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Risk, Wealth and Sectoral Choice in Rural Credit Markets

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Selected Paper prepared for presentation at the American Agricultural Economics

Association Annual Meeting, Denver, Colorado, August 1-4, 2004

Abstract

We develop a model of sorting and matching between borrowers and lenders across formal and informal credit markets in a developing country context. We highlight the role of risk both on credit access and sectoral choice. We examine how activity and sectoral choice vary across agents with heterogeneous wealth endowments.

1 Introduction

In developing countries, informal and formal segments of credit markets coexist.¹ Despite the evolution of the role attributed to the informal sector from the exploitative moneylender to a potentially key agent for rural development (Von Pishke et al. 1983), the informal sector is still seen primarily as attending to the credit needs of borrowers shut out of the formal sector for lack of collateral assets.² Because they have ongoing economic and social relationships with community members, informal lenders have an informational advantage over more centralized formal banks. This advantage, which we can think of as more cost efficient technologies for screening, monitoring and enforcement, makes it possible for informal lenders to rely less on collateral to overcome the adverse selection and moral hazard problems implicit in credit transactions. While they may be able to make loans available to the asset poor when banks cannot, the cost may be high as informal lenders typically have high opportunity cost of liquidity and resources spent on screening and monitoring may be non-trivial. The large interest rate differentials that have been documented between the formal and informal sectors lend support to the view of the informal sector as recipient of the “spillover” demand from the formal sector: only borrowers shut out of the formal sector freely choose a more expensive informal loan (Barham et al., 1996; Conning 1996; Bell et. al. 1998).

There are important exceptions to this view. Naranong (1995), Chung (1993) and Kochar (1997), for example call for caution in the estimation of costs of loans and claim that, once transaction costs are accounted for, the informal sector may be able to offer loans that are actually cheaper than formal ones. Consequently some borrowers may prefer to borrow from the informal sector, even though they have access to a formal loan. Those analyses are important because they suggest that understanding the demand side of the market is crucial and that an informal borrower should not be automatically assumed to have no access to a formal loan.

In this paper we offer an alternative explanation of why some borrowers may find an informal loan more attractive than a formal one, even though informal loans are more expensive. In particular we relax

¹Much of the empirical evidence on formal-informal credit market interactions is focused on Asia. See, for example, Bell et al. (1997) and Kochar (1997) for India; Townsend (1995) for Thailand; and Floro and Yotopolous (1991) for the Phillipines. Recent studies in Latin America include Conning (1999) for Chile, Barham et al. (1996) for Guatemala and Trivelli (1998) for Peru.

²See Barham et al. (1996), Conning (1998) and Zeller (1994) for empirical evidence of wealth biased quantity rationing in the formal loan sector of developing countries.

the assumption - implicit in all the mentioned studies - that the choice across sector is based only on the monetary price of loan. We argue that the relevant cost differential across sectors is not in terms of expected income but instead expected utility. By limiting the analysis to the existence of a contract and a choice based only on expected return, the literature has left out a crucial dimension: the riskiness of the contract. Indeed under moral hazard the provision of the “right incentives” requires the agent to bear down-side risk by posting collateral for example. This gives rise to the classic trade-off between incentive provision and efficient risk-sharing. When a risk averse agent maximizes his expected utility, both the expected return and the distribution of the returns across states of nature (in other words, the degree of riskiness of the contract) are important. Boucher and Carter (2001) show - in a single loan sector - that a risk averse borrower who has access to an expected income enhancing contract may reject the contract and instead retreat to a certain, low return activity. This individual is qualified as “risk rationed.” Since most models of sectoral choice in credit markets are cast with risk neutral borrowers, they rule out any potential impacts of the incentive/risk-sharing trade-off on credit demand. However risk neutrality is not a reasonable assumption when dealing with poor farmers in rural areas of developing countries where insurance markets are underdeveloped. Accounting for risk aversion of borrowers adds an important dimension to the analysis of sectoral choice since the ability to overcome information asymmetries - and thus the degree of risk sharing in available contracts - may differ across sectors.

Understanding the relationship between the formal and informal sectors of the credit market is particularly relevant in the current policy context of liberalization of rural financial markets in Latin America. Expectations were high that these reforms would enhance both welfare and equity. Today however, rural poverty rates remain high and inequality in much of Latin America is rising (Londoño and Székely, 2001). This raises questions about the structure and functioning of the post-liberalization rural credit markets that have emerged in the region. Indeed one objective of these policies was - via credit and land market liberalization - to increase the poor’s access to formal credit. The prevalence of risk rationing would suggest, however, that an increased ability to post collateral (via land titling programs) may not translate into an increase in the poor’s willingness to participate in formal credit markets. These farmers may prefer to continue financing production with expensive but lower risk informal loans. In that case improvements

in insurance mechanisms may better serve the goal of raising efficiency and equity than policies aimed at increasing credit access via ‘collateralization’ of wealth.

The paper is structured as follow. In Section 2 we describe a model in which competitive, risk neutral lenders in both sectors face asymmetric information in the form of moral hazard over the risk averse borrower’s effort level. Informal lenders have a higher opportunity cost of capital, however they are able to monitor borrower effort levels at a lower cost than formal lenders. We show that the informal sector may both offer loans to borrowers who are shut out of the formal sector and be preferred by some borrowers who do have access to a cheaper formal loan. In Section 3 section we examine how the sorting and matching of borrowers and lenders depends on the wealth level of the borrower. While the impact of wealth on quantity rationing is straightforward, its impact on risk rationing and sectoral choice is more ambiguous as offsetting effects are at play. We develop intuitions regarding these effects and discuss the dependence of the results on borrower preferences. Finally we give some directions for future work.

2 Assumptions and Model Structure

2.1 Endowment, Technology and Preferences

In this section, we outline the key assumptions about preferences, technology and information and then describe the potential choices that agents may face. The model contains three types of actors: farmers, formal lenders, and informal lenders. Farmers are endowed with financial wealth, $W \in [\underline{W}, \overline{W}]$, which will be the sole source of heterogeneity. They are also endowed with two mutually exclusive income generating activities. The farmer’s fallback, or reservation, activity is to work as a wage laborer and earn a certain wage equal to w . Alternatively, the farmer can undertake risky own-farm production which requires a fixed investment, $K > W$. To capture uncertainty, we assume that gross farm revenues are X_g if the state of nature is “good” and X_b if the state of nature is “bad,” with and $X_g > K > X_b$. Note that farmers’ own wealth is less than the fixed capital requirement so that undertaking the risky project requires outside finance.

The agent potentially has three choices. The first is whether to undertake risky production or the certain

wage activity. If she chooses to farm, she faces two additional choices. First, if contracts are available, she must choose her source of financing between the formal versus informal credit sectors. Second, she must choose the level of effort, e , she applies to farming. The effort level - which we assume can be either high or low - affects welfare and choice in two ways. First, high effort increases the probability of the good state of nature and thus raises the expected project return. Letting p^H and p^L denote respectively the probability of the good state under high and low effort levels, this assumption implies: $p^H > p^L$. Let \bar{X}^H and \bar{X}^L denote expected gross revenues under high and low effort. To make the moral hazard story meaningful, we assume that expected farm returns under high effort are greater than the certain wage while under low effort expected farm returns are negative:

$$\bar{X}^H - K > w > 0 > \bar{X}^L - K \quad (\text{A1})$$

While high effort increases expected farm returns, it also causes disutility. To capture this, we assume the following additively separable utility function:

$$U(I, e, c) = u(I) - d(c; e) \quad (1)$$

The first term is the utility of income which we assume is increasing and concave. Income, I , in turn is composed of initial wealth plus the net income from the chosen activity - i.e., either the wage or the payoff from a credit contract. The second term is the disutility of effort which depends both upon the effort level chosen by the farmer and c , the resources devoted to monitoring by the lender in the case of farm production or the employer under the wage activity. By monitoring, the lender (or employer) can increase the farmer's disutility, for example by imposing social sanctions or negatively influencing the farmer's economic relationships in the community. As such, monitoring is only effective if the agent is exerting low effort. We also assume that, under low effort, the farmer's disutility is increasing at a decreasing rate in the amount of

monitoring. These assumptions are summarized by:

$$d(c; H) = \bar{d} \quad \forall c > 0 \quad (\text{A2})$$

$$d(c; L) < \bar{d} \quad \forall c > 0 \quad (\text{A3})$$

$$\frac{\partial d(c; L)}{\partial c} > 0; \quad \frac{\partial^2 d(c; L)}{\partial c^2} < 0 \quad \forall c > 0 \quad (\text{A4})$$

By raising disutility under low effort, monitoring reduces the farmer's incentive to shirk. Consider the following definition:

$$B(c) \equiv \bar{d} - d(c; L). \quad (2)$$

B is the farmer's private benefit of taking low instead of high effort. Given assumptions 2, 2, and 2 the monitoring technology is decreasing and convex in the lender's monitoring expenditures.

Finally, we assume that in a loan contract effort is private information and is non-contractible. If instead the farmer chooses the wage activity, she will always exert high effort. This assumption - which would be consistent with a piece-rate task or a job where the worker's effort is easily inferred by her output - is made so that we can focus our comparison of activities on the utility of income component of preferences.

The third choice the farmer makes is, again conditional on farming, the loan sector from which she will seek financing. The formal loan sector - corresponding to commercial banks - is characterized by centralized, regulated institutions with relatively little local information. Specifically, formal lenders will be unable to monitor borrowers in a cost-effective manner. The informal sector, corresponding to local economic actors such as agro-processing firms, input supply stores, and local merchants - have greater information and are able to monitor borrowers. As we will develop more concretely below, the ability to monitor will provide a means of reducing the incentive problem facing the informal lender and may make available contracts with lower collateral requirements. In addition to easing quantity rationing, the reduction in collateral allows more efficient risk sharing between borrower and lender and thus may induce some farmers to prefer the informal to formal contracts. The reduction in risk, however, comes at a cost as the informal lender's expenditures on monitoring must be compensated in the form of lower expected returns to the borrower. The net impact of lower risk versus higher cost will be explored in detail below.

2.2 The formal credit market

We now turn to describing the two different types of lenders and to characterizing the feasible contract set and the optimal contract in each case. Risk neutral, formal lenders offer loans to maximize expected profits, π^F . Formal lenders' gross opportunity cost of funds is equal to r^F . We make the stylized assumption that formal lenders do not have a monitoring technology or, equivalently that monitoring is prohibitively expensive for formal lenders, so that all formal sector contracts set $c = 0$. Let R_j^F be the the borrower's payoff from a formal sector contract under state j . A formal loan contract, then, is defined by the pair of state contingent borrower payoffs, (R_g^F, R_b^F) .³ We also assume that if the loan is financed, the lender provides the entire capital amount, K and the farmer does not use any of her own wealth.

We assume a competitive formal loan sector so that finding the optimal contract is a principal-agent problem in which the lender (principal) offers the feasible contract that maximizes the farmer's (agent) expected utility. A feasible contract must satisfy three constraints. First, it must be incentive compatible. Given the assumption of negative project returns under low effort, this requires:

$$EU(W + R_g^F, H, 0) > EU(W + R_b^F, L, 0) \quad (3)$$

or that the borrower finds it optimal to choose high effort. Letting $\Delta = p^H - p^L$ and rewriting this equation yields:

$$[u(W + R_g^F) - u(W + R_b^F)] \Delta \geq B(0) \quad (4)$$

Equation 4 is the *formal sector incentive compatibility constraint* (FICC), which guarantees that the expected utility gain from choosing high instead of low effort is greater than the disutility cost.

³Note that defining the borrower payoffs R_g^F and R_b^F is equivalent to the definition of an interest rate, r^F and a level of collateral, C^F :

$$\begin{aligned} R_g^F &= X_g - (1 + r^F)K \\ R_b^F &= X_b - C^F \end{aligned}$$

The second requirement of feasibility is that the formal lender's expected profits, π^F , are non-negative:

$$\pi^F \equiv p^H(X_g - R_g^F) + (1 - p^H)(X_b - R_b^F) - r^F K \geq 0 \quad (5)$$

Equation 5 states this constraint which we call the *formal sector participation constraint* (FPC). Finally, contracts must be financially feasible for the borrower. Specifically, contracts must satisfy the *limited liability constraint* (LLC) which states that borrowers cannot be made liable for an amount greater than their initial wealth:

$$R_j^F \geq -W; \quad \text{for } j = g, b \quad (6)$$

Let $V_F(W)$ be the borrower's formal sector value function - or the expected utility from the optimal formal sector contract for a borrower with wealth W :

$$V_F(W) \equiv \max_{R_g^F, R_b^F} EU(R_j^F, H, 0) \quad (7)$$

$$\text{subject to} \quad : \quad (8)$$

$$[u(W + R_g^F) - u(W + R_b^F)](p^H - p^L) \geq B(0) \quad (9)$$

$$p^H(X_g - R_g^F) + (1 - p^H)(X_b - R_b^F) - r^F K \geq 0 \quad (10)$$

$$R_j^F \geq -W; \quad \text{for } j = g, b \quad (11)$$

The solution to this problem is analyzed by Boucher et. al. (2004). The primary features of the problem and the implications of asymmetric information are illustrated in Figure 1. The axes represent the contractual payoff to the borrower under each state. The risk averse borrower's indifference curves are convex to the origin and are increasing to the northeast. The risk neutral lender's expected profit contours are straight lines and are increasing to southwest. The cross-hatched area gives the set of feasible contracts. Contracts must lie below the curve labeled FICC - which represents the locus of contracts such that the borrower is indifferent between high versus low effort. Contracts must lie to the SW of the curve labelled FPC -

which gives the locus of contracts yielding zero formal lender profits conditional on high effort. Finally, contracts must lie above the curve labelled LLC - which gives the maximum feasible collateral requirement for a borrower with wealth W .

The constrained optimal formal contract - if it exists - is unique and is found at the intersection of the FICC and FPC curves. The intuition behind the simultaneously binding constraints is straightforward. Consider first the FPC. If the lender were earning positive profits, he could slightly increase the borrower's payoff under success - thereby maintaining incentive compatibility - and make the borrower strictly better off. Similarly, if the FICC were not binding, the lender could slightly increase the borrower's payoff under failure while decreasing the payoff under success in a way that maintains constant the lender's profit. This would decrease the variability of the contract while holding the expected payoff constant and - given the borrower's risk aversion - would make her strictly better off.

The efficiency loss from asymmetric information is also easy to see in Figure 1. If the lender could costlessly enforce high effort, the optimal contract would be at point A and would provide the borrower full insurance. Under asymmetric information this contract is not available since the borrower's income would be independent of the state of nature and she would thus have no incentive to apply high effort. In order to induce the borrower to work hard, the lender must reward her under the good state of nature and punish her under the bad state of nature. We can easily observe this conventional trade-off between the provision of incentives and risk sharing in Figure 1. The presence of asymmetric information effectively 'removes' the contracts between points A and B from the feasible set. These contracts force the borrower to bear insufficient risk - and therefore do not provide her sufficient incentive to choose high effort.

Figure 1 also demonstrates the potential for non-price rationing in credit markets. If the incentive problem is sufficiently severe such that the FICC intersects the FPC curve at a point such that the value of that the collateral requirement exceeds the farmer's wealth (i.e., to the SE of point C) then the feasible contract set would be empty and the farmer would be forced into the low return reservation activity. This is the case of moral hazard induced quantity-rationing which is well known in the literature (Stiglitz and Weiss 1981, Carter 1988).

Even if the feasible set is not empty, however, asymmetric information can drive the borrower to choose

the reservation activity instead of the more lucrative farming activity. In Figure 1, this “risk rationing” outcome would obtain if the farmer’s indifference curve through the optimal contract at point B crosses the 45-degree line at a value below w . In this situation, the certainty equivalent of the optimal contract is less than the certain reservation wage.

2.3 The informal credit market

As in the case of the formal sector, we assume informal lenders are risk neutral and competitive. An informal lender differs from a formal one in two ways. First $r^I > r^F$, so that the informal lender’s cost of funds is higher than the formal lender’s so that an informal loan will always be more expensive than a formal one. Second, informal lenders have access to the monitoring technology described above. Thus in addition to the borrower’s state contingent payoffs, R_j^I , an informal contract also specifies a level of monitoring, c . As in the formal sector, an informal loan contract will always induce high effort.

Let $V_I(W)$ be the farmer’s informal sector value function:

$$V_I(W) \equiv \max_{c, R_j^F} EU(R_j^F, H, c) \quad (12)$$

$$\text{subject to} \quad : \quad (13)$$

$$[u(W + R_g^I) - u(W + R_b^I)] \Delta \geq B(c) \quad (14)$$

$$p^H(X_g - R_g^I) + (1 - p^H)(X_b - R_b^I) - r^I K \geq c \quad (15)$$

$$R_j^I \geq -W; \quad \text{for } j = g, b \quad (16)$$

Note the inclusion of the monitoring cost in the informal lender’s participation constraint, IPC and the borrower’s informal sector incentive compatibility constraint, IICC.

How does the availability of the monitoring technology affect the set of contracts the informal lender can make available? By looking at equation 14, $B' > 0$ implies that an increase in monitoring relaxes the IICC and permits a reduction in contractual risk or, equivalently, a smoothing of consumption across states.

However, relative to the reduction in expected consumption accompanying additional monitoring, this risk reduction may be insufficient to allow the informal sector to relax the quantity and risk rationing in the formal sector. A necessary condition for the informal sector to be relevant is that the collateral requirement of the optimal contract be decreasing in monitoring over some range of monitoring levels. Whether or not an increase in monitoring decreases the collateral requirement depends on two factors. First, a large B' - or large reduction in the private benefit of low effort - leads to a large reduction in the utility differential across states. A given decrease in the utility differential, in turn, will translate into a reduction in collateral if utility in the good state is not very sensitive to a reduction in consumption. A necessary and sufficient condition for an increase in monitoring to lead to a reduction in the collateral requirement is:

$$\frac{u'(W + R_g^I)}{p^H} \leq \left| \frac{B'(c)}{\Delta} \right| \quad (17)$$

This condition says that the collateral requirement will decrease if the marginal utility in the good state is small enough such that if R_g^I were reduced by $1/p^H$ while R_b^I remained unchanged the decrease in the utility differential is less than B'/Δ .⁴

Let the *informal contract set* (ICS) represent the set of optimal contracts conditional on a level of monitoring. Without making additional assumptions regarding preferences and the monitoring technology, the shape of the informal contract set can take multiple forms, two of which are depicted in Figure 2. To develop intuitions, first consider the left hand panel of Figure 2 which depicts the ICS for a risk neutral borrower. Under risk neutrality, the LHS of equation 17 is constant while the RHS is decreasing in c . Thus initial increases in monitoring - since they give large decreases in the private benefit of shirking - lead to a decreasing collateral requirement. As diminishing returns to monitoring set in, however, and the RHS falls below the LHS, additional expenditures in monitoring beyond c^{\max} raise the collateral requirement. Formally, c^{\max} is the value of monitoring such that equation 17 holds with equality.⁵ This portrayal of monitored lending with risk neutral lenders was developed by Conning (1996, 1999). Under risk neutrality,

⁴In other words, the unit reduction in expected consumption required such that IPC continues to bind when monitoring expenditures are increased by \$1 is achieved by only reducing consumption under success.

⁵While risk neutrality implies a concave ICS, it does not imply an upward sloping section. A necessary and sufficient condition for an initially decreasing collateral requirement is that $\frac{u'(W+R_g^I)}{p^H} \leq \left| \frac{B'(0)}{\Delta} \right|$.

the borrower's indifference curves are straight lines - coinciding with the lender's expected profit contours - so that the optimal contract will always be at the minimum monitoring level consistent with the borrower's wealth.

Note that - as drawn in Figure 2 - the ICS crosses the horizontal axis so that there would never be quantity rationing in the informal sector. Let $R_b^{I^{Max}}$ be the payoff in the bad state under the optimal contract with $c = c^{\max}$. Then $-R_b^{I^{Max}}$, the minimum collateral requirement in the informal sector, can be either positive or negative and the turning point of the ICS could instead be below the horizontal axis implying a positive collateral requirement so that quantity rationing may occur even in the informal sector. We will make the following assumption throughout:

$$-R_b^{I^{Max}}(W) < W \quad (\text{A5})$$

Assumption A5 ensures that quantity rationing will never occur in the informal sector.

The shape of the ICS under risk aversion is less straightforward. The reason is that marginal utility is not constant so that the impact of monitoring on the collateral requirement depends both on the convexity of $B(\cdot)$ and the concavity of utility. The main implication is that - in contrast to the risk neutral ICS which is everywhere concave - the risk averse ICS may be initially convex before turning concave. To see this, assume that for a given monitoring level, equation 17 holds. The amount by which the collateral requirement decreases depends upon marginal utility the bad state. Since marginal utility is decreasing in income, the collateral requirement may need to decrease at an increasing rate to maintain a binding IICC. The right hand panel of Figure 2 shows this case.

Ignoring the liability constraint, the optimal informal contract under risk aversion will be the point on the ICS that yields highest expected borrower utility. Since borrower indifference curves are convex, the optimal contract can either be an interior solution - depicted by the contract at point A in Figure 2 - or a corner solution at zero monitoring. If the liability constraint is violated at A - i.e. $W < -R_b^{I^*}$ - then the optimal contract would occur at the point on the ICS with $r_b = -W$. In this case, the borrower's lack of collateral wealth obliges her to accept a contract with "too much" insurance.

2.4 Two potential roles of informal sector

Given this stylized portrayal of the two loan sectors, we now take up the question of sectoral choice. Specifically, we want to think about why individuals would end up with an informal loan. As stated in the introduction, there are three main answers to this question. The first is that the informal sector is the lowest cost source of funds. This may be, as found by Kochar (1997) in India, because family and friends are willing to offer loans with very low or zero nominal interest rates. Alternatively, in spite of higher nominal interest rates, the relatively low transaction costs of informal loans make their effective cost lower. In our context, however, we observe the more conventional result that informal loans are quite a bit more expensive - even accounting for transaction costs. Thus we explore two alternative explanations: namely that the informal sector may relax both quantity and risk rationing in the formal sector.

We portray these two possibilities in Figures 3 and 4. First consider Figure 3 which shows the case of a farmer who resorts to the informal sector because she is shut out of the formal sector. As depicted, the farmer's feasible contract set in the formal sector is empty. The minimum collateral, incentive compatible formal contract is at point A , which requires collateral greater than the farmer's wealth, W . This farmer is quantity rationed in the formal sector. The optimal informal contract is at point B . Recall that the ICS represents the set of optimal contracts conditional on the monitoring level. Given the tangency between the farmer's indifference curve and the ICS, point B , is the best of these conditionally optimal contracts and is feasible since it requires collateral less than W . As drawn, the farmer would prefer this informal contract to the reservation activity since the indifference curve through B intersects the 45-degree line to the NE of the fixed wage, w . Equivalently, the certainty equivalent of the optimal informal contract is greater than the reservation wage. This corresponds to the informal sector as recipient of "spillover" demand from the formal sector. The farmer would prefer to borrow from the formal sector (indifference curve through A is above the curve through B) but is denied the formal loan and must "settle" for the informal loan.

Figure 4 depicts the case of a farmer who instead *chooses* to borrow from the informal sector even though a formal contract is available. In this case, even though the optimal informal contract at B yields lower expected income, it implies sufficiently lower risk (offers sufficient insurance) such that it is strictly preferred to both the formal contract and the reservation activity. Note that without the informal sector, this farmer

would be risk-rationed in the formal sector since the certainty equivalent of the optimal formal contract at A is less than w .

3 Wealth, optimal contract and activity choice

Now that we have depicted the two potential roles of the informal sector - we turn to the question of for whom does the informal sector play these roles? Specifically, we want to see:

1. Who is excluded from the formal sector and informal sectors?
2. Of those excluded, who chooses an informal loan instead of the reservation activity?
3. Of those who have access to both a formal and informal contract, who chooses the informal contract?

In all of the ensuing analysis, by “who” we explicitly mean farmer wealth.

3.1 Wealth biased quantity rationing

Here we answer question 1. It is intuitive that if anyone is quantity rationed in the formal sector, it will be the relatively poor who have insufficient wealth to post as collateral. That quantity rationing in the absence of monitoring is wealth-biased has been established by Boucher et. al. (2004). We briefly discuss the logic here because the result is not as obvious as it may first appear because the endogeneity of contract terms to farmer wealth implies offsetting wealth effects in the availability of a contract. On one hand, an additional dollar of wealth relaxes the liability constraint and allows a wealthier farmer to post greater collateral. On the other hand, the collateral requirement is increasing in wealth because as wealth increases, a risk averse farmer becomes less sensitive to a given spread in consumption across states. Thus the lender will raise the collateral requirement to maintain incentives for the farmer to choose high effort. Boucher et. al. show that the relaxation of the liability constraint dominates the tightening of the incentive compatibility constraint so if anyone is quantity rationed, it will be the relatively poor.

Let W_F^* denote the wealth level such that all three constraints simultaneously bind and a single formal contract is available. It is easy to show that, if it exists, W_F^* is unique so that any farmer with wealth greater than W_F^* will have a formal contract available while those with wealth less than W_F^* will be quantity rationed.

The following conditions are necessary and sufficient for $W_F^* \in [\underline{W}, \overline{W}]$:

$$\begin{aligned} B(0) &> \Delta u \left(\frac{\underline{W} + \overline{X}^H - K}{p^H} \right) \text{ and} \\ B(0) &> \Delta u \left(\frac{\overline{W} + \overline{X}^H - K}{p^H} \right) \end{aligned}$$

Under assumption A5, farmers that are quantity rationed in the formal sector will always have access to an informal loan. So we have seen that any farmer with $W > W^*$ will have access to contracts in both sectors. In the next section, we see how - for wealth levels above W^* - wealth endowments map into activity choice.

3.2 Wealth and Risk Rationing

Understanding activity choice requires a comparison across three activities. We proceed as follows. First, we compare the best available contract in each sector to the reservation activity. When both contracts are preferred to the reservation activity, we need to compare farmer welfare in each sector.

3.2.1 Reservation activity versus formal loan

In this section we ignore quantity rationing (i.e., assume we're dealing with $W > W^*$) and focus on the role of wealth in the comparison between financing production with a formal contract versus the wage activity. Stated another way - we examine the wealth effect in a principal-agent model. Several papers have shown the rather counter-intuitive result that higher wealth farmers (agents) are more likely to choose the reservation activity. We review this argument in the current model.

Figure 5 shows the multiple and offsetting effects of wealth on the farmer's activity comparison. First, assuming decreasing absolute risk aversion, the borrower becomes less risk averse. Therefore, holding contract terms fixed, the certainty equivalent of a given contract increases in wealth. We call this effect the *risk aversion effect* which implies that if a borrower is indifferent between the formal contract and reservation activity, an increase in wealth - holding contract terms constant - leads her to strictly prefer the formal contract. In Figure 5 the farmer's indifference curve through the optimal contract at A flatten out as wealth

increases so that it crosses the 45-degree line at D , to the NE of the reservation wage.

The contract terms, however, do not remain constant as wealth increases. This is the result of the *incentive effect* rooted in the concavity of the utility function, which implies that a wealthier borrower is less sensitive to a given difference in contractual payoffs across states. Consequently, he cares less about being in the bad rather than the good state and, thus, has less incentive to increase the probability of success by choosing high effort. To counter this negative incentive effect, the lender has to increase the difference between success and failure payoffs. As a consequence the incentive effect negatively impacts the risk averse borrower. In figure 5, the worsening of contract terms is given by the SE shift of the optimal contract from A to B .

What is the net result of these opposing effects? In Figure 5, the risk aversion effect dominates so that it is the relatively poor who are risk rationed while the wealthy accept the contract and undertake risky farming. We could, however, draw the picture to show the opposite result. Ultimately, the relative size of these effects depends on the assumptions made about preferences. There are two relevant papers that derive sufficient conditions to answer this question. Newman (1995) - in an application to insurance markets and activity choice - shows that a sufficient condition for the incentive effect to dominate is that $\frac{1}{u'}$ is convex. Thiele and Wambach (1999) re-examine this issue in a more general optimal labor contract context with the principal having full market power (i.e. similar to Grossman and Hart (1983)) and derive a slightly less restrictive sufficient condition. Let P and A denote respectively the coefficient of absolute prudence and risk aversion. Consider the following 2 conditions:

$$\text{Condition 1:} \quad P < 3A \quad (18)$$

$$\text{Condition 2:} \quad P > 3A \quad (19)$$

Condition 1 is Thiele and Wambach's sufficient condition for the dominance of the incentive effect. In our context, Condition 1 is sufficient for the counter-intuitive result that wealthier households are more likely to be risk rationed. Condition 2 is sufficient for the more intuitive wealth-biased risk rationing to occur.

Proposition 1 summarizes these results.

Proposition 1 *Wealth biased formal risk rationing. Let \widehat{W}_F denote the wealth level of the agent who is indifferent between financing the risky investment with her optimal formal contract versus the certain reservation activity and let $CE^F(W)$ denote the certainty equivalent associated with the optimal contract for an agent with wealth W in the formal sector so that:*

$$V_F(\widehat{W}_F) = u(\widehat{W}_F + CE(\widehat{W}_F)) = u(\widehat{W}_F + w) \quad (20)$$

Then $P > (<)3A \rightarrow \frac{\partial CE}{\partial W} > (<)0$ so that any agent with wealth greater than (less than) \widehat{W}_F will strictly prefer the risky investment with their optimal formal contract while agents with wealth less than (greater than) \widehat{W}_F prefer the reservation activity.⁶

The first equality in equation 20 implicitly defines the certainty equivalent associated with the marginal farmer's optimal formal contract. The second equality follows from the definition of the marginal wealth level - and implies that the indifferent farmer's certainty equivalent is just equal to the fixed wage.

In general, which comparative static result do we expect to hold? Without additional assumptions about $u(\cdot)$ then the relationship between P and A depends on the value of consumption at which these functions are evaluated. Thus, while DARA implies that $P > A$, whether or not condition 1 or condition 2 holds at $\widehat{W}_F + w$ is not clear and depends on the other parameters of the model. If, however, we restrict attention to the class of constant relative risk averse preferences, then knowing the degree of relative risk aversion is sufficient to know which of the two conditions holds. Specifically, if r is the coefficient of relative risk aversion, then $r < 1/2$ is equivalent to $P > 3A$.⁷ Restricting attention to constant relative risk aversion, thus has strong implications for the direction we would expect to observe for risk rationing. Empirical studies such as those cited in Gollier (2001), for example, suggest that plausible values for r lie between 1 and 4. This would imply that condition 1 holds so that the wealthier households are risk rationed.

⁶ proofs for all propositions are available by request.

⁷This is because CRRA implies a constant ratio of P/A . Specifically:

$$\frac{P}{A} = \frac{1+r}{r}$$

3.2.2 Reservation activity versus informal loan

What about risk rationing in the informal sector? In the informal sector, the agent has the possibility of choosing the level of monitoring, and we argued that - to some extent - this enables the agent to trade risk against expected income. As wealth increases we argued that the “incentive effect” requires the difference in payoffs between the good and the bad state to increase in order for contracts to remain incentive compatible. The choice over c enables the agent to potentially mitigate this increase in risk by choosing a higher level of monitoring. However this additional flexibility does not change the direction of the risk rationing result established for the formal sector. In fact, under the same assumptions about the utility function the same results hold. We restate these results in the following proposition.

Proposition 2 *Wealth biased informal risk rationing. Restrict attention to CRRA utility functions. Let $CE^I(W, c)$ denote the certainty equivalent associated with the optimal contract at the level of monitoring c for an agent with wealth W in the informal sector. Define $c^*(W)$ as the optimal level of monitoring in the informal sector for an agent with wealth W . Let \widehat{W}_I denote the wealth level of the agent who is indifferent between financing the risky investment with her optimal informal contract versus the certain reservation activity so that:*

$$V_I(\widehat{W}_I) = u\left(\widehat{W}_I + CE\left(\widehat{W}_I, c^*(\widehat{W}_I)\right)\right) = u\left(\widehat{W}_I + w\right) \quad (21)$$

Then $P > (<)3A \rightarrow \frac{\partial CE}{\partial W} > (<)0$ so that any agent with wealth greater than (less than) \widehat{W}_I will strictly prefer the risky investment with their optimal informal contract while agents with wealth less than (greater than) \widehat{W}_I prefer the reservation activity.

The logic behind the proof is straightforward. Consider condition 2, i.e. $P > 3A$. By definition, the optimal contract is the one with the highest certainty equivalent. Let $c^*(\widehat{W})$ denote the optimal monitoring level in this contract. Now consider an increase in wealth from \widehat{W} to W' . Under CRRA, we know that if we keep the monitoring level at $c^*(\widehat{W})$, the new certainty equivalent, $CE\left(W', c^*(\widehat{W})\right)$ will be greater than $CE\left(\widehat{W}, c^*(\widehat{W})\right)$. Since the certainty equivalent of the new optimal contract is at least as large as $CE\left(W', c^*(\widehat{W})\right)$, the wealthier farmer will strictly prefer farming with the informal contract to the

reservation activity.⁸

Even though monitoring does not reverse the direction of the wealth bias, the monitored informal sector may still alleviate the risk rationing problems of the formal sector. Consider CRRA utility functions and assume that condition 2 holds. We established that in this case, if $W < \widehat{W}_F$ then the agent prefers the fixed wage activity to a formal loan while if $W > \widehat{W}_I$ then the agent prefers an informal contract to the fixed wage activity. This suggests that if $\widehat{W}_I < W < \widehat{W}_F$ then this relatively poor agent would retreat to the fixed wage if she had access only to a formal loan while in the presence of the informal sector she chooses to undertake the project with an informal loan. If instead condition 1 holds, the informal sector may similarly alleviate risk rationing of rich agents. We will discuss the conditions necessary for the informal sector to play this role below. Until now we have focused on the agent's comparison between a loan in each sector and the reservation activity. The final piece of the analysis - which will permit us to map sectoral and activity choice in wealth space - is to compare the relative attractiveness of the optimal formal versus informal contracts.

3.3 Comparison across sectors

We now ask who is more likely to prefer an informal loan over a formal one conditional on positive access in both sector. Since an informal loan is both less risky and more expensive than a formal loan, it is closer to the fix wage activity in term of risk and expected return. Therefore our intuition suggests that, under condition 2 (that led to risk rationing of the poor), a poor agent is more likely to prefer an informal loan, while under condition 1 the opposite holds (the rich are more likely to prefer the informal loan). Indeed this intuition holds and is summarized in the following proposition:

Proposition 3 *Sectoral choice. Restrict attention to CRRA utility functions. Let $\widehat{W}_{I/F}$ denote the wealth level of the agent who is indifferent between financing the risky investment with her optimal informal contract versus her optimal formal contract so that:*

$$V_I(\widehat{W}_{I/F}) = u\left(\widehat{W}_{I/F} + CE^I\left(\widehat{W}_{I/F}, c^*(\widehat{W}_{I/F})\right)\right) = V_F(\widehat{W}_{I/F}) = u\left(\widehat{W}_{I/F} + CE^F\left(\widehat{W}_{I/F}\right)\right) \quad (22)$$

⁸If we relax constant relative risk aversion, then we are not sure what happens. The reason is as follows. While we know that either condition 1 or 2 will hold at the optimal monitoring level, the same condition need not hold at other monitoring levels. Thus the certainty equivalent at different monitoring levels may move in opposite directions as wealth increases. In future research, will explore this more.

Then if $P > (<)3A$ any agent with wealth greater than (less than) $\widehat{W}_{I/F}$ will strictly prefer the formal contract while agents with wealth less than (greater than) $\widehat{W}_{I/F}$ prefer the informal contract

This last proposition enables now a complete mapping of activity preferences over the wealth spectrum. In the following discussion we assume that the three indifferent wealth level (\widehat{W}_F , \widehat{W}_I and $\widehat{W}_{I/F}$) lie within the wealth support $[\underline{W}, \overline{W}]$.

Assume condition 1 holds. Propositions 1 and 2 establish that the value functions V_F and V_I cross V_w (the utility of the agent in the reservation activity) from above at \widehat{W}_F and \widehat{W}_I respectively. Proposition 3 establishes that V_F crosses V_I from above at $\widehat{W}_{I/F}$. Furthermore since V_F , V_I and V_w are all strictly increasing in wealth, and the direction of the crossing is unambiguous at each crossing point, the crossing points are unique. The relative position of \widehat{W}_I and $\widehat{W}_{I/F}$ is crucial for the prediction of activity choice. If $\widehat{W}_{I/F} > \widehat{W}_I$, the informal sector would never be chosen. If $\widehat{W}_{I/F} < \widehat{W}_I$ agents with wealth in the intermediate range $\widehat{W}_{I/F} < W < \widehat{W}_I$ will choose the entrepreneurial activity financed by an informal loan. Figure 6 illustrates this case. Similarly under condition 2, the informal sector is chosen by some agents only if $\widehat{W}_{I/F} > \widehat{W}_I$. Figure 7 illustrates this case. Let us briefly discuss what the relative position of $\widehat{W}_{I/F}$ and \widehat{W}_I depends upon. In addition to preferences, the level of the fixed wage and the relative attractiveness of the contracts in each sector determine the relative position of $\widehat{W}_{I/F}$ and \widehat{W}_I . The informal sector is relatively more attractive as its reservation cost of funds decreases and the efficiency of monitoring increases.

In this model the presence of the informal sector relaxes risk rationing in the formal sector for some agents. As depicted in Figures 6 and 7, for whom the informal sector relaxes risk rationing depends on preferences. Figure 6 portrays the empirically more plausible case where condition 1 holds. In this case, in the absence of the informal sector, agents with wealth between \widehat{W}_F and \widehat{W}_I would be risk rationed. The availability of less risky informal contracts induces this additional group of agents to undertake risky production. In this case - relative to the formal sector - the informal sector induces wealthier agents to undertake production. Figure 7 portrays the more intuitive results that hold under the empirically less plausible condition 2. In this case, the informal sector relaxes risk rationing for relatively poorer agents.

We have now studied the impact of wealth successively on access to a loan, on preference for a risky activity over a certain activity and on preference for a formal versus a informal loan. We will now summarize

the predictions of our model in terms of the partitioning of wealth space into the different activities when both supply (quantity rationing) and demand (risk rationing) are accounted for.

3.4 Bringing supply and demand together: mapping of activities in wealth space

We present here a brief summary of the predictions of the model as well as numerical simulations. Recall that some agents may lack access to a formal loan because they cannot post sufficient collateral. These agents are quantity rationed in the formal sector. We argued that if some agents are excluded from the formal sector they are at the low end of the wealth spectrum and gave conditions under which this occurs. To make the supply issue relevant we assume now that these conditions hold, so that $W_F^* \in [\underline{W}, \overline{W}]$ and agents with wealth W smaller than W_F^* do not have access to a formal loan.

Assume again that \widehat{W}_F , \widehat{W}_I and $\widehat{W}_{I/F}$ are in the wealth spectrum $[\underline{W}, \overline{W}]$. The impact of quantity rationing depends upon the position of W_F^* relatively to the various indifference points. A complete description of all possibilities would be cumbersome so that we simulate and discuss only two cases.

Figure 8 presents results of a numerical simulation for preferences such that condition 2 holds and $W_F^* < \widehat{W}_F < \widehat{W}_{I/F}$. The parameters used in the simulation are given in Table 1. The figure plots differences between the three value functions ($V_w - V_F$, $V_w - V_I$, and $V_I - V_F$) against wealth and activity choices are reported under the graph. First note that $W_F^* < \widehat{W}_F$ implies that nobody who is denied a formal loan would want one, thus the informal sector is not the recipient of the spill-over demand. It does however alleviate risk rationing in the formal sector for agent with wealth between \widehat{W}_I and \widehat{W}_F who, in the absence of the informal sector, would not undertake the project.

Figure 9 shows what happens when condition 1 instead holds. For the parameter value chosen (Table 1), the following relationship holds: $W_F^* < \widehat{W}_{I/F} < \widehat{W}_I$. In this case, the informal sector plays both roles. Since condition 1 holds, agents with wealth less than \widehat{W}_F would prefer a formal loan to the reservation activity, thus the poorest are quantity rationed in the formal sector and recur to the informal sector to finance their project. Furthermore, since condition 1 holds, the informal sector relaxes risk rationing for the relatively wealthy, i.e. those with wealth between \widehat{W}_F and \widehat{W}_I .

4 Conclusions and a Sketch of a Model Extension

In this paper, we have developed a model which suggests a re-evaluation of the role of the informal loan sector. The informational advantage of informal lenders is portrayed as the ability to monitor borrowers. Monitoring, by limiting the private benefit the borrower perceives by shirking (i.e., choosing low effort) reduces the incentive problem and allows for contracts with lower collateral. This enables informal lenders to serve two types of clients: 1) Those who *cannot* post the collateral required by the formal sector; and 2) Those who are able but *do not want* to post collateral. The model is thus consistent with the conventional view of the informal sector as recipient of spillover demand (quantity rationed) from the formal sector. It also demonstrates an additional role of the informal sector - namely as provider of insurance as the lower collateral requirement implies greater consumption smoothing across states of nature. This potential insurance role may especially help in understanding the prevalence of informal loans in rural areas of developing countries where risk is high and insurance markets are virtually non-existent. It also suggests that policies such as land titling programs which seek to activate credit market participation by augmenting the poor's ability to post collateral may fall short of their objective.

Under empirically plausible preferences (constant relative risk aversion greater than $1/2$), the model generates a counter-intuitive result: namely that the beneficiaries of the insurance provided by the informal sector are the relatively wealthy. In a related paper applied to occupational choice, Newman (1995) concludes that this type of model would lead to the conclusion that the poor would become entrepreneurs and hire-in the rich as wage laborers. If we are to trust our intuitions, we must conclude that the current model somehow fails to capture important components of reality. One possibility, as explored by Thiele and Wambach (1999), is to relax the assumption of additive separability between consumption and effort. For example, if the disutility of effort were decreasing in consumption (a nutrition based argument could be used, for example, to suggest that exerting additional effort is more costly for the extreme poor) then the incentive problem would become less severe as agent wealth increased making it more likely that wealthy agents accept their optimal contract and undertake the high return productive activity.

An alternative approach is to acknowledge the heterogeneity of types of wealth. Our model has implicitly held project size - or productive wealth - constant while allowing only heterogeneity in liquidity. In developing

countries, land endowments vary widely within regions. In terms of our model, why would the difference between financial wealth (W) and land wealth matter? Consider the thought experiment we have conducted throughout the paper. We have held farm size constant and increased financial wealth so that financially wealthier agents become less sensitive to the outcome of their farm. To make the agent care about the outcome, lenders respond by shifting disproportionately large downside risk to the agent. In contrast, as her land wealth increases the agent naturally has greater incentive to work hard and increase the probability of the good state of nature because, for a given contract, the spread in consumption across states increases. In addition, the expected consumption foregone by choosing the reservation activity increases in farm size. These impacts both work towards the more intuitive result that wealthier agents are more likely to undertake the risky productive activity.

Figure 10 shows what happens when we introduce heterogeneity in farm size by mapping activity choice in two-dimensional wealth space. The parameters of the simulation are given in Table 1. As before, the activity choices are to finance production on the entire farm with either a formal or informal loan or rent out the entire farm. A CRRA utility function was chosen with a plausible coefficient of relative risk aversion equal to 1.2. While the counter-intuitive direction of risk rationing holds in a vertical (increasing W) direction, it is reversed in the horizontal direction. so that land poor households are more likely to be risk rationed while the land rich undertake production. While future work will need to relax some of the restrictive modeling assumptions, this analysis suggests that heterogeneity of asset types controlled by an individual - as well as heterogeneity of total wealth across individuals - is important in understanding credit market participation and the way which individuals utilize their productive assets.

Appendix: Tables and Figures

Table 1: functional forms and parameter for the simulations

Simulation 1, 2 & 3	
Utility of consumption (CRRA with r: coef. Of relative risk aversion)	$u(x)=(1/(1-r))x^{\{(1-r)\}}$
Disutility of effort B(c)	$B(c)=(a+b*c)^{-1}$

parameters	Simulation 1	Simulation 2	Simulation 3
coef of RRA r	0.4	1.2	1.2
Parameter of B: a	10	2/3	2
Parameter of B: b	1/15	1/5	2
Gross return from project	70	70	70
Capital requirement, K	55	55	55
Fixed wage, w	7.87	0.5	3 (rental rate)
Proba state G with effort H	0.8	0.8	0.8
Diff in proba good state, Δ	0.7	0.7	0.7

Simulation 1, 2 & 3		
Sector	Formal	Informal
Opportunity cost of fund	1.073	1.09
Net return from the project	11	10

Figure 1: Formal Sector Feasible Set and Optimal Contract

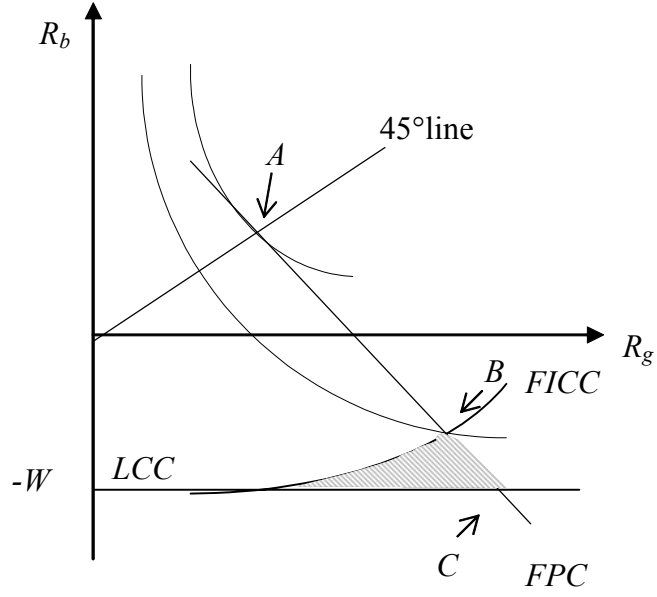


Figure 2: Informal Contract Sets and the Optimal Informal Contract

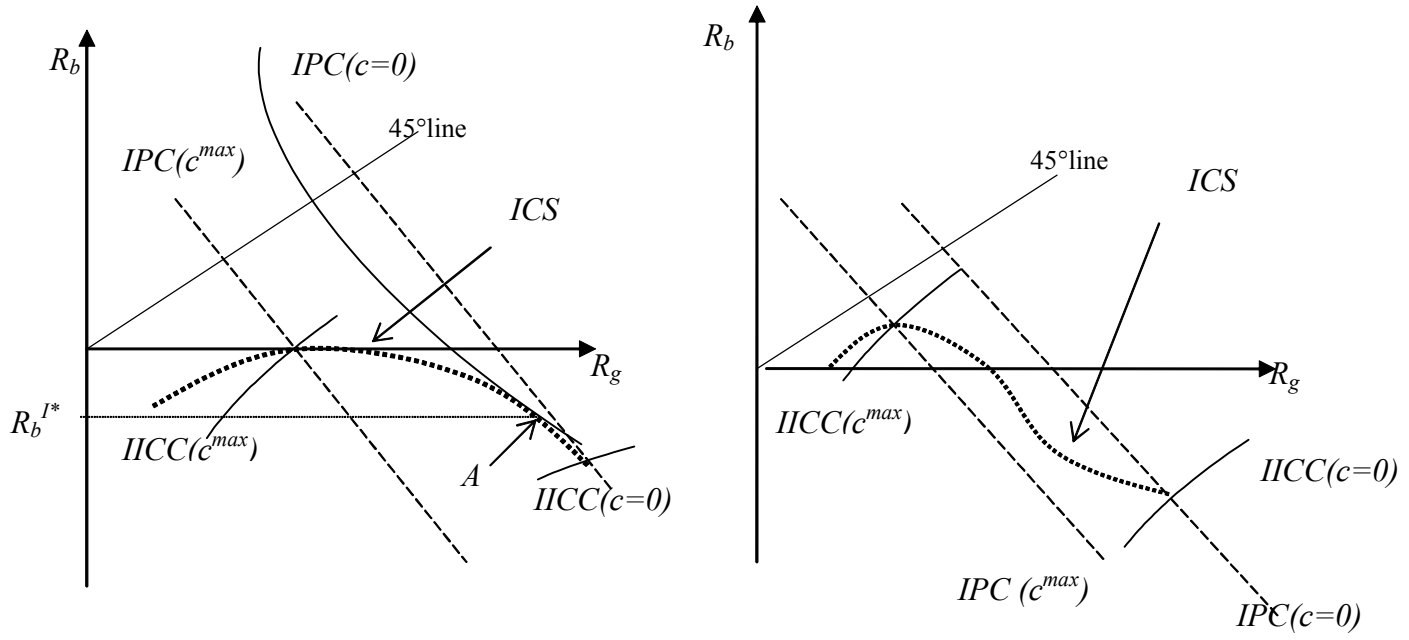


Figure 3: Informal sector can relax quantity rationing in the formal sector

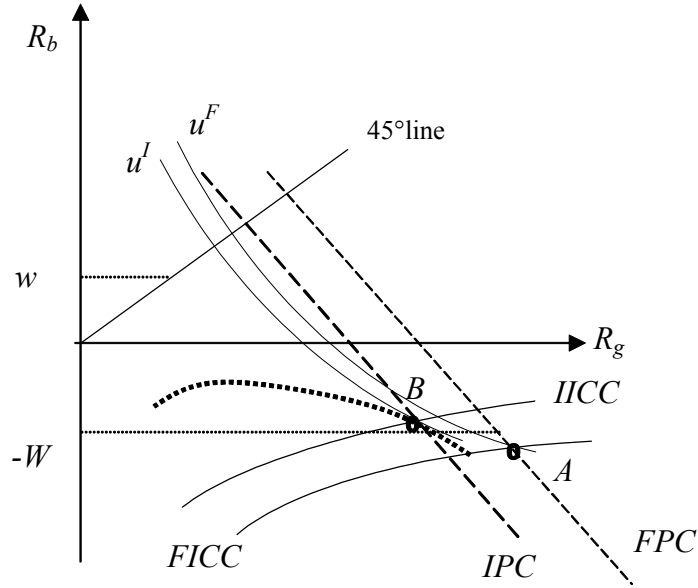


Figure 4: Informal sector can relax risk rationing in the formal sector

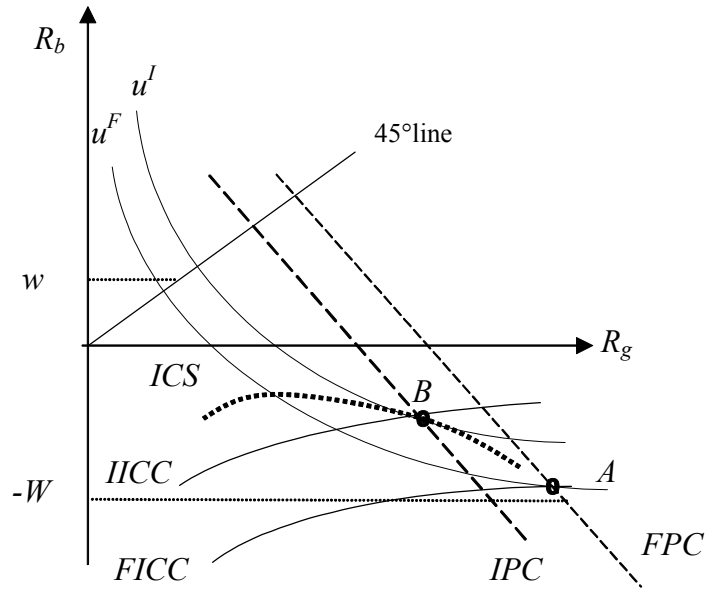


Figure 5: Higher wealth farmers are risk rationed

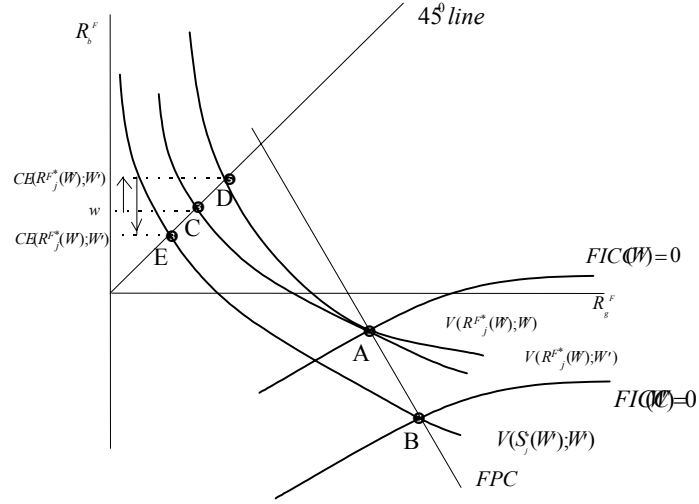


Figure 6: Activity preferences under $P < 3A$ and $\widehat{W}_{I/F} < \widehat{W}_I$

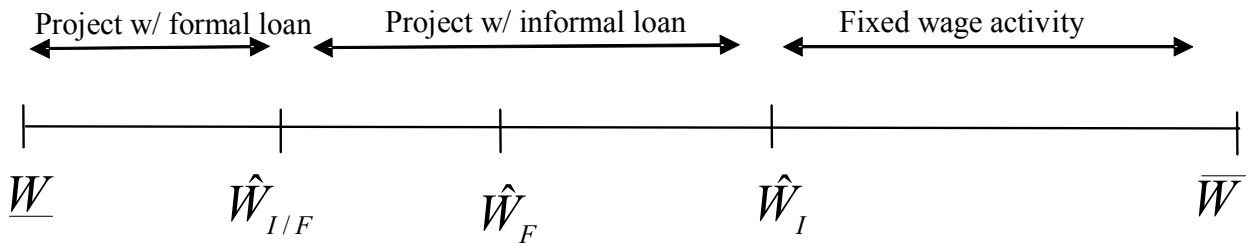


Figure 7: Activity preferences under $P > 3A$ and $\hat{W}_I < \hat{W}_{I/F}$

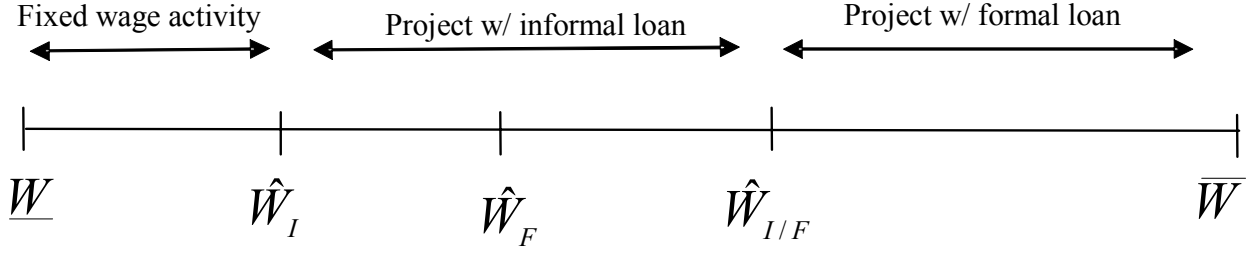


Figure 8: Activity choice and credit market outcomes under $P > 3A$: Simulation 1

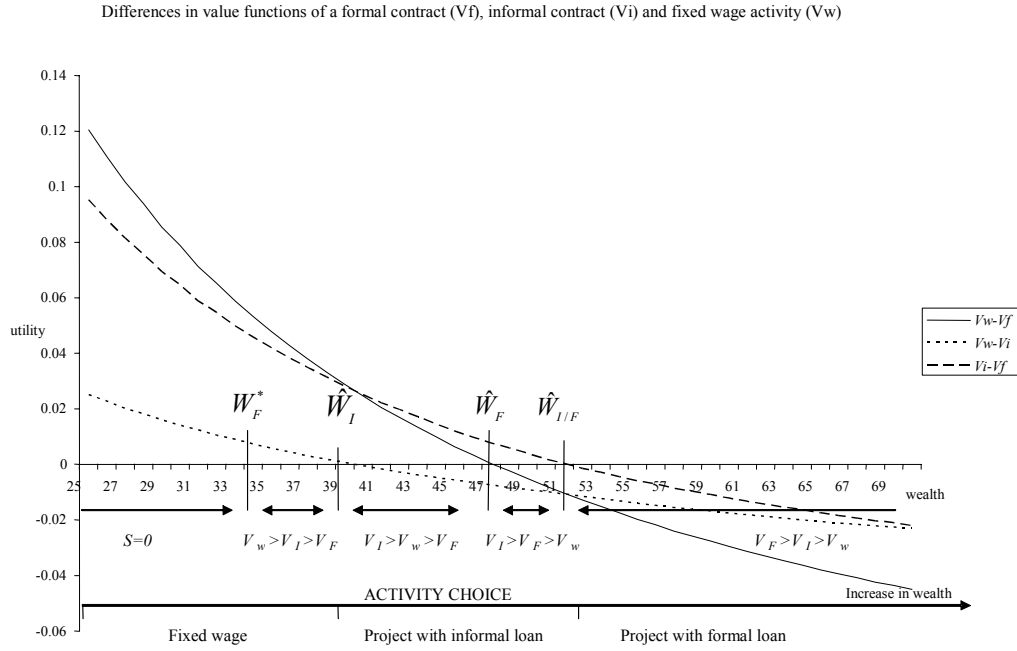


Figure 9: Activity choice and credit market outcomes under $P < 3A$: Simulation 2

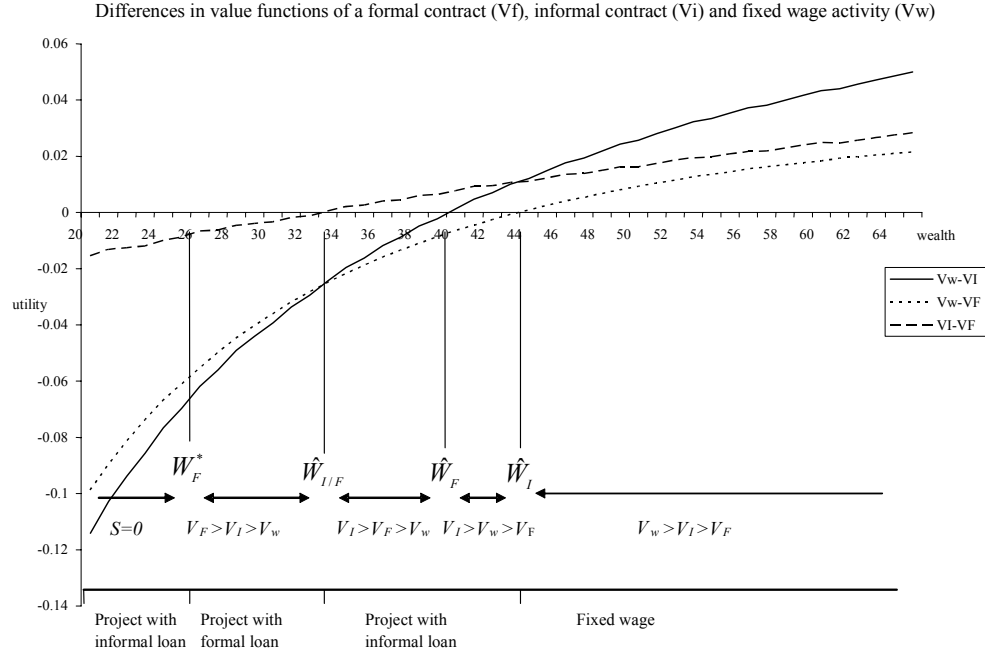
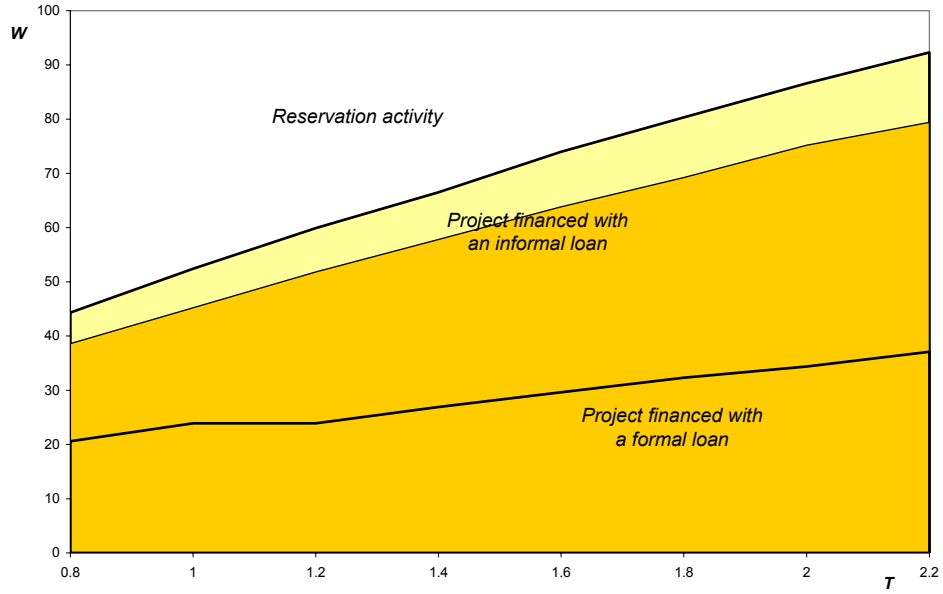


Figure 10: Activity choice with $P < 3A$ and two types of wealth: Simulation 3



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