Are Land Titles the Constraint to Enhance Agricultural Performance? Complementary Financial Policies to Crowd-in Credit Supply and Demand in Risk-constrained Rural Markets

Bradford Barham
University of Wisconsin, Madison

Stephen Boucher
University of California, Davis

Michael R. Carter
University of Wisconsin, Madison

April 2008

Abstract

Despite several decades of land titling programs expected to increase supply and demand in agricultural credit markets, rural credit markets remain a weak spot in Latin America and that smallholder agricultural sectors are underperforming. This paper develops a theoretical model to demonstrate how this troubling result could reflect the presence of uninsured agricultural risks that restrict both supply and demand for credit. If correct, this model would imply that land titling programs might partially relax quantity rationing constraints, but still may leave a significant proportion of borrowers 'risk rationed'. Uninsured (covariant) risk may also directly lower the willingness of micro lenders to invest heavily in an agricultural loan portfolio. Using panel data from a coastal region in Northern Peru, this paper then explores the impact of land titling on credit market outcomes. The maximum likelihood framework deployed is closely tied to the theoretical model, but is difficult to estimate. Results from the maximum likelihood estimation framework only partially support the theoretical hypotheses. Further innovation is needed to make the estimation strategy more robust and fertile in its examination of the theory

1. Introduction

Provision of secure, mortgageable land titles to rural producers has been hypothesized to increase both the supply of, and the demand for credit (Binswanger and Deininger, 1999; de Soto 2000; Carter and Olinto, 2003). The positive supply effect derives from the impact of land titles on the collateral value of farm assets and their potential signal to the lender about important information regarding the borrower, such as their capacity to understand and follow formal rules, their integration with markets, their managerial abilities, and the quality of their assets (Dower and Potamites, 2006).[1] The demand side effect stems from the potential for the title to increase the borrower's security in making investments (Deininger and Chamorro, 2004) that comes with more robust ownership rights over their property. Combined, these two effects could 'unleash' informal assets (to use de Soto's 2000 colorful language) and power increased economic performance.

Yet, despite several decades of (donor-promoted) land titling programs, along with the 'micro-finance revolution,' rural credit markets remain a weak spot in Latin American economic performance.[2] To illustrate this point, Figure 1 presents credit market indicators from in the three countries for which we have comparable survey data.[3] Overall, about 40% of the rural households in Honduras, Nicaragua, and Peru were credit constrained (using full quantity rationing, transaction cost rationing, and risk rationing categories). Those constraints are reflected in the key performance indicators depicted in Figure 1. For example, constrained

---

[1] Field and Torero (2006) suggest that in some circumstances publicly provided titles might have a negative or negligible supply effect if the bank perceives the government provided title as reducing their ability to foreclose on a loan.

[2] A handful of studies have tried to directly evaluate the credit market effects of land titling in Latin America. They tend to find relatively weak credit market access impacts from land titling programs, especially in rural areas (Galiani and Schargrodsky, 2006; Field and Torero, 2006; Boucher, Barham, and Carter, 2006; Boucher, Guirkinger, and Trivelli, 2006). In one of the most explicit studies of this sort, Carter and Olinto (2003) find that land tilting only boosts credit supply for producers located in the upper deciles of the wealth distribution.

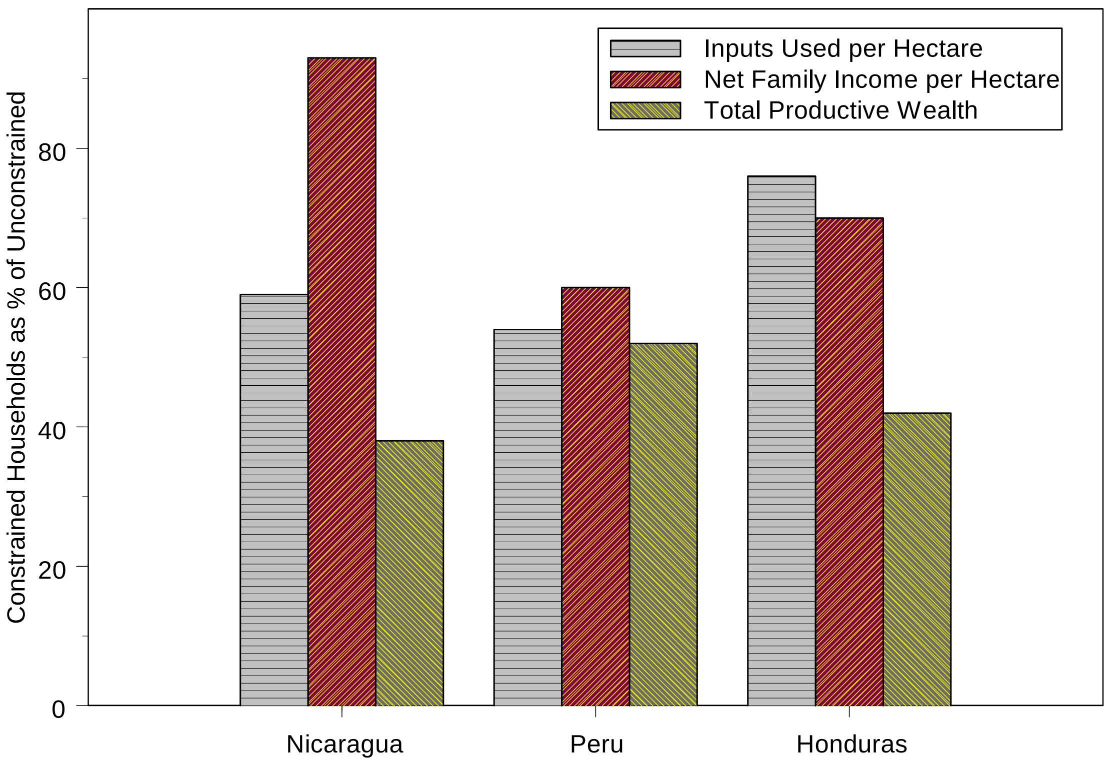
[3] The data are all based on random surveys of individual farms that elicited the credit market constraints faced by each (see Boucher, Guirkinger, and Trivelli, 2006 for a discussion of their constraint elicitation strategy).

producers on average use 50-75% of the purchased inputs of unconstrained producers and enjoy net incomes (returns to land and family labor) that range from 60-90% of the level of unconstrained farm households. The costs of these constraints in the form of agricultural underperformance can be substantial, as shown in the case of Peru by Boucher and Guirkinger (2007). Their econometric analysis of the Peruvian data suggests that the value of total agricultural output could be increased by 25% if all of the credit constraints could be eliminated.

What has gone wrong? A closer look at the Peruvian data used in this study reveals that this agricultural underperformance has its roots in both conventional quantity rationing - where lenders are unwilling to write a contract for borrowers with insufficient wealth holdings - as well as in risk rationing – where borrowers could secure a contract but are unwilling to bear the risk of default associated with weather and other negative shocks (Boucher, Carter, and Guirkinger, forthcoming). More specifically, while land titling can reduce significantly the prevalence of quantity rationing outcomes, it may also have the effect of moving a large proportion of borrowers from quantity rationed to risk rationed outcomes, and thus still not result in higher returns from agricultural activities. Improved credit market performance, at least in the near term, seems likely to require complementary institutional reforms, such as risk insurance, that would allow borrowers to exploit the increased credit market access possibilities associated with titling programs.

This paper develops that basic argument in two steps. The most significant contribution is in the theoretical model that explores how risk shapes demand and supply side behavior in rural credit markets where land title improvements are occurring. The model also demonstrates how land titling efforts that secure collateralizable wealth could be complemented by insurance services that would allow both borrowers and lenders (both formal and micro-credit) to overcome the risks associated with agricultural activity/loan portfolios. The key theoretical finding for policy is that in risk constrained credit markets, land titling programs may fill a necessary but not sufficient condition for improving the performance of the rural credit market and economy. Thus, innovative efforts to address risk through other incentive-compatible institutional mechanisms (such as area-yield based insurance) may be required to unleash the intended positive effects of the titling program.

Figure 1 Incidence & Cost of Credit Constraints



. Source: Boucher, Carter and Guirkinger, 2006

The second contribution of this paper is to estimate a structural econometric model based on the theory. Sections 3 and 4 pursue that goal and set forth a coherent estimation framework and test them against a panel data set from the Piura region, along the northern coast of Peru, an area where small-holder agriculture prevails. The estimation strategy is a challenging one, and the results reported provide relatively weak support for the theoretical findings. Further innovation on the econometric approach will be required before a robust evaluation can be made of the role of wealth and risk rationing in this region. The final section of the paper summarizes the main findings of the paper.

2. The Impact of Land Titling on Credit Markets in the Presence of Uninsured Risk: A Theoretical Model

This section builds on the theoretical model of Boucher, Carter and Guirkinger (2008), hereafter cited as BCG. After laying out the basic model structure and intuition, we will summarize its implications for the incidence and nature of non-price rationing in agricultural credit markets. Further analysis of the model shows that a generalized program of land titling would be expected to only partially resolve the problem of non-price rationing in rural credit markets. Insights from this model will be used to structure the empirical analysis in sections 3 and 4 below.

2.1 A Model of Non-price Rationing in Agricultural Credit Markets

BCG consider a rural household that can work full time and devote its resources to running a commercial agricultural technology. Specifically, farmers must choose to use their land in either a safe, subsistence activity or a more profitable but also more risky, commercial activity. The subsistence activity does not require capital and yields a certain return of ω per-unit land. The commercial activity requires a fixed investment per unit-land, k. Returns to the commercial activity are uncertain. Gross revenues per-unit land are equal to x_g and x_b if the realized state of nature is “good” and “bad” respectively wth $x_g > k > x_b$.

A farmer's well being in state j depends on her end of period consumable wealth, C_j, and the effort she exerts, e, according to the following additively separable utility function: $U(C_j, e) = u(C_j) - d(e)$. Consumable wealth is the sum of initial financial wealth, the market value of land holdings ($p_T T$), and net income from the chosen activity. Effort, in turn, can be either high ($e=H$) or low ($e=L$). The disutility of effort, $d(e)$, is increasing in effort so that $d(H)>d(L)$.

While higher effort causes greater disutility, it also lowers the riskiness of the commercial activity. Letting ϕ^H and ϕ^L denote the probability of the good state when the farmer exerts high and low effort respectively, BCG assume that $\phi^H x_g + (1-\phi^H)x_b > \omega + \bar{\gamma}k > \phi^L x_g + (1-\phi^L)x_b$, where $\bar{\gamma}$ is the market cost of funds. In other words, high effort raises expected income from the commercial activity above that of the subsistence activity, while under low effort the commercial activity is not economically viable.

With this background, BCG explores how a competitive financial sector would offer loans to farm households. We restrict attention to farmers with endowments such that $W < kT$, i.e. to those who must borrow in order to utilize the commercial technology. The lender faces a conventional moral hazard problem; namely the borrower's effort level is private information and is not contractible. Given that under low effort the commercial activity does not generate positive returns, lenders will only offer loan contracts that induce the borrower to choose high effort. Loan contracts, in turn, specify an interest rate, r, and per-hectare collateral requirement, c. Under our assumption of a competitive loan market, the optimal loan contract, if it exists, solves the following program:

$$\begin{aligned} &\underset{c,r}{Max} \quad Eu(C_j \mid e = H) \\ &subject\ to: \end{aligned} \tag{1}$$

$$\pi(r,c \mid H) \equiv \frac{\phi^H rk + (1-\phi^H)c}{k} \geq \overline{\gamma} \tag{2}$$

$$[u(C_g) - u(C_b)](\phi^H - \phi^L) \geq d(H) - d(L) \tag{3}$$

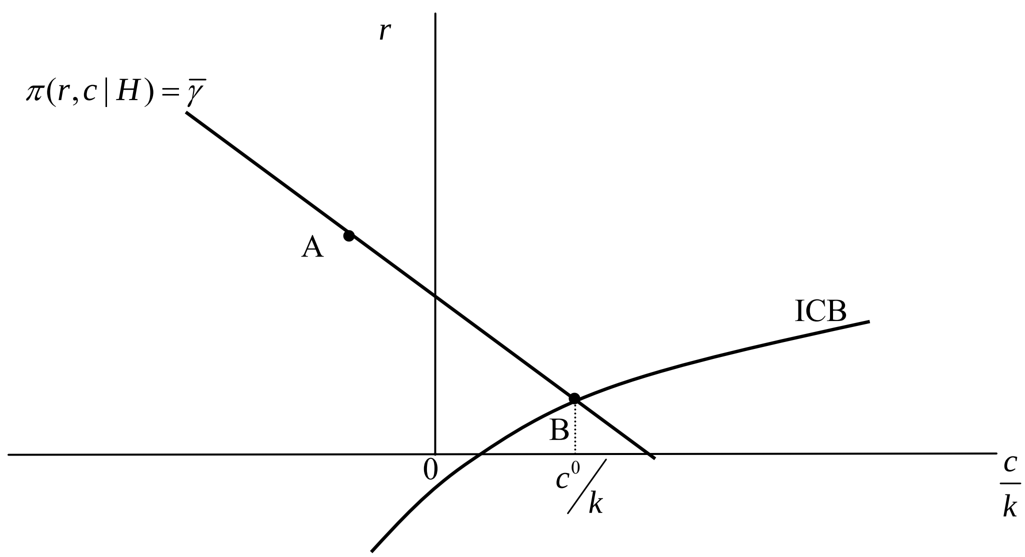
$$c \leq p_T + \frac{W}{T} \tag{4}$$

Let $\pi(r,c \mid e)$ denote the lender's rate of return, defined as the expected repayment per dollar loaned when the borrower applies effort level *e*. Equation 2 is the lender's participation constraint (LPC) and requires that the lender's rate of return under high borrower effort be at least as large as his cost of funds, $\overline{\gamma}$. Equation 3 is the borrower's incentive compatibility constraint (ICC) and requires that the expected utility gain from choosing high instead of low effort exceeds the disutility cost of high effort. Finally, equation 4 is the limited liability constraint which states that contracts must require a level of collateral that is feasible for the borrower given his wealth.

In choosing whether or not to accept the loan package and run the commercial technology, the household compares its expected utility under the optimal loan to the expected utility it would receive in the subsistence (reservation) activity. Two forces will shape whether or not the household will undertake the commercial activity: 1) The level of expected returns under the optimal contract and, 2) The extent of risk imposed by the optimal contract. Distinguishing between expected return and the amount of risk implied by the credit contract will be important for the purpose of understanding land titling.

To develop insights into these two factors, consider the outcome if effort were contractible. In terms of the optimization program above, this would correspond to a world in which the lender could costlessly force the borrower to apply high effort so that we could ignore the ICC. Figure 2 shows that in this "first-best" world, lenders could offer any interest rate-collateral combination along the downward sloping line through points A and B. The contracts on this line yield zero expected lender profits and thus represent one boundary of the feasible contract set. Contracts on this line also yield a constant expected consumption although not, as we will see shortly, expected utility to the borrower. Moving to any contract above this line increases lender profits and reduces borrower income. The location of the lender's zero profit line depends on the market cost of funds. As the cost of funds rises, this zero-profit locus shifts to the northeast.

Figure 2. The Lender's Zero-Profit Line



The slope of the zero profit line is $\frac{-(1-\phi^{H})}{\phi^{H}}$, implying that the risk neutral lender is willing to trade interest rate reductions for an increase in collateral at a rate equal to the ratio of failure to success probabilities. Note that the lender's zero expected profit locus includes relatively high collateral contracts with low interest rate such as the contract at point B and contracts with high interest rate and negative collateral, such as point A. While the negative collateral contract at point A might seem counter-intuitive (it would imply that the lender give an additional *payment* to the borrower under failure) its logic is clear. In fact, if borrowers are risk averse, the first best contract (i.e., ignoring the ICC) would be a high interest, negative collateral contract that equalizes household income across the two states of nature. In the absence of information problems, then, credit could serve the dual purpose of providing both liquidity for investment and insurance.

Let $\overline{y}_i(\gamma)$ denote the expected income per hectare generated by the *i*'th farmer when implementing the commercial project when the lender's cost of funds is γ.[4] Recalling that $\overline{\gamma}$ is the market cost of funds, under the first best contract the borrower would earn $\overline{y}_i(\overline{\gamma})$ independent of the state of nature. Denote as $EU_i^{FB}(\overline{\gamma})$ household *i*'s expected utility under this first best contract, i.e., $EU_i^{FB}(\overline{\gamma}) = u((\overline{y}_i(\overline{\gamma}) + p_T)T + W) - d(H)$. Further, define γ_i^* as the lender's cost of funds that would make the *i*'th household indifferent between running the commercial technology with the first best contract versus the subsistence activity. The following equation implicitly defines γ_i^*:

$$EU_i^{FB}(v) = u((\overline{y}_i(\gamma_i^*) + p_T)T + W) - d(H) = u((\omega_i + p_T)T + W) - d(H) = EU_i^S, \qquad (5)$$

where EU_i^S denotes the farmer's expected utility under the subsistence activity.[5] Since the first best credit contract offers full insurance, the farmer will be indifferent between the commercial and subsistence activities if lender's cost of funds is such that $\overline{y}_i(\gamma_i^*) = \omega_i$, or the expected income generated by the commercial project equals the safe, subsistence income.

---

[4] Expected income for household *i* under the commercial activity and high effort is:
$\overline{y}_i(\gamma) = \phi_i^H x_{ig} + (1-\phi_i^H)x_{ib} - \gamma k$. As our eventual goal is to move towards an econometric model, we allow for heterogeneity across households in project returns, and hence add the *i*-subscript.

[5] Note that in equation 5 we have assumed that the reservation activity requires high effort. This assumption simplifies the ensuing analytics but does not change the qualitative nature of the analysis.

We are now in a position to determine whether or not a household would borrow in a world not plagued by asymmetric information. Define a farmer as having positive ***notional demand*** if $\gamma_i^* > \overline{\gamma}$, or if the lender's cost of funds that would make the household indifferent between the commercial activity with a first-best loan versus undertaking their reservation activity is greater than the market cost of funds. Note that γ_i^* will depend on the relative profitability of the two activities for the household. On one hand, holding ω_i fixed, farm households with high quality land and the ability to adopt and manage new farm technologies will generate high expected income under the commercial activity and thus will have a greater willingness to pay for first-best loans. These households would have a high value of γ_i^* and positive notional demand. On the other hand, holding farm productivity fixed, households with better reservation (subsistence) options, such as those with members who can work in high wage salaried jobs, will have a relatively high ω_i. As they can productively employ their household endowments elsewhere, these households would have a relatively low value of γ_i^* and would be less likely to have positive notional demand.

2.2 Asymmetric Information and Non-Price Rationing

In a first best world, any household with positive notional demand would always seek a loan. This is not the case in the presence of asymmetric information. When lenders cannot monitor borrower effort, we must consider how satisfying the ICC (equation 3) affects the set of contracts lenders are willing to make available. As BCG show, the ICC truncates the feasible set in Figure 2 from above. The logic is straightforward. Restrict attention to the lender's zero profit line. The contract at point A was the optimal contract in the first best world because it protects the borrower from income fluctuations associated with the risky commercial activity. But it is precisely the insurance implicit in this contract that makes it incentive incompatible in a symmetric information world. With his income shielded from risk, the borrower would have no incentive to exert high effort. To restore incentives, the lender must shift some risk back to the borrower. In terms of Figure 2, the lender accomplishes this by eliminating the low collateral, high interest contracts between point A and B and instead offers only those relatively high collateral, low interest contracts to the southeast of point B. The curve labeled ICB is the incentive compatibility boundary and gives the locus of contracts such that the borrower is indifferent between exerting high versus low effort. All points on or below the ICB are incentive compatible. In a world of symmetric information, the best contract (from the borrower's point of view) that the lender is willing to offer is at point B, which still yields zero profit to the lender but is the lowest risk contract that is also incentive compatible.

This shrinking of the set of available contracts due to asymmetric information creates the potential for two types of non-price rationing; i.e. two reasons that households with positive notional demand (and thus who would borrow in a symmetric information world) do not borrow in an asymmetric information world. The first form of non-price rationing is *quantity rationing*. Let $S_i > 0$ and $S_i = 0$ denote, respectively, the situations where household *i* faces a positive versus a zero supply of credit. A quantity rationed household is one that has positive notional demand ($\gamma_i^* > \overline{\gamma}$) but does not possess the minimum collateral required to gain access to a loan ($S_i = 0$). In Figure 2, farmers that have wealth endowments to the left of point B, and thus cannot post at least $\frac{c_0}{k}$ in collateral per-hectare, would be quantity rationed if they also had positive notional demand.

Quantity rationing is a supply-side phenomenon that occurs when asymmetric information leads to an empty feasible contract set. BCG point out that asymmetric information can cause would-be borrowers in a symmetric information world to drop out of the credit market in an asymmetric information world even though lenders are willing to make them a loan. As discussed above, lenders provide borrowers incentives to choose high effort by obliging them to bear an incentive compatible amount of risk. In Figure 2, this was represented by the shift from contract A to contract B. While this shift leaves the level of the borrower's expected consumption unaffected, it destabilizes consumption across good and bad states of the world and, as a result, lowers the household's expected utility. If the drop in expected utility is large enough, the household will withdraw from the credit market, preferring to forgo the additional expected consumption associated with the commercial activity in favor of the safe reservation activity. BCG labels this phenomenon *risk rationing*. A risk rationed household has access to an expected-income-enhancing credit contract that requires them to bear so much risk that they prefer instead to undertake a lower return but safer alternative.

In general, the incentive compatibility-constrained contract (point B in Figure 2) will be similar to an risk-free, symmetric information contract at a higher market cost of funds. Let $\tilde{\gamma}_i$ denote the lender's cost of funds such that household *i* would be indifferent between the risk-free, symmetric information contract that would be available when $\gamma = \tilde{\gamma}_i$ and the asymmetric information-constrained optimal contract available when $\gamma = \overline{\gamma}$. The following equation implicitly defines $\tilde{\gamma}_i$:

$$Eu[(y_{ij}(\overline{\gamma}) + p_T)T + W] = u[(\overline{y}_i(\tilde{\gamma}_i) + p_T)T + W], \qquad (6)$$

where $y_{ij}(\overline{\gamma})$ is the household's income per-hectare from the commercial activity in state j when the lender's cost of funds are $\overline{\gamma}$, and $\overline{y}_i(\tilde{\gamma}_i)$ is certain income from the same activity when financed with the riskless, symmetric information contract under lender's cost of funds $\tilde{\gamma}_i$. It is straightforward to derive the following intuitive relationship between the market cost of funds, $\overline{\gamma}$, and the second household specific critical cost of funds, $\tilde{\gamma}_i$:

$$\tilde{\gamma}_i = \overline{\gamma} + \frac{\sigma_i}{k}, \tag{7}$$

where $\sigma_i \geq 0$ is the household's per-hectare risk premium associated with running the commercial activity financed by the constrained optimal contract.[6] Note that if $\tilde{\gamma}_i > \gamma_i^*$, the household will *not* take the loan as expected utility would be higher under the reservation activity than under the constrained optimal contract. Equation 7 also shows that $\tilde{\gamma}_i$ will be shaped by the same factors that determine the household's risk premium. These factors include environmental and market conditions affecting the riskiness of the commercial activity, household specific risk preferences, and the household's access to formal and informal insurance.

As discussed above, a household is risk rationed if it would borrow in a symmetric information world but chooses not to borrow in an asymmetric information world. A risk rationed household is thus characterized by three conditions: 1) Access to a contract ($S_i > 0$), 2) Positive notional demand ($\gamma_i^* > \overline{\gamma}$) and, 3) Zero effective demand ($\tilde{\gamma}_i > \gamma_i^*$).

---

[6] To see this, note that σ_i is implicitly defined as: $Eu[(y_{ij}(\overline{\gamma}) + p_T)T + W] = u[(\overline{y}_i(\overline{\gamma}) - \sigma_i + p_T)T + W]$. Comparing this equation to equation 6 shows that $\sigma_i = \overline{y}_i(\overline{\gamma}) - \overline{y}_i(\tilde{\gamma}_i)$. The difference between these two borrower expected income levels is the difference in expected loan repayment which is equal to $[\tilde{\gamma}_i - \overline{\gamma}]k$.

We have seen above that a household's credit rationing regime is determined by whether or not it has access to a loan and the relative sizes of the market cost of funds, $\bar{\gamma}$, and the two household-specific cost of funds defined above, γ_i^* and $\tilde{\gamma}_i$. Table 1 summarizes the credit rationing regimes.

Table 1. Credit Rationing Regimes

	No Contract Available ($S_{it}^* < 0$)	Contract Available ($S_{it}^* > 0$)
No notional demand ($\gamma_i^* < \bar{\gamma}$)	A Price rationed non-borrowers	B Price rationed non-borrowers
Positive notional demand, no effective demand ($\bar{\gamma} < \tilde{\gamma}_i < \gamma_i^*$)	C Quantity rationed	D Risk rationed
Positive effective demand ($\bar{\gamma} < \gamma_i^* < \tilde{\gamma}_i$)	E Quantity rationed	F Price rationed borrowers

Households that have no notional demand and thus would not borrow even in a symmetric information world are classified as price rationed non-borrowers whether or not they have access to a contract in the asymmetric information world (cells A and B). Households with positive notional demand but who have no available contract are quantity rationed (cells C and E). Households with a contract available and positive notional demand but no effective demand are risk rationed (cell D). Finally, households with both positive supply and effective demand are price rationed borrowers (cell F).

2.3 The Impact of Land Titling on Credit Rationing

The theoretical framework presented above suggests various means by which land titling may affect credit rationing. The first order effect is to increase the household's holdings of collateral wealth. This can be seen clearly in the contract design problem given by equations 1 – 4. Specifically, acquisition of a property title raises p_T, the value of the household's landholdings and thus relaxes the limited liability constraint given by equation 4.[7] This increase in household wealth is the impetus underlying the optimistic scenario depicted by Hernando de Soto (2000). The receipt of land title "activates" the previously "dead" land asset of poor households, enabling them to borrow and undertake more profitable activities. In terms of our model, titling would lead to an expansion of the feasible contract set that, if sufficiently large, would allow households to post the collateral required by lenders, leading to a reduction in the incidence of quantity rationing. In Table 1, this optimistic scenario corresponds to a move out of cells C and E and into cell F.

The model presented above, however, suggests two potential pitfalls to this optimistic vision. First, the increase in collateral wealth brought about by titling may not be sufficient to meet lenders' collateral requirements. In this case a household remains in cells C/E even after receiving its land title. If the fixed costs associated with lending are large, this is likely to be a particularly severe problem for small-holders. Second, even if receipt of title raises the household's wealth sufficiently to relax the supply-side constraint, it may not lead a previously quantity rationed household to participate in the credit market and undertake the high return, commercial activity. The reason is that the household may find the contracts that are now available to be too risky. Again in terms of Table 1, this would correspond to a previously quantity rationed household becoming risk rationed (moving from cells C/E to D).

In their theoretical analysis, BCG points out an additional complication to the impact story. Specifically, the first-order impact story above was told imagining that the increase in

---

[7] We do not concern ourselves here with the mechanism by which title increases the value of the land. Besley (1995) provides multiple theoretical explanations for an increase in investment and thus the net present value of land resulting from an increase in property rights.

collateral wealth would make the constrained optimal contract at point B in Figure 2 feasible for some previously quantity rationed households. In fact, this relaxation of the limited liability constraint will be offset by a tightening of the incentive compatibility constraint. In other words, the increase in household wealth would, under decreasing absolute risk aversion, make the borrower less sensitive to a given contractual risk. The lender would respond by increasing the amount of risk born by the borrower, thereby shifting the ICB in Figure 2 downward and partially negating the increase in wealth by raising the minimum collateral requirement.

In summary, our theoretical analysis of the credit contracting problem in the presence of asymmetric information suggests that the impact of land title on credit rationing is complex, with several potential impediments to the realization the optimistic vision laid out by Hernando de Soto. In the next two sections, we empirically explore the degree to which the de Soto vision is realized by first descriptively and then econometrically examining how the recent land titling program in Peru shifted farm households across different credit rationing regimes.

3. Descriptive Evidence of Titling, Credit Market Outcomes, and Risk Rationing

The empirical analysis exploits a panel dataset (1997/2003) from Peru to examine the role of title, risk, and other factors shaping credit market rationing outcomes. The full 1997 sample included 547 farm households and was stratified geographically to ensure representation of the five main valleys in the Piura region of Coastal Peru and by farm size to ensure inclusion of large farms. In 2003, 499 of the original households were relocated and interviewed, of which 443 were still farming. The analysis that follows is based on the 443 households for whom we have titling credit market outcome data for both years.

An important fraction of households in this data set acquired a title between the two survey years. Households in the Peru data set are split between those owning private land versus those owning land in peasant communities. At the time of the baseline survey in 1997, land within peasant communities was not individually titled and could not be mortgaged. This changed in 1998, however, as peasant communities in the study region agreed to move to private land ownership. The titling process was partially completed at the time of the follow-up survey in 2003, providing a source of exogenous variation in title status. Table 2 provides a breakdown of titling status and credit rationing outcomes.

Table 2. A Comparison of Credit Rationing Mechanisms by Tenure Type in Piura

	Private Land (n=252)		Peasant Community (n=191)	
	1997	2003	1997	2003
% with title	85%	93%	2%	39%
Constrained	**44%**	**36%**	**70%**	**52%**
Quantity Rationed	34%	13%	56%	31%
Risk Rationed	10%	23%	14%	21%
Unconstrained	**56%**	**64%**	**30%**	**48%**
Borrowers	41%	40%	12%	11%
Non-borrowers	15%	23%	18%	37%

Note that in 1997, only 2% of the peasant community households held title. By 2003, 39% did. By contrast, titling among private landholders also rose from 85% to 93%. Thus, while the change in titling among the peasant communities was substantial, the change among the private land holders was not.

Households were asked about their participation and perceptions of credit markets in a fashion that allows a direct classification of households as constrained or unconstrained in the formal credit market (Boucher, Guirkinger, Trivelli, 2006). Households are classified as either price rationed (formal sector borrowers and non-borrowers who have no project requiring a loan), or as non-price rationed. For this latter category, three non-price rationing mechanisms are identified: quantity-rationed, transaction-cost rationed, and risk-rationed. For the empirical analysis undertaken here, we collapse the first two non-price rationed categories into one, called quantity-rationing and focus on three categories of credit market outcomes, price rationed, quantity rationed, and risk rationed.

These data are also presented in Table 2 by credit market status to help explore the impacts of land title on credit access. Note first that an increase in titling between 1997 and 2003 is clearly associated with a reduction in the percent of households reporting themselves as quantity rationed in credit markets. This change is most evident among peasant community households, for whom quantity rationing drops from 56% of households to 31%. A large decline in quantity rationing is also reported by private land holding households (34% to 13%), but this change is not as clearly linked to the change in titling, since only 8% more private land holding households added title during this time. Overall, the lower percentage of quantity rationing among this predominantly land-titled group in both time periods also provides supportive evidence that titling may help to reduce quantity rationing among rural households.

The other major observation that Table 2 offers is that the impact of titling on reducing credit constraint outcomes appears to be significantly muted by the rise in households of both types reporting themselves to be risk rationed. Among private land holders, the percentage of risk rationed households rises from 10% in 1997 to 23% in 2003, and among the peasant community, it rises from 14% to 21%. Thus, there appears to be a switch in the credit rationing status away from quantity rationing and toward risk rationing which limits the potential impact of titling and other changes in local financial markets on the prevalence of credit constraints. This outcome is further examined in Table 3, a transition matrix for households that details transitions in credit rationing and titling outcomes for the 1997 to 2003 time period. Perhaps the most interesting cells are in the middle row that track what happened to quantity rationed households in 1997. Of the 207 households that reported being quantity rationed in 1997, about half reported themselves as price rationed in 2003 and about 25% reported themselves as risk rationed. The other 25% remained quantity rationed. The price and risk rationed groups (in this middle row) were also the most likely of all the cells in the transition matrix to have acquired a title during this time period (43% and 38%, respectively). Titling appears to have made a significant difference in rationing outcomes for this group, but in an uneven fashion.

Another useful comparison in Table 3 is the title and wealth data across the bottom row. Not surprisingly, the price rationed households are more likely to have title, larger farm size, and more non-farmland wealth than the quantity rationed outcomes. However, the only significant difference between the price and risk rationed households is in terms of wealth, of which the price rationed have about 50% higher holdings. These descriptive statistics are consistent with the theoretical outcomes presented in Table 1, where a titling program could have the effect of relaxing credit constraints for some by making their wealth collateralizable but not for others who move into the category of risk-rationed borrowers. The next step is test the robustness of these correlations with a structural econometric model of supply and demand for credit.

Table 3. Transition Matrix for Formal Sector Rationing Mechanism: 1997 to 2003

		Rationing Mechanism in 2003				
		Price Rationed	Quantity Rationed	Risk Rationed	1997 Means	
Rationing Mechanism in 1997	Price Rationed	N = 129 % acquiring title = 9%	N = 36 % acquiring title = 19%	N = 33 % acquiring title = 12%	N = 198 Has Title = 67% Farm Size = 5.4	
	Quantity Rationed	N = 103 % acquiring title = 43%	N=49 % acquiring title = 26%	N=55 % acquiring title =38%	N=207 Has Title = 31% Farm Size = 3.5 Wealth = 3.71	
	Risk Rationed	N = 18 % acquiring title = 17%	N=9 % acquiring title = 22%	N=11 % acquiring title = 0%	N=38 Has Title = 60.5% Farm Size = 4.29 Wealth = 4.68	
	2003 Means	N = 250 Has Title = 74% Farm Size = 4.3 Wealth = 4.7	N=94 Has Title = 51% Farm Size = 3.6 Wealth = 3.1	N=99 Has Title = 77% Farm Size = 4.5 Wealth = 3.0	1997 N=443 Has Title = 49.4% Farm Size = 4.4 Wealth = 6.5	2003 N=443 Has Title = 70% Farm Size = 4.2 Wealth = 3.95

- % acquiring title is the percentage of households in each cell that did not have a registered property title in 1997 and acquired one by 2003.
- Farm size is the area owned by the households and is measured in hectares.
- Wealth is the non-farmland wealth of the household and is measured in thousands of dollars. It includes the value of house and residential land, business assets, farm equipment, livestock and consumer durables.

4. Simulated Maximum Likelihood Estimates of the Structural Model

The descriptive statistical analysis reported in the prior section does not allow us to reliably estimate the impact of land titling on credit market status. After specifying the key structural equations identified by the structural model, this section will employ simulation-based maximum likelihood methods to derive panel data estimates of the structural model.

4.1 Structural Model

Our structural econometric analysis is based on the fact that the data described in the prior section allow us to uniquely classify each household, in each time period, into one of the six credit market regimes summarized in Table 1. Estimation of a limited dependent variable model only requires specification of the structural equations hypothesized to determine the sorting of households between the six regimes.

Let S_{it}^* denote the loan supply to the *i*'th farmer in period *t*. We model S_{it}^* as the following linear function:

$$S_{it}^* = \theta^S L_{it}^R + \beta^S Z_{it} + \tau^S t + [v_i^S + \varepsilon_{it}^S]; \qquad (8)$$

where L_{it}^R is the farm area owned with a registered title; Z_{it} is a vector of household specific factors affecting supply; *t* indicates the time period; v_i^S represents time invariant, individual factors affecting credit supply; and ε_{it}^S is a mean zero error term. The ability to control for latent individual characteristics (the v_i^S) is key to the identification strategy. These characteristics could include things like entrepreneurial skill. High skill individuals are both more likely to have buoyant credit supply and also make it more likely to have titled land (given the incompletely random distribution of land titles in Peru. Failure to control for such latent factor could under these conditions lead to biased estimates of the impact of title on credit supply.

Following Mundlak (1978), we write the latent effect as:

$$v_i^S = \alpha_1^S \overline{L}_i^R + \alpha_2^S \overline{Z}_i + u_i^S, \tag{9}$$

where $\overline{L}_i^R = \sum_{t=1}^{2} \frac{L_{it}^R}{T}$ and $\overline{Z}_i$ is similarly defined as the mean level of the observed characteristics for household *i*. In the standard linear panel data model, after substituting in expression (9), GLS estimation of (8) would be equivalent to a standard fixed effects estimator if (8) were a standard linear and continuous panel data model.

As discussed in section 2, the key theoretical object determining notional credit demand is γ_{it}^*, the interest rate that would make the individual indifferent between the fallback, non-loan activity and the loan under a first best (symmetric information contract). Recall that an individual has positive notional demand for credit if γ_{it}^* is greater than the market cost of capital, $\overline{\gamma}$. Analogous to (8), we write this first-best, subsistence-equivalent interest rate as a linear function of observed and unobserved variables:

$$\gamma_{it}^* = \beta^{ND} X_{it} + \tau^{ND} t + [v_i^{ND} + \varepsilon_{it}^{ND}]; \tag{10}$$

where X_{it} are household specific factors affecting demand; t again indicates the time period; v_i^{ND} represents time invariant, individuals factors affecting notional demand; and ε_i^{ND} is a mean zero error term. Note that we do not include the title variable in the equation for notional demand. As we mentioned in the theoretical section, our model does not incorporate a tenure-security induced demand effect. This is likely to be not too violent of an assumption in our study area because virtually all farmers hold (and have held) alternative documents that clearly define their property rights to the land. Again following Mundlak, we write the individual latent effect as a linear function of the means of the regressors over the two years:

$$v_i^{ND} = \alpha^{ND} \overline{X}_i + u_i^{ND}. \tag{11}$$

The final element needed to fully specify the model is $\tilde{\gamma}_{it}$, the lender's cost of funds such that household *i* in period *t* would be indifferent between the risk-free, symmetric information contract that would be available when $\gamma = \tilde{\gamma}_{it}$ and the asymmetric information-constrained optimal contract available when $\gamma = \overline{\gamma}$. As implicitly defined by equation (6) above, $\tilde{\gamma}_{it}$ reflects the actual opportunity cost of capital and the risk premium attached by individual *i* to the second best (asymmetric information constrained) credit contract. As such, the larger is $\tilde{\gamma}_{it}$, the lower is the probability that the individual will have positive effective demand, or would want the collateralized contract available in the asymmetric information world. We model $\tilde{\gamma}_{it}$ as a deterministic function of observed farmer characteristics:

$$\tilde{\gamma}_{it} = \beta_0^{ED} + \beta^{ED} R_{it}; \tag{12}$$

where R_{it} are factors affecting the willingness and capacity to bear risk.

4.2 Stochastic Specification and Econometric Approach

Expressions (8)-(12) give us the pieces that we need to estimate the bivariate ordered probit structure defined in Table 1. In order to estimate this model, we employ the following stochastic assumptions.

- $(\varepsilon_{it}^{ND}, \varepsilon_{it}^{S})' \sim N(0, \Sigma_\varepsilon)$, where $\Sigma_\varepsilon = \begin{bmatrix} \sigma_{ND}^2 & 0 \\ 0 & \sigma_S^2 \end{bmatrix}$; and,

- $(u_i^{ND}, u_i^S)' \sim N(0, \Sigma_v)$, where $\Sigma_v = \begin{bmatrix} \eta_{ND}^2 & \sigma^u \\ \sigma^u & \eta_S^2 \end{bmatrix}$ and σ^u is the correlation coefficient between v_i^S and v_i^{ND}.

While the likelihood function that would result from these assumptions would be analytically unmanageable (requiring cuadravariate integration), simulated maximum likelihood methods can be used to reduce the dimensionality of the problem. While we do not observe the vector of errors on the time-invariant components for household *i*, $u_i = (u_i^{ND}, u_i^S)'$, following Gourieroux and Monfort (1993) we can simulate the vector *H* times using Monte Carlo methods. Denoting replication *h* of u_i as u_{ih}, we can write the conditional likelihood that household *i* in time *t* is a price-rationed non-borrower (regime A of Table 1) as:

$$\begin{aligned} &\Pr(regime\ A \mid T_{it}^R, Z_{it}, X_{it}, u_{ih}) = \\ &\Pr(\gamma_i^* < \bar{\gamma}, S_{it}^* < 0 \mid T_{it}^R, Z_{it}, X_{it}, u_{ih}) = \\ &\Pr(\varepsilon_{it}^{ND} < \bar{\gamma} - \delta^{ND}, \varepsilon_{it}^S < -\delta^S \mid T_{it}^R, Z_{it}, X_{it}, u_{ih}) = \\ &\int_{-\infty}^{\bar{\gamma}-\delta^{ND}} \int_{-\infty}^{-\delta^S} \Phi(\varepsilon_{it}^{ND}, \varepsilon_{it}^S) d\varepsilon_{it}^{ND} d\varepsilon_{it}^S \end{aligned} \tag{13}$$

where $\delta^{ND} = \beta^{ND} X_{it} + \tau^{ND} t + \alpha^{ND} \bar{X}_i + u_{ih}^{ND}$ and $\delta^S = \theta^S L_{it}^T + \beta^S Z_{it} + \tau^S t + \alpha_1^S \bar{L}_i^T + \alpha_2^S \bar{Z}_i + u_{ih}^S$ and $\Phi(\cdot)$ is the bivariate normal pdf. Notation indicating conditioning on the parameter vector has been suppressed to reduce clutter.

Likelihood for the other 5 regimes can be similarly constructed using the information in Table 1. Extending and simplifying the above notation in an obvious way, overall conditional likelihood for replication *h* of household *i* in period *t* becomes:

$$\begin{aligned} \Gamma_{ih}(\varepsilon_{it}^{ND}, \varepsilon_{it}^S \mid \mathbf{u}_{ih}) = &\left[\Pr(regime\ A)\right]^{A_{it}} \times \left[\Pr(regime\ B)\right]^{B_{it}} \times \left[\Pr(regime\ C)\right]^{C} \times \\ &\left[\Pr(regime\ D)\right]^{D_{it}} \times \left[\Pr(regime\ E)\right]^{E_{it}} \times \left[\Pr(regime\ F)\right]^{F_{it}}, \end{aligned}$$

where A_{it}, B_{it}, … F_{it} are binary indicator variables that take on the value of one when observation i, t belongs to the indicated regime. The mean-simulated log likelihood estimate for household i across the H replications of $\boldsymbol{u}_i$ is then given by:

$$\overline{\Gamma}_i = \ln[\frac{1}{H}\sum_{h=1}^{H} L_{ih}(\varepsilon_{it}^{ND}, \varepsilon_{it}^{S} \mid \mathbf{u}_{ih})], \tag{14}$$

Maximization of (14) summed across households will yield consistent estimators of the parameters in the model above, and will yield a good approximation of the true likelihood even with a moderate H, as long as different replicates of u_i are created for each observation (Gourieroux and Monfort). In the analysis that follows, H is set equal to 25. A univariate (ordered) probit was used to generate starting values for the supply (demand) parameters.

4.3 Econometric Results

The computational requirements are fairly high and convergence of the model proved challenging. As a result, we estimate the parameters of equations 8 – 12 using a sparse set of variables in a fully linear specification without higher order or interaction terms. The variable definitions and means are reported in Table 5. The lender's binary supply rule for household i is assumed to depend on both the household's overall land endowment and the proportion of that land that has a registered property title. The household's notional demand, in turn, is a function of its endowments of land and liquidity. As discussed above, in the study area households are secure in their land tenure independent of possession of a registered title, so we do not include the title variable in this equation. Finally, the constrained-contract equivalent, risk-free interest rate, $\tilde{\gamma}_i$, is a function of the degree of agro-environmental risk facing the borrower. This variable is proxied by the coefficient of variation of yields in the district of the farmer's primary parcel. We expect that the larger is the coefficient of variation, the greater will be $\tilde{\gamma}_i$ and thus the greater will be the probability of risk rationing. Finally, since identification relies on changes in the exogenous variables over time, we do not include time any invariant regressors such as human capital or land quality.

Table 5 Definitions and Sample Means of Regressors

Variable Name	Definition	Mean
Supply, S_{it}^{*} (equation 8)		
L_{it}^{R}	Owned farm area with a registered property title (ha.)	3.3
Z_{it}	Owned farm area (hectares)	4.3
t	Dummy taking value 1 in 2003; 0 in 1997	0.5
Reservation-equivalent interest rate, γ_{it}^{*} (equation 10)		
Z_{it}	Owned farm area (hectares)	4.3
M_{it}	Value of cash, small animals, and stocks of grain and inputs (S/.000)	1.3
t	Dummy taking value 1 in 2003; 0 in 1997	0.5
Constrained contract-equivalent interest rate, $\tilde{\gamma}_i$ (equation 12)		
CV_i	Coefficient of variation of yields in the farmers district from 1996 - 2006	0.24

The model was estimated in Gauss using simulated maximum likelihood. Parameter estimates and standard errors are given in Table 6. The point estimates were calculated at the mean values of the regressors. Once we control for farm size, the probability that the household faces a positive credit supply from formal lenders is strongly increasing in the title variable. This suggests that acquisition of title, as suggested by the de Soto hypothesis, is likely to result in a relaxation of supply-side constraints and credit rationing for Peruvian farmers. It is also interesting to note that the coefficient on the time dummy in the supply equation is positive and significant, suggesting an overall loosening of credit supply in the region between 1997 and

2003. This is consistent with the observed entry of several new lenders and the intensification of competition as lenders pursued potential borrowers.

Table 6. Parameter Estimates and Standard Errors

Variable	Parameter Estimate	Standard Error	Estimate/Std Error
Supply, S_{it}^{*} (equation 8)			
Constant	0.3317	0.0953	3.482**
Titled area (L_{it}^{R})	0.2062	0.0614	3.357**
Farm size (Z_{it})	-0.0455	0.0794	-0.573
Time period (t)	0.4331	0.1098	3.946**
Controls for fixed effects (equation 9)			
Mean titled area ($\overline{L_i^R}$)	-0.0058	0.0782	-0.074
Mean farm size ($\overline{Z}_i$)	-0.1307	0.0957	-1.365
Reservation-equivalent interest rate, γ_{it}^{*} (equation 10)			
Constant	1.1096	0.1501	7.395**
Farm size (Z_{it})	0.1909	0.0388	4.920**
Liquidity (M_{it})	0.0079	0.0525	0.150
Time period (t)	-0.6055	0.1117	-5.420**
Controls for fixed effects (equation 11)			
Mean farm size ($\overline{Z}_i$)	0.0441	0.0331	1.334
Mean liquidity ($\overline{M}_i$)	-0.0429	0.0502	-0.854
Constrained contract-equivalent interest rate, $\tilde{\gamma}_i$ (equation 12)			
Constant	0.8618	0.1338	6.442**
CV_i	0.0362	0.3561	0.102

Among the determinants of notional demand, first note that the coefficient on farm size is positive and significant. This result implies that the reservation-equivalent interest rate, and thus notional demand, is increasing in farm size. We anticipated a negative coefficient on the liquidity variable as own-liquidity is a substitute for credit. In contrast to this expectation, the estimated coefficient is positive, although not significantly different from zero. In contrast to the supply equation, in this equation for notional demand, the coefficient on the time period is negative and significant, implying an overall reduction in first-best credit demand. One possible explanation is that the strong El Niño occurrence of 1998 caused a loss in assets for farm households from which they have not yet completely recovered. This is consistent with the reduction in mean sample wealth over the two survey years reported in Table 3.

Finally, we turn to the results of the effective demand equation. We expected the parameter estimate on the district-level coefficient of yield variation to be positive, since greater environmental risk would make households more reluctant to post a given level of collateral and thus be less likely to have positive effective credit demand. While the coefficient is positive, it is not significantly different from zero. The constant term is large, positive and significant, suggesting that there exists a significant wedge between notional and effective demand. Without a finer proxy for household-level risk exposure and risk preferences, however, we are unable to arrive at conclusive evidence about the source of this wedge.[8]

5. Conclusion: Land Titling and the Shape of the Rural Credit Market in Peru

In this paper we built on the theoretical model of Boucher, Carter and Guirkinger (2008) to explore the potential impacts of land titling on credit market participation and credit rationing outcomes for farm households. The model delivers a cautionary message: the anticipated gains resulting from the relaxation of supply-side credit constraints may be dampened by the presence of risk rationing. Risk rationing - a demand-side constraint caused by the absence of insurance markets - leads farmers to forego income-increasing credit contracts, because the contracts available in the market require them to bear significant risk.

---

[8] We are currently experimenting with several household specific risk aversion parameters that can be estimated from the 2003 survey data. Future estimations will incorporate a risk aversion measure as a regressor in the effective demand equation.

We developed and estimated a structural econometric model to test the theory and to explore the impacts of land titling on the sorting of farm households across credit rationing regimes. We found that land title indeed has a positive and significant impact on farmers' credit access. The outstanding question, however, is: To what degree does this increase in credit access translate into reduction in non-price rationing and increased participation in the credit market? Table 7 provides an initial insight into this question.

Table 7. The Impact of Title on Credit Rationing Regime Probabilities

	No Contract Available ($S_{it}^* < 0$)	Contract Available ($S_{it}^* > 0$)
No notional demand ($\gamma_i^* < \bar{\gamma}$)	A Price rationed non-borrowers [1.4%, 1%]	B Price rationed non-borrowers [2.4%, 2.9%]
Positive notional demand, no effective demand ($\bar{\gamma} < \tilde{\gamma}_i < \gamma_i^*$)	C Quantity rationed [5.4%, 3.6%]	D Risk rationed [9.1%, 10.9%]
Positive effective demand ($\bar{\gamma} < \gamma_i^* < \tilde{\gamma}_i$)	E Quantity rationed [31%, 21%]	F Price rationed borrowers [51%, 61%]

The parameter estimates from Table 6 were used to generate the probability that a "mean" household would fall in each of the six rationing regimes. The first element in square brackets reports the regime probability when none of the household's land is titled. The second element reports the same probability when all of the household's land is titled. The figures reported in cell A, for example, imply that when none of its land is titled, the probability that the mean household would have no notional demand and would face a zero supply is 1.4%. When the same household has its entire landholding titled, this probability falls to 1%.

Consistent with the regression results reported above, the most significant impact evident in this simulation exercise is the decrease in the probability of quantity rationing. Combining the two quantity rationing groups in cells C and E, titling reduces the probability of quantity rationing for the mean household by 11.8 percentage points, from 36.4% to 24.6%. The bulk of this increased access to credit is, in fact, accompanied by an increase in effective demand. Considering cell F, we see that titling increases the probability that the mean household borrows from the formal sector by 10 percentage points (from 51% to 61%). The results in Table 7 also suggest that, conditional on having a quantity rationing constraint relaxed, the risk rationing is not a major impediment to credit market participation. In cell D, we see that land titling results in only a modest increase (from 9.1% to 10.9%) in the probability of risk rationing. Thus it would seem that, at least for our mean household, a relatively small subset of those for whom a property title allows them access to credit would be restrained from borrowing by uninsured risk. A larger fraction would instead take advantage of the relaxation of quantity rationing by participating in the formal credit market. These results are consistent with the de Soto hypothesis and thus give a basis for hope that land titling in smallholder areas like the Piura region of Northern Peru could give rise to substantive improvements in credit access for the rural poor. It could be interesting to contrast the results from this region where smallholder agriculture is predominant with one where it is not to see whether titling impacts prove to be sensitive to the underlying agrarian structure.

The discussion above focused on the direction of shift in probability resulting from land titling. A "glass-half-full" perspective would cite the predominance of the shift from quantity-rationed to price-rationed borrowers (as opposed to risk-rationed non-borrowers) caused by land titling as evidence of the efficacy of property rights reforms in enhancing rural credit market efficiency. The results reported in Table 7 also clearly imply, however, that property titles are, at best, a partial solution to credit rationing. For the mean household, the overall reduction in the probability of non-price rationing brought about by titling is 10 percentage points. Even after titling, however, the probability of credit rationing remains high, at 35.5%, of which risk-rationing accounts for 10.9%. This "glass-half-empty" result implies that significant work remains in enhancing the performance of rural credit markets.

We conclude with a methodological caveat. Given the lack of a significant coefficient on the environmental risk variable (coefficient of variation of district yields) in the effective demand equation, the empirical results fail to provide conclusive evidence that the risk-rationed outcome developed in the theoretical model and in the direct elicitation approach used in the field work can be recovered or simulated from the structural econometric model we have estimated. As a result, we have not yet developed strong empirical evidence using this approach that the "risk-rationed" outcome which was evident in the descriptive data can be demonstrated robustly in a structural econometric model. Whether this result will change following refinement of the specification of the econometric approach to include additional risk-related data and some non-linear terms will be a target of ongoing research. Overall, this paper provides evidence that land titling programs can be a critical addition to the credit access situation of smallholder farmers. The theoretical model and some of the empirical results suggest that land titling efforts might be more effective in improving credit market outcomes if they were combined with complementary programs that provide insurance against weather and other shocks. Ongoing experimental policy research in Peru is exploring that conjecture, and will be a source of further direct evidence on this issue (Carter, Galarza, and Boucher, forthcoming).

References

Besley, T. (1995). Property Rights and Investment Incentives: Theory and Evidence from Ghana, *Journal of Political Economy*, 103(5), 903-937.

Binswanger, H. and K. Deininger (1999). The Evolution of the World Bank's Land Policy: Principles, Experience, and Future Challenges. *World Bank Research Observer*, 14(2): 247-276.

Boucher, S., B. Barham and Carter, M. (2005). The Impact of "Market-Friendly" Reforms on Credit and Land Markets in Honduras and Nicaragua. *World Development*, 33(1), 107-128.

Boucher, S., M. Carter and Guirkinger, C. (2008). Risk Rationing and Wealth Effects in Credit Markets. *American Journal of Agricultural Economics*, 90(2), 409-423.

Boucher, S. and C. Guirkinger. (2007). Risk, Wealth and Sectoral Choice in Rural Credit Markets. *American Journal of Agricultural Economics*, 89(4), 991-1004.

Boucher, S., Guirkinger, C., and Trivelli, C. (2006). Direct Elicitation of Credit Constraints: Conceptual and Practical Issues with an Application to Peruvian Agriculture. Working Paper, University of California – Davis.

Carter, M.R. (1988). Equilibrium Credit Rationing of Small Farm Agriculture. *Journal of Development Economics*, 28: 83-103.

Carter, M.R. and B. Barham (1996). Level Playing Fields and *Laissez Faire*: Post-Liberal Development Strategy in Inegalitarian Agrarian Economies *World Development*, 24, 7: 1133-1149.

Carter, M.R., F. Galarza and S. Boucher. (forthcoming). Underwriting Area-Based Yield Insurance to Crowd-In Credit Supply and Demand," *Savings and Development*.

Carter. M.R. and P. Olinto. (2003). Getting Institutions Right for Whom? Credit Constraints and the Impact of Property Rights on the Quantity and Composition of Investment. *American Journal of Agricultural Economics*, 85(1), 173-186.

Deininger, K. and J. Chamorro (2004). Investment and Equity Effects of Land Regularisation: The Case of Nicaragua. *Agricultural Economics*, 30(2): 101-116.

De Soto, H. (2000). The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else. Basic Books, New York.

Dower, P. and E. Potatmites (2006). Signalling Credit Worthiness: Land Titles, Banking Practices, and Access to Formal Credit in Indonesia. Unpublished mimeo, New York University.

Field, E. and Torero, M. (2006). Do Property Titles Increase Credit Access Among the Urban Poor? Evidence from a Nationwide Titling Program. Harvard University, mimeo.

Galiani, S. and E. Schargrodsky (2006). Property Rights for the Poor: Effects of Land Titling. mimeo, UTDT.

Gourieroux, A., and C.S. Monford. 1993. Simulation-based inference : A survey with special reference to panel data models, Journal of Econometrics 59, 5-33.

Mundlak, Y. (1978). On the Pooling of Time Series and Cross Section Data, *Econometrica*, **46**(1), 69-85

Stiglitz, J. and A. Weiss. (1981). Credit Rationing in Markets with Imperfect Information. *American Economic Review*, 3(71), 393-410.