the detection probability has a similar effect. The last point brings out the disciplining role of dissemination of information regarding borrower credit histories. Improved credit information networks lower outside options of borrowers: by Proposition 4 this reduces both interest rates and credit constraints, consistent with the empirical results of McMillan and Woodruff (1996).

Finally, we wish to check whether equilibria that provide higher profits to the lender create more credit rationing and reduce efficiency. This was the feature that emerged in the partial equilibrium analysis, and we now demonstrate that it extends to this more general formulation. First, observe that a rise in z shifts the ϕ-function downwards, implying that the equilibrium value of v must fall (see Figure 8). Next, remembering that in equilibrium $\phi(v, z) = v$ and using (15), we can write:

$$v = (1 - \rho)[(1 - \delta)F(\tilde{L}) + \delta v]$$

which, on rearrangement, yields:

$$v = \frac{(1 - \rho)(1 - \delta)F(\tilde{L})}{1 - \delta(1 - \rho)} \tag{16}$$

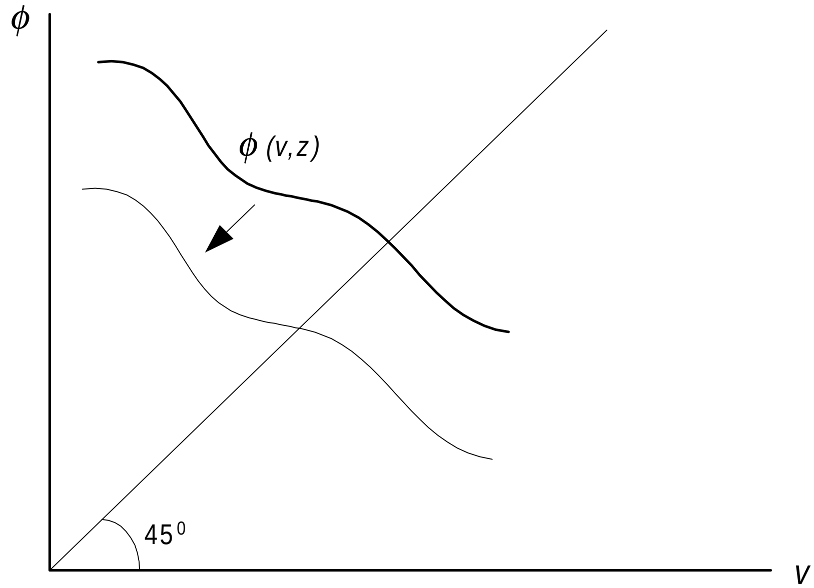

Figure 8: Effect of an Increase in Lender's Profit.

where $\tilde{L}$ denotes the equilibrium loan. This establishes that in equilibrium, v and $\tilde{L}$ are positively related. Since v falls due to a parametric increase in lenders' profit z, so does $\tilde{L}$.

We saw from Proposition 5 that existence of equilibrium requires that the detection probability is sufficiently high. What if it is not? The immediate possibility is credit rationing at some macroeconomic level. To see how this fits, suppose that a past defaulter may be excluded from future loan dealings for two distinct reasons:

Targeted Exclusion. Incidence of past defaults are discovered by a new lender (with probability p), and he is refused a loan. This is already incorporated in the model above.

Anonymous Exclusion. Whether or not a potential borrower has actually defaulted in the past, he may face difficulty in getting a loan. This is macro-rationing of credit, analogous to the equilibrium unemployment rate in Shapiro and Stiglitz (1984). Let us denote the probability of such exclusion (in any period) by q. Notice that to build a coherent model in which $q > 0$, we really have to answer the question of why the market may not clear. After all, if some borrowers are shut out of the market, an individual lender may be tempted to make profit by offering them credit at interest rates equal to or higher than the market interest rate[20]. One coherent model is given by the case in

[20] Note, by the way, that the same issues come up when we attempt to explain why defaulting

which lenders make zero expected profits, so that they are always indifferent between lending and not lending. In equilibrium, lenders can then mix between giving and not giving credit to a new borrower. Lending to a new borrower on market terms does not add to profits; attempting to earn positive profits by lending to rationed borrowers on stiffer terms leads to violation of the incentive constraint.[21]

The main point is that anonymous exclusion may be an equilibrium-restoring device. To see this, let us calculate ρ, the effective scarring factor, when there is both targeted and anonymous exclusion. The corresponding equation is

$$\rho \equiv \frac{\pi(1-\delta)}{1-\delta\pi} \tag{17}$$

where π, now, is the overall probability of being excluded at any date. It is easy to see that

$$\pi = 1-(1-p)(1-q). \tag{18}$$

Now notice that irrespective of the value of p, q can always adjust to guarantee that an equilibrium exists. (To be sure, the determination of q becomes an interesting question, but this is beyond the scope of the present exercise).

4 Concluding Comments

Despite their differences in detail, the two theories of credit rationing described above are similar in a number of broad respects. Both are driven by the positive effect of higher repayment burdens on default risk. Accordingly limiting default risks necessitate restrictions on repayment burdens. This is achieved by limiting loan sizes below what borrowers desire — the phenomenon of micro-credit rationing, and preventing interest rates from rising to excessively high levels — which can precipitate macro-credit rationing when loanable funds are scarce.

Access to credit is especially restricted for the poor, owing to their inability to provide collateral. Collateral both reduces default risk (for incentive reasons) and lender exposure in the event of default. Existing poverty and wealth inequalities may therefore tend to be perpetuated, an issue typically investigated in dynamic extensions of the models described here.

As for policy implications, macroeconomic stabilization policies often ignore the consequences of raising interest rates on default risks in times of financial crises: accordingly they may be ineffective or even counterproductive in attracting investors and

borrowers may be shut out from the market, without taking recourse to any reputational factors.

[21] For a more careful analysis of how such rationed equilibria can be constructed, see Ghosh and Ray (1999).

restoring financial stability. In terms of structural reforms aimed at alleviating poverty in the long term, the models illustrate the possible perils of large infusions of subsidized credit by the public sector. If informal markets are competitive to start with, such credit programs will typically run into losses (even if government banks were as well informed about borrower characteristics and able to enforce loan repayments as are informal lenders, both questionable assumptions). For if existing loan contracts are constrained Pareto efficient, there is no scope for Pareto improvements from supplementary credit provision or subsidies.[22] Indeed, the provision of cheap credit from the formal sector can increase the outside options of borrowers in their informal credit relationships, thus disrupting the informal market seriously.[23] The government or other nonprofit institutions can, however, play a potentially useful role by altering the root cause of the market distortions: the institutional environment within which lenders and borrowers interact on the informal market. This involves measures to increase the bargaining power of borrowers, reduce asset inequality, and improve credit information networks.

References

Aghion, P. and P. Bolton (1997). "A Theory of Trickle-Down Growth and Development," *Review of Economic Studies* **64**, 151–172.

Aleem, I. (1993). "Imperfect Information, Screening, and the Costs of Informal Lending: A Study of a Rural Credit Market in Pakistan," in K. Hoff, A. Braverman and J. Stiglitz (eds.), *The Economics of Rural Organization: Theory, Practice and Policy.* London: Oxford University Press (for the World Bank).

Clay, K. (1997). "Trade Without Law: Private Order Institutions in Mexican California," *Journal of Law, Economics and Organization* **13**, 202–231.

Dasgupta, P. and D. Ray (1986). "Inequality as a Determinant of Malnutrition and Unemployment: Theory," *Economic Journal* **96**, 1011–1034.

Dutta, B., D. Ray, and K. Sengupta (1989). "Contracts with Eviction in Infinitely Repeated Principal Agent Relationships," in P. Bardhan (ed.) *The Economic Theory of Agrarian Institutions.* Clarendon Press, Oxford.

[22] However if lenders have market power then the provision of government credit or measures to encourage entry of new lenders can potentially increase the bargaining power of borrowers, with attendant improvement in borrower incentives and social efficiency.

[23] For a more detailed exploration of these issues, see Hoff and Lyon (1995), Kahn and Mookherjee (1995, 1998), Kranton (1996), Kranton and Swamy (1998) and McMillan and Woodruff (1996).

Eaton, J. and M. Gersovitz (1981). "Debt with Potential Repudiation: Theoretical and Empirical Analysis," *Review of Economic Studies* **48**, 289–309.

Ghosh, P. and D. Ray (1996). "Cooperation in Community Interaction without Information Flows," *Review of Economic Studies* **63**, 491–519.

Ghosh, P. and D. Ray (1999). "Information and Repeated Interaction: Application to Informal Credit Markets." Mimeograph, Department of Economics, Texas A&M University.

Ghosh, P. and D. Ray (2000). "Contracts with Imperfect Enforcement," mimeo.

Greif, A. (1989). "Reputation and Coalitions in Medieval Trade: Evidence on the Maghribi Traders," *Journal of Economic History* **49**, 857–882.

Greif, A. (1993). "Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition," *American Economic Review* **83**, 525–548.

Greif, A. (1994). "On the Political Foundations of the Late Medieval Commercial Revolution: Genoa during the Twelfth and Thirteenth Centuries," *Journal of Economic History* **54**, 271–287.

Greif, A., Paul Milgrom and Barry Weingast (1994). "Coordination, Commitment and Enforcement: The Case of the Merchant Guild," *Journal of Political Economy* **102**, 745–76.

Hoff, K. and A. Lyon (1995). "Non-Leaky Buckets: Optimal Redistributive Taxation and Agency Costs," *Journal of Public Economics* **58**, 365–390.

Hoff, K. and J. Stiglitz (1993). "Imperfect Information in Rural Credit Markets: Puzzles and Policy Perspectives, " in K. Hoff, A. Braverman, and J. Stiglitz (eds.), *The Economics of Rural Organization: Theory, Practice and Policy.* London: Oxford University Press (for the World Bank).

Jaffee, D. and T. Russell (1976). "Imperfect Information, Uncertainty and Credit Rationing," *Quarterly Journal of Economics* **90**, 651–666.

Kahn, C. and D. Mookherjee (1995). "Market Failure and Moral Hazard with Side Trading," *Journal of Public Economics*, **58**, 159-184.

Kahn, C. and D. Mookherjee (1998). "Competition and Incentives with Nonexclusive Contracts," *Rand Journal of Economics*, **29(3)**, 443-465.

Kranton, R. (1996). "The Formation of Cooperative Relationships," *Journal of Law, Economics and Organization* **12**, 214–33.

Kranton, R. and A. Swamy (1998). "The Hazards of Piecemeal Reform: British Civil Courts and the Credit Market in Colonial India," *Journal of Development Economics* **58**, 1–24.

McMillan, J. and C. Woodruff (1996). "Trust and Search in Vietnam's Emerging Private Sector," mimeo, Graduate School of International Relations and Pacific Studies, University of California, San Diego.

Mookherjee, D. and D. Ray (1999). "Persistent Inequality and Endogenous Investment Thresholds," mimeograph.

Piketty, T. (1997), "The Dynamics of the Wealth Distribution and the Interest Rate with Credit Rationing," *Review of Economic Studies* **64**, 173–189.

Rosenzweig, M. and H. Binswanger(1993). "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments," *Economic Journal* **103**, 56–78.

Shapiro, C. and J. Stiglitz (1984). Equilibrium Unemployment as a Worker Discipline Device, *American Economic Review* **74**, 433–444.

Siamwalla, A., C. Pinthong, N. Poapongsakorn, P. Satsanguan, P. Nettayarak, W. Mingmaneenakin, and Y. Tubpun (1993). "The Thai Rural Credit System adn Elements of a Theory: Public Subsidies, Private Information, and Segmented Markets," in K. Hoff, A. Braverman and J. Stiglitz (eds.), *The Economics of Rural Organization: Theory, Practice and Policy.* London: Oxford University Press (for the World Bank).

Stiglitz, J. and A. Weiss (1981). "Credit Rationing in Markets with Imperfect Information," *American Economic Review* **71**, 393–410.

Udry, C. (1994). "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria," *Review of Economic Studies* **61**, 495–526.