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Credit Constraints and Productivity in Peruvian Agriculture

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Credit Constraints and Productivity in Peruvian Agriculture

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Abstract: In this paper we theoretically and empirically evaluate the impact of credit constraints on agricultural productivity in a developing country context. We develop a simple model that illustrates how different types of credit constraints have a similar negative impact on farm productivity. We then empirically explore the relationships between productivity and endowments of land and liquidity for constrained and unconstrained households using panel data from Peru. We estimate a switching regression model using a first difference and a semi-parametric approach to control for selection and unobserved heterogeneity. Consistent with the model, we find that productivity depends on endowments for constrained households but not for unconstrained households. We estimate that alleviating all types of credit constraints would raise the value of output in the study region by 26%.

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Credit market failures are a long acknowledged problem in developing economies and have multiple implications in terms of efficiency and equity. A growing empirical literature analyzes the impacts of credit constraints both on long term investments, such as fixed farm assets (Carter and Olinto, 2003), and on short term profitability (Feder et. al., 1990; Foltz, 2004.) In Latin America, additional evidence on the prevalence of credit constraints and their impacts on farm efficiency is particularly important as pressure to relax or overturn the financial liberalization policies widely implemented in the past two decades rises. The primary contribution of this paper is to quantify the impact of formal sector credit constraints on farm productivity in Peru, which liberalized rural financial markets in the early 1990's.

Our empirical methodology builds on several recent papers that acknowledge that credit constraints may take multiple forms (Boucher, Carter and Guirkinger (2005); Field and Torero (2006); Gilligan, Harrower and Quisumbing (2005)). In most empirical literature, households are classified as constrained only if they demonstrate an excess demand for credit. While quantity rationing may certainly impact farm productivity, there are two additional means by which asymmetric information may affect the credit contracts households have access to and thus impact households' resource allocation decisions. First, banks may pass on to borrowers the transaction costs associated with screening applicants, monitoring borrowers and enforcing contracts. Farmers with investments that are profitable when evaluated at the contractual interest rate may decide not to borrow once transaction costs are factored in. Second, lenders may require borrowers to bear significant contractual risk in order to mitigate moral hazard. If this risk is too great, a farmer will prefer not to borrow even though the loan would, on average, raise his productivity and income. Just like a quantity rationed household, the resource allocation and productivity of a household facing transaction cost rationing or risk rationing will be altered relative to a first-best world. We thus argue that quantity rationed, transaction cost rationed and risk rationed individuals should all be considered credit constrained.

Our analysis proceeds as follows, we first introduce a model that generates the three types of non-price rationing underlying credit constraints and show how each type lowers farm productivity. We then turn to our empirical application in rural Peru. Peru represents a particularly interesting context for two reasons. First, it recently carried out a far-reaching liberalization of rural credit markets. Second, small farms, for whom we expect information problems to be particularly severe, control the vast majority of high quality land. After describing the study context, we turn to the challenge of econometrically identifying the impacts of credit constraints using non-experimental data. We examine impacts in two ways. First, we compare the relationship between productivity and endowments of land and liquidity across constrained and unconstrained households. We control for potential problems of selection and unobserved heterogeneity by estimating a switching regression model with panel data. Consistent with the theoretical model, we find that productivity of households that are unconstrained in the formal credit market is independent of their endowments. Productivity of credit constrained households, in contrast, is tightly linked to their endowments of land and liquidity. We then use the results of the regressions to generate an estimate of the increase in productivity that would result from relaxing formal sector credit constraints. We find that relaxing credit constraints would raise the value of output in the study region by just over 25%.

Multiple Forms of Credit Constraints and Household Resource Allocation: A Basic Model

As noted in a long line of theoretical literature, multiple market failures can give rise to heterogenous resource allocation across households with varying endowments of productive assets.[1] An important conclusion of this literature is that a household that is quantity rationed in the credit market, i.e. one that has unmet demand for contracts that exist in the market, will under-invest relative to a credit unconstrained household. As shown by Stiglitz and Weiss (1981), equilibrium quantity rationing derives from lenders' unwillingness to raise the interest rate to clear excess demand because doing so would result in adverse selection of the applicant pool or morally hazardous behavior by borrowers. Quantity rationing may also result from a household's inability to post the quantity or quality of collateral the lender requires to overcome the information problems intrinsic to credit transactions. The adverse consequences of quantity rationing are clear; quantity rationed individuals are *involuntarily* excluded from the credit market and forego an expected income enhancing opportunity.

The actions taken by lenders to reduce information problems may also induce some households to *voluntarily* withdraw from the credit market even though they have investments that are profitable when considered against the interest rate, or price, of available loans. In this paper, we focus on two additional forms of non-price rationing, namely transaction cost rationing and risk rationing. Ex-ante screening of applicants and ex-post monitoring of borrowers can imply significant monetary and time costs. Meeting collateral requirements may also imply significant costs including verification that the asset has a registered title and is free of liens as well as the registration of the lien in favor of the lender. An individual is *transaction cost rationed* if the non-interest monetary and time costs that arise because of asymmetric information lead an individual to refrain from borrowing. If individuals lack access to insurance, then collateral may have an additional repressive effect on loan demand as some individuals may not be willing to risk losing their assets. Without asymmetric information, lenders would be willing to write highly state-contingent credit contracts that shift risk from the borrower to the lender . This type of insurance cum credit contract is infeasible in the presence of moral hazard, however, because the insurance inherent in the credit contract dilutes the borrower's incentives to reduce default risk. We follow Boucher, Carter, and Guirkinger (2005) and label as *risk rationed* those individuals who have access to an expected-income-enhancing loan but do not take it, instead retreating to a lower return but lower risk reservation activity.

We define as credit *constrained* those individuals that would participate in the credit market in a first-best world but withdraw from the credit market as a result of asymmetric information. Quantity rationed individuals involuntarily withdraw; they have excess demand for credit that is not met by lenders. Transaction cost and risk rationed individuals involuntarily withdraw; they have access to loans that, considering the interest rate, would raise their expected income; however the non-interest costs deriving from lenders' strategies to mitigate adverse selection and moral hazard drive their expected utility from borrowing below their reservation utility. A key insight from this discussion is that the interest rate is only one component of the cost of a loan. The transaction costs and risk implied by the loan contract represent additional costs born by the borrower and create a wedge between the market price (interest rate) and the true cost of a loan. As in the market participation literature (Goetz (1992); Key, Sadoulet and de Janvry (2000); and Bellemare and Barrett (2006)), those households whose willingness to pay for first-best loan contracts falls within this "price band" will refrain from participating in the credit market and their resource allocation will be tightly linked to their endowments. In the remainder of this section we develop a basic model that demonstrates that each of the three forms of non-price rationing breaks the independence between household endowments and input intensity, so that credit constrained households reach a lower level of farm productivity than unconstrained households.

Consider a farm household endowed with land, A, and liquidity, K. Land quality is homogeneous across households; however, some farmers have a title for their land while others do not and cannot acquire one. Let T be a binary variable taking value zero if the household has a title and zero otherwise. For simplicity, also assume there is no land rental market.[2] Farm production is certain, and is carried out with a technology, $F(N, A)$, that exhibits constant returns to scale in land and a variable input, N, that we call fertilizer. Given that land is a fixed factor, farm profit, P is:

$$P(n; A) = A[f(n) - pn] \tag{1}$$

where $n \equiv \frac{N}{A}$, is the per-hectare level of fertilizer, p is the fertilizer price and $f(n) \equiv F(\frac{N}{A}, 1)$ is the per-hectare production function. The output price is normalized to one. The function f is strictly concave so that there exists a unique profit maximizing level of fertilizer per hectare, n^*, that is independent of the household's land endowment.

Households may seek a bank loan to finance production. A loan contract specifies three terms: loans size, B, interest rate, and collateral. We do not explicitly endogenize the latter two terms. Instead, we assume that, in response to asymmetric information, lenders require that all loans be fully collateralized. Assume that the bank's opportunity cost of funds is zero so that, under competition, the interest rate charged on loans is also zero.[3] Borrowers potentially face two types of transaction costs. First, all borrowers incur a fixed cost, t, representing the time and monetary costs of loan application and disbursement and the costs of collateral registration. Second, defaulters incur an additional cost, v, representing the administrative cost of land foreclosure which is passed on to the borrower.

The household maximizes the expected utility of its end-of-period consumption which is financed by farm income and the value of end-of-period assets which includes any liquidity not used in farming plus the value of land. Liquidity not used in farming earns a zero interest rate, and the household sells any land that was not foreclosed upon at price r per unit area.

To capture uncertainty, assume that with probability $1 - \pi$, the household confronts a consumption shock of size s. When hit by the shock, households who borrowed to finance production must divert farm revenues intended to repay their loan to instead cover the consumption need and, as a result, they default. The lender forecloses on the land and sells it to recuperate the principal plus the foreclosure cost, v.

The consumption shock captures non-production sources of risk facing rural households such as sickness, injury, theft, and ceremonial obligations. The primary reason for invoking this additive form of risk is analytical simplicity. The additive shock implies that, conditional on their credit market participation decision, households will behave as profit maximizers in their production decisions. Household risk aversion will, however, influence the decision of whether or not to participate in the credit market.[4] Non-production shocks are, in northern Peru as in many rural areas of the developing world, an important source of uncertainty and can significantly influence households' credit market participation. In the sample, 80% of the negative shocks reported by households for the 12 months preceding the survey in 2003 were unrelated to farm production. This type of risk can significantly influence households' credit market participation.

With this background, the household chooses the level of input, n, and borrowing B, to maximize expected utility according to the following program:

$$\underset{n,B}{Max} \quad \pi U(C^g) + (1-\pi)U(C^b) \tag{2}$$

$$\begin{aligned}
\text{subject to} \quad &: \\
C^g &= P(n;A) + K + rA - tI(B>0) \quad (3)\\
C^b &= P(n;A) + K + rA - s - (t+v)I(B>0) \quad (4)\\
pAn &\leq K + B - tI(B>0) \quad (5)\\
0 &\leq B \leq rAT \quad (6)
\end{aligned}$$

Equations 3 and 4 give the household's consumption under the two states of nature. C^g is the household's consumption under the good state of nature and is the sum of the household's full income minus the transaction cost of loan application if, as indicated by the indicator function I, the household borrows. C^b is consumption under the bad state which is reduced by the consumption shock, s, and, if the household borrowed, by the cost of foreclosure v. Equation 5 limits expenditures on fertilizer to the value of the household's liquidity plus borrowing. Finally, equation 6 describes the household's credit limit, which is equal to the value of its titled land. Assume that $n^* < r$, so that borrowers can obtain a loan amount sufficient to reach n^*.

This framework enables us to explore the interplay between endowments, the various types of credit constraints and resource allocation. Of particular interest is whether or not a household reaches the maximum attainable farm profits given its land endowment. First, consider households with $K \geq pAn^*$. Given that there is no production risk, these high liquidity households will self-finance farm production and reach the maximum attainable profit. These households are unconstrained – or price rationed – in the credit market.

Next, consider the remainder of households with $K < pAn^*$. These households have insufficient liquidity to reach the maximum attainable profit without borrowing. Households with land titles have the option of borrowing or self-financing production. If the household borrows, its choice of fertilizer intensity is governed by the first order condition: $f'(n) = p$. Borrowing households thus mimic the production decision of the high liquidity, self-financing households and reach the profit maximizing level, n^*. If instead the household self-finances, it invests its entire stock of liquidity in farm production and falls short of the profit maximizing input level, so that: $f'(n) > p$.

Why would a low-liquidity household that is able to borrow choose not to reach the profit maximizing input level? There are two reasons. First, for households with intermediate liquidity to land ratios, the fixed transaction costs of borrowing may drive the expected value of consumption with a loan below the expected value under self-finance. In this case, borrowing would be both more expensive and more risky than self-finance. Households in this situation are transaction cost rationed.[5] Second, compared to self-finance, borrowing implies an additional risk. If borrowers experience the negative consumption shock, they default and incur the foreclosure cost, v. Thus, even if a loan raises expected consumption relative to self-finance, a household will forego the loan if the additional risk is too large.[6] For these risk rationed households consumption is, on average, higher with a loan; however, it is lower in the bad state when it is most valuable.

The final group to consider includes those households that have neither title - and thus cannot qualify for a loan - nor sufficient liquidity to purchase the unconstrained profit maximizing input level. These households will be either quantity rationed, transaction cost rationed or risk rationed. Quantity rationed farmers are those who would borrow if they had access to a loan (i.e., if they had title). Households who would not borrow, even if they had a title, are either transaction cost rationed or risk rationed.

To summarize, all three forms of credit constraint break the independence between a household's endowments and its resource allocation decisions. Unconstrained farmers, whether they self-finance or borrow, operate at the profit maximizing level of inputs per hectare. An increase in their endowment of land or liquidity would have no effect on either output or profit per hectare. Thus, for unconstrained households the following condition holds: $\frac{\partial f}{\partial K} = \frac{\partial f}{\partial A} = 0$. In contrast, for credit constrained households, a change in endowments will affect output per hectare. Consider the effect of an increase in liquidity for a constrained household. As discussed above, whether this constrained household is transaction cost, risk or quantity rationed, it applies less than the profit maximizing level of inputs per hectare. Since there is no risk-return tradeoff in the investment of own liquidity in farm production, any increase in a constrained household's endowment of liquidity will be invested in farm production. Thus, for constrained households $\frac{\partial f}{\partial K} > 0$; output per hectare is increasing in liquidity. Conversely, an increase in a constrained household's land endowment will lower productivity, $\frac{\partial f}{\partial A} < 0$, since scarce variable inputs will be spread over a larger area. These comparative static relationships are the focus of the ensuing empirical analysis.

Data and Context

The Study Area

The study is set on the northern coast of Peru in the department of Piura. Agriculture in this area is exclusively irrigated and the well-developed system of reservoirs and irrigation and drainage canals greatly reduces risk associated with the amount and timing of water. Rice, cotton and corn are the main annual crops and are destined primarily for the domestic market. Piura's tropical climate and relatively good ports also favor the production of perennial export crops including bananas and mangos.

As a result of Peru's agrarian reform (1969-1979), small farms control the majority of agricultural land. In Piura, 91% of irrigated land is controlled by farmers that own less than ten hectares, and the mean farm size is just under three hectares. While all land is individually operated, not all land has a formally registered property title. In 1997, the first year of our panel data set, there were two main reasons that a parcel might not have been titled. First, a significant portion of agricultural land is controlled by peasant communities (*comunidades campesinas)*. Similar to Mexico's ejidos, the community owns the land and grants usufruct rights to individual community members. While use rights over community land can be bequeathed, land cannot be sold without community authorization nor can it be registered in the private property registry. As a result, community land cannot be mortgaged. Second, a large fraction of parcels were previously part of the collectively operated agrarian reform cooperatives. By the end of the 1980s, virtually all cooperatives completed a privatization process that allocated land to individual cooperative members. In many cases, this process was not accompanied by a formal survey of the individual parcels so that owners of these parcels were unable to acquire a registered property title. By the end of the 1990s, two policies were implemented to extend private property titles. First, congress passed a law allowing peasant communities to privatize their land. Second a large scale titling program was carried out both in the peasant communities that opted for privatization as well as throughout the ex-cooperative areas.[7]

The limited liquidity of most small farmers plus the high input requirements of the commercial crops grown in the region combine to make credit a critical determinant of farm production. The rural credit market in turn, has undergone significant changes in the last fifteen years. Until 1992, the Agrarian Development Bank (*Banco Agrario*) held a monopoly over formal agricultural credit in Peru. The government of Alberto Fujimori (1990-2000) implemented a financial liberalization program that shut down the Agrarian Development Bank in 1992, and eliminated interest rate controls in order to induce commercial banks to increase their presence in rural areas. The government also promoted the establishment of rural banks (*cajas rurales*), and the strengthening of municipal banks (*cajas municipales*). These local banks are the primary formal financial intermediaries for small farmers in the post-liberalization environment. Alongside this set of formal institutions, a vibrant informal credit sector coexists. Informal loans are primarily offered by local business owners, such as grain traders, rice mills and input supply stores. Finally, there is a small set of microfinance institutions run by NGO's and local government that provide a small amount of subsidized loans to small farmers. We refer to these institutions as the semi-formal sector.

Given this background, the specific question we seek to answer is: How do *formal sector* credit constraints impact farm productivity? Whether or not and how much credit constraints in the formal sector matter will depend, in part, on the alternatives available in the informal sector. In fact, because they enjoy informational advantages vis-a-vis banks, informal lenders may potentially relax each of the three types of constraints may face in the formal sector. First, since informal lenders tend to offer loans to households they know through previous transactions in input or output markets for example, loan applications in the informal sector imply minimal transaction costs (Mushinski, 1999). In addition, informal lenders rely less on physical collateral and more on monitoring and social sanctions to enforce contracts. As a result, informal lenders may be able to offer the types of low collateral, high interest rate loans that banks are unable to supply. An active informal sector may thus relax constraints due to quantity and risk rationing that households face in the formal sector (Boucher and Guirkinger, 2006). Indeed, if the informal sector is a good substitute for an imperfect formal sector, then we would expect to find little difference in the resource allocation of households that are constrained versus those that are unconstrained in the formal sector. However, as we show in the econometric analysis, formal sector credit constraints indeed affect resource allocation, suggesting that the informal sector is not a perfect substitute to the formal sector.

Sample and Data

Our econometric analysis is based on a panel data set of farm households that were surveyed in 1997 and again in 2003. The full 1997 sample included 547 farm households. 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 farm production data for both years.[8] Detailed information was collected about farm output, production costs, off-farm income, assets and the household's participation in and perceptions of credit markets.

The survey allows us to use a "direct elicitation" approach to classify households as constrained or unconstrained in the formal credit market and, if constrained, to further identify whether the constraint derives from quantity, transaction cost or risk rationing. This approach utilizes a combination of observed outcomes and qualitative questions to detect credit constraints.[9] The first step is to separate households that applied versus those that did not apply for a formal loan. Applicant households are classified according to the outcome: rejected applicants are quantity rationed (constrained), while those whose demand was met are price-rationed (unconstrained). Classification of non-applicant households requires additional information. These households were first asked whether or not any formal lender would offer them a loan if they were to apply. If they said yes, they were then asked why they had not applied. Those that said they had sufficient liquidity, the interest rate was too high, or they had no profitable investments were classified as price-rationed (unconstrained). Those that instead stated that the time, paperwork and fees of applying were too costly were classified as transaction cost rationed (constrained); while those that cited fear of losing their land were classified as risk rationed (constrained). Finally, households that stated that no formal lender would offer them a loan were asked whether or not they would apply for a loan if they were guaranteed that a bank would approve their application. Those that said yes were classified as quantity rationed (constrained). Those that said no were then asked why not, and their answers were used to classify them as price rationed, transaction cost rationed, or risk rationed as above.

Descriptive Statistics

In this section, we briefly describe households' participation in credit markets and the prevalence of credit constraints in the sample. We also provide descriptive evidence of the differences in farm productivity between constrained and unconstrained households that will motivate the ensuing econometric analysis.

Table 1 reports the fraction of sample households that borrowed from each sector in the two survey years. In both years, the majority of households used some credit, although the frequency of households with a loan drops between the two years. This drop in loan use is mainly due to a decrease in the use of semi-formal loans. Several NGOs offering loans at the time of the first survey were either shut down or significantly curtailed their agricultural loan portfolios due to widespread loan default in 1999 and 2000 resulting from the 1998 El Niño occurrence, and the general financial and political crisis facing Peru at the end of President Fujimori's term.

Table 2 compares loan terms across the three sectors. The first two columns report interest rates for those loans that charged a strictly positive interest rate.[10] On average, informal lenders charged just over 8% interest per month in 1997 and 10% in 2003. The average interest rate on formal loans was just under 4% per month in both years. The lowest interest rates are found in the semi-formal sector, reflecting their subsidized status.

The next four columns of table 2 compare loan size and maturity across sectors and years. In 1997, formal loans in the sample were significantly larger and longer term than loans from the other two sectors. The differences across sectors decreased, however, by 2003 as the mean loan size in the formal sector fell by 45%, from $2,965 to $1,560. In 2003, the mean maturity increased substantially in the formal and semi-formal sector. This increase is driven by the refinancing of a few formal and semi-formal loans over a 20 year period.[11] In fact, *median* maturities across loan sectors (not reported in the table) decreased between 1997 and 2003 from 7 to 6 months for formal loans, from 6 to 5 months for informal loans and from 8 to 6 months for semiformal loans. These maturities are consistent with households' reporting that loans from all sectors were overwhelmingly used to finance variable costs of agricultural production. Formal loans, in general, require borrowers to post titled property (either agricultural land or homes) as collateral while informal and semi-formal lenders only rarely require any form of physical collateral.

Table 3 gives the frequency of formal sector rationing outcomes for the two survey years. The fraction of households that reported being constrained in the formal sector decreased from 56% to 43% between the two years. This decrease was spurred by a large decrease in the fraction of households that were quantity rationed (37% to 10%.) This is consistent with the advances in the government's land titling program between survey years. The fraction of sample households with a registered title increased from 50% to 70% between 1997 and 2003 and among those who switched from quantity rationed to unconstrained, the increase was even larger from 33% to 73%. This large decrease was partially offset, however, by an increase in the incidence of risk rationing (9% to 22%.) This decrease in households' willingness to enter into loan contracts that require them to bear significant risk is consistent with the high degree of political and economic instability of recent years in Peru. Many sample households were adversely impacted by the 1998 El Niño occurrence and the regional economic downturn that ensued.

We now turn to descriptive evidence regarding the impact of credit constraints on farm productivity. The specific question we seek to answer is: By how much would productivity increase if formal credit constraints would be relaxed? Table 4 compares various productivity measures across constrained and unconstrained households and thus can be used to generate a naive, or unconditional, impact estimate. The first column shows that the average revenues of constrained farmers were $884 per hectare while for unconstrained farmers revenues were just over $1,537 per hectare. The second column shows that expenditures per-hectare on variable inputs were also significantly less for constrained than unconstrained farmers. The final column shows that, subtracting expenditures from gross revenues, unconstrained farmers' net revenue per-hectare was about $350 more than that of constrained farmers. According to these unconditional, estimates credit constraints have a large dampening effect on farm productivity. Because the credit constraint status was not randomly assigned across households, we need to control for systematic differences across constrained and unconstrained households in order to move beyond correlation and identify the causal impact of credit constraints. This is the task we now turn to.

Econometric Model

To analyze the impact of credit constraints on productivity we estimate the following switching regression model:

$$y_{it} = \begin{cases} y_{it}^C = \beta^C A_{it} + \gamma^C K_{it} + \delta^{C\prime} X_{it} + \theta^{C\prime} Z_{it} + \alpha_i^C + \varepsilon_{it}^C & \text{if } d^* > 0 \\ y_{it}^U = \beta^U A_{it} + \gamma^U K_{it} + \delta^{U\prime} X_{it} + \theta^{U\prime} Z_{it} + \alpha_i^U + \varepsilon_{it}^U & \text{if } d^* \leq 0 \end{cases} \tag{7}$$

$$d_{it}^* = \lambda' W_{it} + \rho A_{it} + \sigma' X_{it} + \eta_i + \nu_{it} \tag{8}$$

$$d_{it} = \begin{cases} 1 \text{ if } d_{it}^* > 0 \\ 0 \text{ if } d_{it}^* \leq 0 \end{cases} \tag{9}$$

y_{it} is the observed productivity of household i in period t. The data are characterized by censoring since, in a given period, y_{it} is either equal to the constrained value of productivity, y_{it}^C, or the unconstrained value of productivity, y_{it}^U. d_{it}^* is the latent propensity to be constrained for household i in period t. The binary variable d_{it} takes value one if d_{it}^* exceeds a threshold value arbitrarily set at zero and corresponds to household i being observed as constrained, either by quantity, transaction costs or risk, in the formal credit market in period t. If the household is instead unconstrained, d_{it} takes value zero. A_{it} and K_{it} are the household's endowments of land and liquidity. X_{it} is a vector of time varying household control variables that explain both productivity and the household's credit constraint status. Z_{it} is a vector of time varying household control variables that explain productivity, but, along with K_{it}, are excluded from the credit constraint equation because they are potentially endogenous to the constraint status of the household.[12] W_{it} is a vector of exclusion restriction variables that explain the constraint status but not productivity. $\beta^C, \gamma^C, \delta^C, \theta^C, \beta^U, \gamma^U, \delta^U, \theta^U, \lambda, \rho$, and σ are parameter vectors to be estimated. α_i^C, α_i^U, and η_i represent the effect of unobserved household specific, time invariant factors on the household's credit constraint status and productivity. Finally, $\varepsilon_{it}^C, \varepsilon_{it}^U$, and ν_{it} are mean zero, time varying error terms assumed uncorrelated with the regressors in their respective equations.

The productivity measure we use as the dependent variable in equation 7 is the value of output per hectare.[13] Table 5 lists all explanatory variables along with their definition and mean for each constraint regime. The household's land endowment, A_{it}, is measured as the household's farm size which is the sum of land owned plus rented-in. Household liquidity, K_{it}, is the sum of the household's savings plus the total amount of credit received from any source in the previous twelve months.[14]

The vector X_{it} includes the total number of adults in the household, the dependency ratio, the number of adults holding a salaried job, the number of cows owned by the household and the value of durable goods owned by the household. The vector Z_{it} includes dummy variables indicating which crops were grown by the household. We include the first three variables because farm productivity of credit constrained households may depend on the amount of available family labor. If family and hired labor are imperfect substitutes, the available family labor will also affect productivity of unconstrained households. The stock of durable goods is included to control for large shocks between survey years that may have affected productivity. A health shock, for example, could imply a large expenditure and lead to a change in the stock of durables. The herd size and crop choice variables are included to control for differences in input requirements and expenditures across households. As crop choices in year t may depend on the household credit constraint status in that same year, we exclude them from the constraint equation. For the same reason, K_{it} is excluded from the constraint equation.

Finally, W_{it} includes two variables. The first is a binary variable taking value one if the household has a registered land title and zero otherwise. As the primary asset accepted by formal lenders as collateral is titled land, having a title is anticipated to decrease the probability of being constrained.[15] The second is a continuous measure of the proportion of a household's neighbors with a formal loan. A higher fraction of neighbors participating in the formal credit market is anticipated to decrease the probability of being constrained, as it is likely to reduce both the transaction cost associated with loan application and the uncertainty resulting from an incomplete understanding of contract terms. Focus groups with farmers from the sample revealed that a large part of the transaction cost of loan application are related to the lack of information about the process and that new borrowers are often helped by a neighbor when they apply for a loan for the first time. In addition, households who have no contact with borrowers often have a biased perception of the liability rules of credit contracts and tend to overstate the risk associated with a formal loan. This variable is constructed using a weighting matrix where the weights are inversely proportional to the distance between households. Neighbors are defined as households living within 10 km of the household considered.

Estimation Techniques

The theoretical model generated hypotheses regarding the sign of the coefficients on the household's endowments of land and liquidity for constrained and unconstrained households. In particular, we expect $\beta^C < 0, \gamma^C > 0$ and $\beta^U = \gamma^U = 0$. Two potential problems arise in estimating the parameters of interest in the productivity equations. First, selection bias may result if there is a non-zero correlation between unobserved terms across the credit constraint and productivity equations. For example, unobserved land quality may directly affect both the household's credit constraint status and its productivity. Second, an omitted variable bias may result from a non-zero correlation between the household fixed effect and the explanatory variables within each productivity equation. For example, unobserved farming ability may impact productivity and be correlated with the household's endowments.

Given these potential problems, we estimate the parameters of the two productivity equations by running OLS on the first difference, or change in productivity. By "sweeping out" the household fixed effects (α_i^C and α_i^U), the first difference estimation addresses the omitted variable bias mentioned above. It would also address the selection problem if selection is due only to correlation between the unobserved terms from the credit constraint equation and the fixed effect in the productivity equations.[16] Returning to the previous example, if the potential selection bias is due to unobserved time invariant land quality, then the first difference estimation would eliminate the selection bias.[17]

A first difference approach would not yield consistent estimates, however, if the selection bias derives from time varying unobservables. Continuing the previous example, if the quality of land cultivated by a household changed over the 7 years between the two surveys, then the first difference strategy would not completely eliminate the selection bias. There are several techniques that deal with this "residual" selection bias in panel data. Wooldridge (1995) develops a parametric technique that is similar to Heckman's cross-sectional selection correction method. Wooldridge suggests a test for the presence of residual selection bias in this framework. When we run this test, we cannot reject the null of no residual selection bias.[18] If we are willing to make the distributional assumptions underlying the Wooldridge framework, then we would conclude that the first difference parameter estimates are unbiased. These assumptions, however, are strong.[19] We may fail to reject the null hypothesis and yet still face residual selection bias if the errors in the selection and productivity equations do not follow the joint distribution assumed by this technique.

To address this concern, we also estimate the model with the semi-parametric estimation strategy introduced by Kyriazidou (1997). This approach controls for residual selection bias without parameterizing the sample selection effects in the productivity equations. The estimation proceeds in two steps. First, the parameter estimates of the credit constraint equation are estimated using a conditional logit. Then the parameters of each productivity equation are estimated with a weighted OLS on the first difference, with "kernel weights" that are computed using the parameter estimates of the first stage constraint equation.[20]

Results

Before discussing the primary results of interest, namely the estimates of the two productivity equations, we briefly comment on the parameter estimates of the selection equation (column C, table 6) which are used in the Kyriazidou but not the linear panel approach. As expected, possession of a registered property title and a larger proportion of neighbors participating in the formal credit market reduce the probability of being credit constrained in the formal credit market .[21] We now turn to the primary results of the paper. We divide the discussion into two parts. First, we examine the relationship between endowments and productivity for constrained versus unconstrained households. Second, we use the regression results to compute an estimate of the reduction in productivity attributable to credit constraints.

Credit Constraints, Endowments and Productivity

Columns A and B of table 6 give parameter estimates for the unconstrained and constrained productivity equations respectively for the linear panel estimation. Columns D and E do the same for the Kyriazadou estimation. The results of both estimation techniques are consistent with the predictions of the theoretical model. The coefficients on farm size and liquidity are not significantly different from zero for unconstrained farmers, while for constrained farmers, productivity is decreasing in farm size and increasing in liquidity. The magnitudes of these two coefficients are slightly larger with the Kyriazidou technique. A thousand dollar increase in liquidity raises the value of production per hectare by about $180 according to the linear panel results and by $260 according to the Kyriazidou, suggesting that the additional liquidity would indeed be invested in farm production. Given that the mean value of output per hectare reported in table 4 was just under $900 for constrained households, this represents a 20 to 30% increase in productivity. In contrast, an additional hectare of land would decrease output per hectare by just over $130 and $164 according to the linear panel and Kyriazidou estimations respectively.

To examine the robustness of the results, we repeat the linear panel estimations under two alternative specifications. In the per-hectare specification, the dependent variable is again the value of output per hectare, while the household endowment of liquidity and labor are expressed per-unit of land. In the log-linear specification, productivity and households' endowment of land, liquidity and labor are expressed in log form. The parameter estimates are reported in the final four columns of table 6. In general, the results discussed above hold in both alternative specifications. Constrained productivity is a decreasing function of the land endowment, while unconstrained productivity is independent of the household's land endowment. The only departure from the theoretical predictions comes when the log-linear specification is estimated via linear panel. Liquidity has a positive and significant impact on both constrained and unconstrained productivity. We take some comfort in the fact that the magnitude of the coefficient on liquidity is smaller for unconstrained productivity.

Efficiency Loss due to Credit Constraints

The results discussed above suggest that household resource allocation is impacted by credit constraints. We now turn to quantifying the magnitude of this impact on farm productivity. The specific question we ask is: By how much would the productivity of farmers constrained in the formal sector increase if their credit constraint were removed? We are thus interested in constructing an estimate of $\Delta_{it} \equiv y_{it}^U - y_{it}^C$ for households that are credit constrained. The conditional expectation of interest is thus:

$$E(\Delta_{it}|d_{it}=1) = (\beta^U - \beta^C)A_{it} + (\gamma^U - \gamma^C)K_{it} + (\delta^U - \delta^C)'X_{it} + (\theta^U - \theta^C)'Z_{it} + (\alpha_i^U - \alpha_i^C) + E(\varepsilon_{it}^U - \varepsilon_{it}^C|d_{it}=1) \quad (10)$$

The last two terms of equation 10 complicate the estimation of this impact.[22] The final term will be non-zero if there is residual selection. Since the semi-parametric technique of Kyriazidou does not impose a functional form on the joint distribution of ε_{it} and ν_{it}, we cannot estimate this conditional mean. We therefore rely on the results from the linear panel estimation. Estimating the household fixed effects is also problematic. At most, we have two observations to identify α_i^U and α_i^C.[23] As a result we cannot generate reliable estimates of the fixed effects. In order to estimate the impact, we assume that the household fixed effects have the same impact on constrained and unconstrained productivity: $\forall i, \alpha_i^U = \alpha_i^C$. The predicted impact for each constrained household is thus computed as:

$$\hat{\Delta}_{it} = (\hat{\beta}^U - \hat{\beta}^C)A_{it} + (\hat{\gamma}^U - \hat{\gamma}^C)K_{it} + (\hat{\delta}^U - \hat{\delta}^C)'X_{it} + (\hat{\theta}^U - \hat{\theta}^C)'Z_{it} \quad (11)$$

where $\hat{\beta}^U, \hat{\beta}^C, \hat{\gamma}^U, \hat{\gamma}^C, \hat{\delta}^U, \hat{\delta}^C, \hat{\theta}^U, \hat{\theta}^C$ are the parameter estimates reported in the first two columns of table 6.

Table 7 summarizes the predicted impact of alleviating the three types of credit constraints.[24] Column A gives the frequency over the two years of each type of constraint in the sample. The last row of this column shows that, on average, 49.5% of households were constrained each year. Column B reports the mean change in productivity, $\bar{\hat{\Delta}}$, for each type of constraint. The productivity loss due to credit constraints is large. We estimate that, on average, the value of output would increase by \$482 per hectare if all types of credit constraints were fully relaxed. As shown in column C, this represents an increase of 59% over the average observed productivity of constrained households. The final two columns are used to generate a rough estimate of the value of output foregone in the region due to credit constraints.[25] Column D reports an estimate of the percentage of land in Piura in the hands of constrained households. Note that constrained households are estimated to control 44.3% of the region's land, although they account for 49.5% of sample households. This reflects the fact that the average farm size of constrained households, at 4.5 hectares, is slightly below the mean of 4.9 hectares for unconstrained households. Finally, column E, the product of columns C and D, reports the estimated percentage increase in the value of regional output resulting from relaxing each type of credit constraint. If all constraints were alleviated, the value of output would increase by 26%. The vast majority of the impact derives from quantity and risk rationing. While the frequency of risk rationing is less than that of quantity rationing, the increase in regional output due to risk rationing, 10.9%, is almost the same as the increase due to quantity rationing, 11.9%. This is due to the larger relative impact of risk rationing on productivity. These results demonstrate the importance of the broader definition of credit constraints. Ignoring constraints due to transaction cost and particularly risk rationing would result in a significant under-statement of the impact of credit constraints and thus lead to an overly optimistic evaluation of the health of rural financial markets.[26]

Conclusion

In this paper, we developed a basic model to show that credit constraints can take multiple forms, each of which breaks the independence between household's resource allocation and endowments. We then empirically compared the relationship between productivity and endowments across credit constrained and unconstrained households in Peru. While most empirical studies include only quantity rationed households in the constrained category, we also include, as indicated by the theory, households that are risk rationed and transaction cost rationed. We find that the productivity of constrained households, unlike that of unconstrained ones, indeed depends upon their endowments of productive assets. We show that credit constraints have a large negative impact on the efficiency of resource allocation in the study region. We estimate that the value of agricultural production in Piura would increase by 26% if all credit constraints were eliminated.

The broader definition of credit constraints used here suggests that mitigating rural credit market imperfections requires a broader policy response than contemplated in recent financial liberalization efforts. The first stage of most financial liberalization programs in Latin America was accompanied by liberalization of agricultural land markets in the form of land titling programs, investment in land registry institutions and the elimination of legal restrictions on land transfer. The deepening of these reforms, by facilitating the use of land as collateral, may reduce the incidence of quantity rationing. As a portion of the transaction costs associated with loan application derives from collateral registration, these reforms, along with reforms aimed at enhancing the efficiency of the legal system and strengthening information sharing via credit bureaus, may also reduce transaction cost rationing. The aforementioned policies are likely to do little, however, to alleviate risk rationing. The prevalence of risk rationing suggests that enhancing the performance of rural credit markets also requires addressing the insurance market failures endemic to rural areas of developing countries.

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Table 1: Credit Market Participation by Sector

% of sample using:	**1997**	**2003**
Formal loan	27.5%	25.0%
Informal loan	35.5%	33.5%
Semi formal loan	16.0%	7.0%
No loan	28.0%	42.0%

Table 2: A Comparison of Mean Loan Terms across Sectors (standard deviation in parentheses)

	Interest rate (monthly)		**Size** ($US 2003)		**Maturity** (months)		**% Requiring Collateral**	
Sector	**1997**	**2003**	**1997**	**2003**	**1997**	**2003**	**1997**	**2003**
Formal	3.8 (1.3)	4.2 (1.5)	2965 (6481)	1560 (1994)	9.3 (9.2)	11.9 (27.0)	58	60
Informal	8.5 (3.6)	10.1 (4.0)	492 (508)	360 (810)	5.6 (1.9)	5.3 (3.6)	0	9
Semiformal	1.7 (0.8)	3.4 (1.2)	1132 (999)	677 (850)	7.1 (1.69)	35.9 (43.9)	0	14

NOTE: All loan terms in the informal and semi-formal sectors are significantly different (at 5%) from the same term in the formal sector.

Table 3: Rationing Mechanisms in the Formal Sector

	1997	**2003**
Constrained	**56%**	**43%**
Quantity Rationed	37%	10%
Risk Rationed	9%	22%
Transaction Cost Rationed	10%	11%
Unconstrained	**44%**	**57%**
Borrowers	28%	25%
Non-borrowers	16%	32%

Table 4: Productivity Indicators: Pooled Sample Means and Standard Errors (in parentheses)

	Revenue per ha	**Cost per ha**	**Net revenue per ha**
Constrained	$884 (921)	$350 (299)	$534 (753)
Unconstrained	$1537 (1110)	$652 (498)	$885 (818)

Table 5: Mean and Standard Errors of Explanatory Variables by Constraint Status

Vector	**Variable**	**Definition**	**Unconst.**		**Const.**	
			Mean	Std.dev.	Mean	Std.dev.
A	A	Farm size (ha)	4.943	6.492	4.001	4.152
K	K	Liquidity: credit+saving (10^3 $)	2.193	4.809	0.558	1.108
	Labor	# adults	4.257	2.043	4.050	1.872
X	Dep Ratio	Children/household size	0.178	0.194	0.200	0.207
	Reg Inc	# adults w/ salaried job	0.150	0.415	0.103	0.333
	Herd	Head of cattle	1.525	4.417	1.644	4.032
	Rice	1 if cultivates rice	0.587	0.493	0.466	0.499
Z	Cotton	1 if cultivates cotton	0.147	0.355	0.276	0.448
	Banana	1 if cultivates banana	0.205	0.404	0.217	0.413
	Corn	1 if cultivates corn	0.257	0.437	0.441	0.497
	Durables	Value of durable goods (10^3 $)	6.325	23.169	2.947	3.791
W	Title	1 if has a title	0.710	0.454	0.482	0.500
	Neigh Part	proportion of neighbors w/ formal loan	0.362	0.274	0.204	0.221

Table 6: Estimation Results for the Productivity Equations under two Alternative Specifications of the Endowment Variables (standard errors in parentheses)

	Linear specification						**Kyriazidou**				**Per ha specification**				**Log-linear specification**			
	A		B		C		D		E		F		G		H		I	
	Prod		Prod		Selec		Prod		Prod		Prod		Prod		Prod		Prod	
	Uncons		Cons		Pr(Cons)		Uncons		Cons		Uncons		Cons		Uncons		Cons	
land	−85.57	(58.78)	−130.62**	(48.65)	−0.09	(0.09)	−48.86	(74.83)	−164.30**	(60.47)	−46.08	(59.44)	−115.69**	(48.10)				
K	14.45	(13.26)	182.67**	(82.27)			31.83	(30.18)	260.30**	(90.65)								
K/A											−14.31	(123.54)	647.06**	(236.49)				
Labor/A											−5.36	(41.39)	−34.04	(33.10)				
ln(A)															−0.13	(0.21)	−0.75**	(0.24)
ln(K)															0.11*	(0.06)	0.17**	(0.08)
ln(Labor)															−0.04	(0.18)	−0.10	(0.22)
labor	−61.50	(48.74)	2.33	(38.08)	0.15	(0.09)	−138.30*	(74.96)	−12.64	(52.55)								
dep rat.	490.90	(418.87)	10.34	(330.09)	0.62	(0.69)	−29.82	(516.60)	−182.20	(302.60)	739.83*	(392.32)	39.06	(319.62)	0.08	(0.38)	0.04	(0.50)
reg income	263.85	(167.80)	−14.79	(214.76)	0.43	(0.38)	−479.30	(297.90)	3.65	(221.10)	941.71	(331.47)	−76.30	(407.80)	0.21	(0.25)	−0.20	(0.51)
herd size	53.66**	(20.12)	40.89*	(21.76)	0.05	(0.04)	21.40	(35.56)	39.82	(30.39)	54.04**	(19.83)	38.61**	(20.99)	0.06**	(0.02)	0.03**	(0.03)
rice	632.30**	(252.99)	93.30	(147.59)			826.40**	(261.00)	333.10**	(194.70)	577.26	(264.82)	116.86	(147.12)	0.87**	(0.24)	0.90**	(0.22)
cotton	−279.51	(223.06)	−27.99	(153.51)			−628.40**	(271.30)	−245.70	(238.00)	−258.52	(220.96)	−32.23	(146.50)	−0.16	(0.22)	0.14	(0.24)
banana	−374.69	(267.39)	754.11**	(275.51)			182.90	(414.40)	190.50	(206.50)	−432.62	(263.50)	752.79	(270.30)	−0.41*	(0.24)	0.56	(0.42)
corn	61.04	(186.70)	−64.55	(117.97)			52.01	(234.80)	−145.60	(203.30)	3.47	(179.66	−38.63	(116.82)	0.15	(0.17)	0.20	(0.18)
durables	5.03*	(2.67)	4.83	(28.11)	−0.01	(0.03)	8.17	(24.28)	−64.86	(42.40)	6.41	(2.52)	6.31	(26.33)	0.00*	(0.00)	0.03	(0.04)
constant	1493.80**	(344.02)	977.59**	(262.72)			1233.00**	(388.60)	1495.00**	(317.60)	1077.08**	(338.02)	952.11**	(247.90)	6.39**	(0.36)	6.58**	(0.44)
title					−1.18**	(0.30)												
participneigh					−1.20	(0.78)												

*,**: parameter estimate significantly different from zero at 10 and 5%, respectively.

Table 7: Lost Due to the Various Types of Credit Constraints (bootstrapped standard errors in parentheses)

	A	B	C	D	E
Type of credit constraint	Frequency in sample	Productivity change \$ ($\bar{\hat{\Delta}}$)	Relative change ($\frac{\bar{\hat{\Delta}}}{\bar{y}}$)	Land controlled	Impact on regional output
Quantity Rationed	23.5%	516 (176)	58.2%	20.5%	11.9% (4.5)
Risk Rationed	15.5%	478 (175)	68.2%	16.0%	10.9% (4.7)
Trans. cost Rationed	10.5%	413 (216)	49.0%	7.8%	3.8% (2.1)
All constrained hhlds	49.5%	482 (149)	58.9%	44.2%	26.0% (8.4)

Standard errors are obtained by replicating the computation of each cell for 1000 bootstrapped samples.

Notes

[1]Key expositions of non-separable household models are given by Singh et al. (1986) and De Janvry et al. (1991).

[2]This assumption about land markets is roughly consistent with the economic environment of northern Peru, where the empirical analysis is situated. In the sample, only 4% of the total area farmed by households is rented. Rental includes both fixed rent and sharecropping.

[3]A more complete model would fully endogenize collateral and interest rate, recognizing that these two terms are substitutes in the lender's return function. As demonstrated by Boucher, Carter, and Guirkinger (2005), moral hazard limits the degree to which lenders can substitute higher interest for lower collateral and thus truncates the menu of available contracts. The model in this paper can thus be viewed as a severe version of this truncation in which all contracts that are not fully collateralized are ruled out.

[4]Stated another way, this assumption limits the impacts of risk rationing to the credit market participation decision and not the level of borrowing. Moving to a more realistic risk structure such as multiplicative production risk would instead lead to risk rationing on both the extensive margin (participate versus not participate) and the intensive margin (the amount of loan demanded). As both our theoretical and empirical applications focus only on the extensive margin, we likely understate the adverse impact of risk rationing on resource allocation.

[5]Transaction cost rationed households are characterized by the following equation:

$$t + (1-\pi)v > A[g(n^*; A) - g(n^{SF}; A)]$$

where $n^{SF} = \frac{K}{pA}$ is the optimal input level under self-finance.

[6]Sufficient conditions for the existence of risk rationing are given in the on-line appendix.

[7]All peasant communities in the survey area opted for privatization.

[8]Attrition may bias our estimation results if attritors are systematically different from non-attritors after conditioning on our explanatory variables. Given the panel structure of econometric model, we are not aware of a formal test of attrition bias. To get a feel for whether or not attrition bias is a concern we ran a probit of attrition against the explanatory variables plus the residuals from the productivity equations. The coefficient on the residuals is not significantly different from zero, suggesting that once we control for observed characteristics, attritors are not systematically different from non-attritors in a way that affects productivity.

[9]Jappelli (1990) and Feder et. al. (1990) were among the first to utilize this direct survey approach. Boucher, Guirkinger and Trivelli (2006) provide a detailed description of the approach. Petrick (2005) provides a critical discussion of the approach and contrasts it with alternative methodologies.

[10]Zero interest loans are excluded because the majority of these loans are in the form of inter-linked contracts from local traders, processors and input suppliers. The data do not contain sufficient details on the non-credit component of these linked transactions to compute the effective interest rate of these loans. Anecdotal evidence suggests, however that the cost of these transactions are similar to unlinked informal loans.

[11]Following the 1998 El Niño, the state implemented a "financial rescue program" (*rescate financiero*) which facilitated the refinancing of certain delinquent loans.

[12]By excluding these variables, we follow the same approach as Charlier et al. (2001).

[13]Output quantities, output price, and expenditure data on the previous twelve months were collected immediately after harvest. As a result, the quality of recall data for output quantity and price is greater than for the many components of farm expenditures. We thus use the value of output instead of net revenues per hectare as our productivity measure. Feder et. al (1990) also use the value of output per hectare to measure productivity in their exploration of the impacts of credit constraints and productivity in China.

[14]Savings includes deposits in financial institutions and informal savings groups as well as their holdings of cash, gold coins and jewelry.

[15]The literature on property rights (Besley, 1995) suggests that a title may also have a direct impact on productivity if title augments tenure security which, in turn, leads to greater investment. In Piura, a registered title is unlikely to have this direct tenure security effect on productivity because non-titled farmers possess alternative documents recognized by local authorities. The other potential problem with using title as an instrument is reverse causality: there would be direct correlation between title and productivity if ownership of a title is a consequences of a greater intrinsic productivity that, in turn, implies greater credit needs. This is improbable in the context of Piura. The national titling program organizes the distribution of title geographically, based on a administratively established plan that is unlikely to be related to local heterogeneity in productivity.

[16]Formally, a first difference approach would eliminate the selection bias as long as $cov(\eta_i + \nu_{it}, \varepsilon_{it}^C) = cov(\eta_i + \nu_{it}, \varepsilon_{it}^U) = 0$.

[17]This identification strategy has been commonly used in labor economics. Pedersen et al. (1990), for example, use a linear first difference model to estimate wage differentials between public and private sectors.

[18]The test procedure is presented in Appendix B.

[19]In particular it requires normality of the fixed effect in the constraint equation and specifies functional forms for the conditional mean of the time varying error in the productivity equation and of the fixed effects in both the constraint and productivity equations.

[20]Specifically the weights have the following form: $\frac{1}{h_n} k(\frac{\Delta W_i \hat{\lambda} + \Delta A_i \hat{\rho} + \Delta X_i \hat{\sigma}}{h_n})$, where h_n is a sequence of bandwidths, k is a normal Kernel density function, Δ denotes the first difference and $\hat{\lambda}, \hat{\rho}$, and $\hat{\sigma}$ are the estimates of the parameters λ, ρ, and σ. The bandwidth is chosen using the "plug-in" method suggested by Kyriazidou.

[21]A Chi-square of the joint significance of the instruments in the selection equation has a

p-value of 0.0002, suggesting that the instruments are highly correlated with the probability of being constrained. When we regress the residual of the Kyrazidou productivity equations on all exogenous variables and the instruments, we find that the instruments are uncorrelated with those residuals, suggesting that they have no direct impact on productivity

[22]For brevity, the other conditioning variables are suppressed.

[23]Households that do not switch credit constraint status provide two observations to estimate one of the fixed effects and zero to estimate the other fixed effect, while switchers provide one observation for each fixed effect.

[24]We use the parameter estimates from the linear specification.

[25]We ignore any general equilibrium impacts such as changes in factor and product prices that would result from removing credit constraints.

[26]Misclassifying risk and transaction cost rationed households as unconstrained may also lead to bias in the parameter estimates of the productivity equations.