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Direct Elicitation of Credit Constraints: Conceptual and Practical Issues with an Empirical Application to Peruvian Agriculture

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Abstract

This paper provides a methodological bridge leading from the well-developed theory of credit rationing to the less developed territory of empirically identifying credit constraints. We begin by developing a simple model showing that credit constraints may take three forms: quantity rationing, transaction cost rationing, and risk rationing. Each form of non-price rationing adversely affects household resource allocation and thus should be accounted for in empirical analyses of credit market performance. We then outline a survey strategy to directly classify households as credit unconstrained or constrained and, if constrained, to further identify which of the three non-price rationing mechanisms is at play. We discuss several practical issues that arise due to the use of a combination of "factual" and "interpretative" survey questions. Finally, using a data set from northern Peru, we demonstrate the importance of accounting for all three forms of credit constraints by estimating the increase in farm production that would result from relaxing credit constraints. The inclusion of transaction- and risk-rationed households in the constrained group results in an estimated impact that is twice as large as the impact when only quantity rationed households are considered constrained.

1 Introduction

How important are credit constraints in the process of economic development? Economic theory suggests that credit constraints may have significant negative impacts on income and welfare, especially for poor households. *Ex-ante* credit constraints prevent individuals from undertaking desired activities and from realizing profit maximizing investment levels in the activities they do engage in. Thus entrepreneurially talented but poor individuals are prevented from starting businesses while liquidity strapped farmers are unable to purchase a critical pesticide to fend off a pest infestation. By preventing gains from trade, *ex-ante* credit constraints result in income enhancing opportunities being left on the table. *Ex-post* credit constraints prevent individuals from borrowing after investment decisions have been made and production outcomes realized. As demonstrated by Eswaran and Kotwal (1989, 1990) *ex-post* credit constraints both directly reduce welfare by preventing individuals from borrowing to smooth consumption when income flows are risky but also indirectly reduce income and welfare by making risk averse individuals less likely to enter high return but risky activities in the first place. Taken together, *ex-ante* and *ex-post* credit constraints may have strong implications for the likelihood that households fall into or climb out of poverty traps (Carter and Barrett, 2006; Zimmerman and Carter, 2003) as well as for the level and distribution of income in the overall economy (Aghion and Bolton, 1997; Banerjee and Newman, 1993).

Considering the potentially far-reaching consequences of credit constraints suggested by theory, empirical evidence on the impacts of credit constraints is relatively scarce. The lagged response of the empirical literature can be attributed, in part, to the challenge of econometrically identifying the impact of credit constraints. Ideally (at least from an economist's point of view) the economist would analyze a situation in which individuals, households, or firms are randomly, or exogenously, assigned to be either credit constrained or unconstrained. Dif-

ferences in outcomes, such as the probability of starting a business, the level of investment and profit, or the smoothness of consumption, could then be clearly attributed to the credit constraint.

Recently, several researchers have proceeded along this line of randomization. Banerjee and Duflo (2004) use an exogenous change in credit policy in India that increased the supply of credit to medium sized firms to achieve identification. Karlan and Zinman (2006) take a more direct approach. They worked with a consumer lender in South Africa to run an experiment whereby a randomly selected group of loan applicants that would normally be rejected were instead offered loans. A third example of this randomization approach comes from research underway by DeMel, McKenzie and Woodruff (2006) in Sri Lanka in which the authors randomly select a group of micro-entrepreneurs to receive a gift of capital, either in the form of machinery or cash. Again, a comparison of profit and investment across the lucky recipients versus the unlucky non-recipients can identify the impact of credit constraints.

While policy and field experiments provide a clean way of gauging the impacts of credit constraints, their use is still relatively limited. Relevant policy experiments are extremely rare and field experiments, while having great promise, are fraught with their own challenges of design, implementation, financing, and generalizability.

Beginning with papers by Jappelli (1990) and Feder et al. (1990), several authors have followed an alternative approach that relies on more conventional survey-based research, albeit with a methodological twist. This "twist" consists of adding a set of questions that permits the researcher to directly elicit the household's or firm's status as either credit constrained or unconstrained. With the observed separation of the sample into those that are constrained versus unconstrained, the researcher can directly evaluate the impacts of credit constraints on the efficiency of resource allocation. Examples of this approach, which we call the direct elicitation methodology (DEM), include Petrick (2004) who evaluates the impact of credit constraints on farm output in Poland; Foltz (2004) who evaluates the impact

of credit constraints on farm profit in Tunisia; and Carter and Olinto (2003) who examine the impact of credit constraints on investment levels in Paraguay.

Given the centrality of financial market to the process of development, the strengthening of empirical methodologies for identifying credit constraints warrants a high priority among research objectives. By describing, evaluating and suggesting extensions to the DEM, this paper represents a step in this direction. Our objectives are fivefold. First, we provide a general discussion of the concept of credit rationing. This discussion is important because differences in empirical strategies for measuring credit constraints as well as evaluation of the impact of constraints can originate in definitional differences. To facilitate this discussion we develop a simple model to demonstrate that asymmetric information can give rise to three different "mechanisms" of non-price rationing - quantity, transaction costs, and risk. Second, we provide a detailed description of the DEM as well as several important issues and challenges faced by the researcher in its implementation. As we will make clear, identifying the constraint status of individuals that do not participate in the credit market is particularly challenging, requiring a series of counter-factual questions. Our third objective is to provide evidence, using a data set from rural Peru, that the DEM captures the underlying motivations for non-participation. Fourth, we use the same data to demonstrate the importance of accounting for all three manifestations of credit constraints (quantity, transaction costs, and risk) by estimating their impacts on farm productivity under two alternative definitions of credit constraints: a "restrictive" definition in which only quantity rationed households are considered constrained and a "comprehensive" definition which also includes transaction cost and risk rationed households as constrained. Finally, we conclude by offering suggestions for improving methodologies for identifying credit constraints.

2 Non-price Rationing: A Conceptual Framework

In this section we develop a simple model of a credit market and activity choice.[1] Our goal is to introduce the three different types of non-price rationing - quantity, transaction costs, and risk. All three forms of non-price rationing arise because of information and enforcement problems associated with loan contracts and prevent households from realizing profitable projects. Thus households facing any of these three forms of non-price rationing are effectively constrained in the credit market. While quantity rationed households are denied access to loans, risk and transaction cost rationed households instead voluntarily withdraw from the credit market because of the non-price terms of available contracts. It is particularly important to account for credit constraints deriving from these latter two forms of non-price rationing because the types of policies that can alleviate them may be quite different from those designed to alleviate quantity rationing.

A farmer owns T acres of land and produces with a Leontief style technology requiring a fixed investment per-acre which, for simplicity, we assume is \$1. The farmer has no liquidity and thus requires a loan to finance production. The value of the farmer's non-liquid assets, including land and machinery, is A. There are two possible states of nature - success and failure - that occur with probabilities p and $1-p$ respectively. Revenue per unit land under success is Y and under failure is 0. The farmer's reservation activity is to rent out the land and earn w per unit land. Risk neutral lenders operate in a perfectly competitive market and have an opportunity cost of capital equal to $1+r$. Assume that $pY > 1+r+w$ so that, evaluated at the lender's opportunity cost of capital, production is more profitable than renting out the land.

[1] For a recent review of the theoretical literature on quantity rationing, see Udry and Conning (2005).

2.1 Symmetric Information and the First-Best

We begin by assuming that lenders can costlessly observe all relevant borrower characteristics and actions - i.e., they do not confront adverse selection or moral hazard. A credit contract then specifies the borrower's repayment obligation under each state of nature. Letting i denote the interest rate and k the collateral requirement per unit land, the borrower repays $T(1+i)$ under success and Tk under failure. The borrower's consumption in state j, C_j, is thus:

$$C_j = \begin{cases} A + T[Y - (1+i)] & \text{if } j = \text{success} \\ A - Tk & \text{if } j = \text{failure} \end{cases} \tag{1}$$

The lender's return per-hectare, R_j, is:

$$R_j = \begin{cases} i - r & \text{if } j = \text{success} \\ k - (1+r) & \text{if } j = \text{failure} \end{cases} \tag{2}$$

The optimal contract solves the following program:

$$\begin{aligned} \max_{i,k} \quad & EU(C_j) \\ \text{subject to} \quad & : \\ 1 + i \quad & \geq \quad \frac{1+r}{p} - \frac{1-p}{p}k \qquad (3) \\ kT \quad & \leq \quad A \qquad (4) \end{aligned}$$

Equation 3 is the lender's participation constraint and ensures that the lender earns a non-negative return. Equation 4 is the limited liability constraint and acknowledges that, at most, the borrower can post collateral worth A. Using equation 1 in the above program, it

is easy to show that under the optimal contract the borrower would earn the entire surplus (constraint 3 binds) and fully smooth consumption across states of nature. This simple model highlights the dual functions of the credit market as both provider of liquidity and, potentially, insurance. In the absence of information problems, lenders would be indifferent between contracts that trade lower collateral for higher interest rate at the rate of $(1-p)/p$. Efficient risk sharing would be achieved with the borrower paying a relatively high interest rate while fully insuring his consumption against production risk. Thus even in the absence of a well functioning insurance market, all socially desirable investments would be made if credit markets were perfect. We denote the farmer's credit demand in this first-best world as his *notional demand*.

2.2 Asymmetric Information and Non-Price Rationing

As is well established in the theoretical literature, the presence of asymmetric information between borrowers and lenders results in problems of adverse selection and moral hazard which may significantly alter the performance of credit markets relative to the first best world. A common response of lenders to these information problems is to require collateral. By providing incentives for borrowers to take actions that reduce the probability of failure, collateral addresses moral hazard (Hoff and Stiglitz, 1990). Collateral may also serve as a mechanism for sorting borrowers of unobserved types (for example project riskiness) and thereby also addresses adverse selection (Bester, 1987). We acknowledge the presence of asymmetric information in our model by assuming that lenders require that borrowers post a minimum of $\underline{k}$ units of collateral per unit land financed.[2] In addition, we assume that posting any amount of collateral implies a fixed cost, F, to the borrower.[3] In terms of our

[2]While a complete model would endogenize k, that is beyond the scope of this paper. Instead, we simply assume $\underline{k}$ exists and is the same for all borrowers. See Boucher, Carter and Guirkinger (2006) for an example of a model that endogenizes the collateral requirement in a model of moral hazard.

[3]Posting collateral typically requires verification of property deeds, verification that the property is not mortgaged to another party, and the actual registration of the mortgage itself. Each of these transactions

optimization program, we add an additional constraint: $k \geq \underline{k}$.[4] While the lender is still willing to trade interest rate reductions for collateral increases at a rate of $(1-p)/p$, he is only willing to do so over a restricted range of contracts with sufficiently high collateral. This restriction of the feasible contract set gives rise to the first form of non-price rationing - namely *quantity rationing*. Farmers who cannot post the minimum required collateral ($A < T\underline{k}$) are involuntarily excluded from the credit market. Quantity rationing occurs when a farmer has a profitable project, and thus positive notional demand for credit, but faces zero supply.

As pointed out by several studies (Mushinski, 1999; Jappelli, 1990; Boucher et al., ming), even though an agent has both positive notional demand and faces a positive supply, he may not have positive *effective demand*, defined as the demand for contracts available in the "actually existing" or asymmetric information world. There are two reasons that an agent who could obtain a loan to invest in a profitable activity would choose not to borrow. First, transaction costs reduce the expected income associated with a credit contract by F. As a result, a contract yields greater expected income than the reservation activity if $pY > 1 + r + w + \frac{F}{T}$. A farmer who has positive notional demand but zero effective demand because of the size of transaction costs is called *transaction cost rationed*.

Second, the collateral requirement forces the borrower to bear a minimum amount of risk and thus may drive the borrower's expected utility below his reservation utility, even though taking the credit contract would raise expected consumption. In this case the borrower is *risk rationed* - he has access to an expected income enhancing contract but chooses to voluntarily withdraw from the credit market to instead undertake the lower return but certain reservation activity.

To summarize, asymmetric information can give rise to three types of non-price rationing. The first, quantity rationing, has been emphasized in both the theoretical and empirical lit-

implies a trip to the property registry and a fee.

[4]Note that this constraint is essentially an incentive compatibility constraint in a model of moral hazard.

erature. Quantity rationing is a supply side constraint and occurs when a borrower's effective demand exceeds supply. It reflects the reduction in the lender's willingness to offer contracts resulting from the presence of asymmetric information. In contrast, both transaction cost and risk rationing reflect the reduction in credit demand that may result from asymmetric information. Any evaluation of the performance of credit markets should incorporate these three non-price rationing mechanisms, as each implies that profitable investments are forgone. Similarly, efforts aimed at overcoming credit constraints must identify the relative impact of each of these mechanisms as they require a different set of policies. The first step in that direction is to identify which households are credit constrained and by which mechanism.

3 Eliciting Credit Constraints - a Practical Approach

In this section we outline a strategy to directly elicit credit constraints. We first define unconstrained and constrained households based on the relationships between household specific supply, notional demand and effective demand. We then examine how these definitions can be operationalized in household surveys. Finally we discuss three central issues that arise in the direct elicitation approach. Much of this discussion is based on lessons learned from our accumulated efforts to elicit credit constraints in household surveys in Guatemala (Barham, Boucher and Carter, 1996) , Honduras and Nicaragua (Boucher, Barham and Carter, 2005), and Peru (Guirkinger and Boucher, 2006; Guirkinger and Trivelli, 2006)

3.1 Defining Constraint Categories

Let D_i^E and D_i^N denote, respectively, the effective and notional demands for credit of household i. Similarly, let S_i denote the credit limit, or the maximum amount of credit a lender is willing to supply to the same household. The conceptual discussion from section 2 implies

that a household (or individual or firm) will fall into one of three mutually exclusive categories: unconstrained, supply-side constrained, and demand-side constrained. We describe each in turn.

Unconstrained, or price-rationed, households are unaffected by asymmetric information in credit markets. The following relationship holds for unconstrained households:

$$D_i^E = D_i^N \leq S_i \tag{5}$$

While asymmetric information may imply that lenders impose a credit limit, this limit is not binding for unconstrained households. Depending on their endowments and opportunities, unconstrained households may be either borrowers ($D_i^E > 0$) or non-borrowers ($D_i^E = 0$).

Supply-side constrained, or quantity rationed, households face a binding credit limit and are characterized by the following relationship:

$$S_i < D_i^E \leq D_i^N \tag{6}$$

Note that while asymmetric information may reduce these households' effective demand relative to their notional demand, the limiting constraint comes from the supply side. As such, we expect these households to demonstrate excess demand. We take up the question of how to detect this excess demand in practice in the next section.

Finally, *demand-side constrained* households do not face a binding credit limit and thus do not express excess demand. They are described by the following two relationships:

$$D_i^E < D_i^N \tag{7}$$

$$D_i^E \leq S_i \tag{8}$$

The first inequality implies a wedge between notional and effective demand due either to

the risk sharing rules of the best contract available or the transaction costs associated with loan application. The second inequality implies that the limiting constraint comes from the demand side.

3.2 Operationalizing Constraint Categories

The classification of a household's constraint status typically draws on two modules within the credit section of a household survey. Figures 1 and 2 provide examples of these two modules. Figure 1 depicts the first half of the "loan characteristics module" from the survey of farm households in Peru that will serve as the basis for the empirical analysis of Sections 4 and 5. This module collects information to characterize loan contracts and is administered to households that borrowed during the recall period. Figure 2 consists of two portions. The upper portion (above the dotted line) depicts a "credit market perceptions module" used to describe experiences in, and perceptions of, the credit market for households that did not borrow during the recall period. The bottom portion of Figure 2 does not appear in the survey but instead shows how non-borrowers' responses lead to the classification of their constraint status and rationing mechanism.

3.2.1 Identifying supply side constrained households

We now turn to operationalizing the classification scheme described above. We begin with supply-side constrained households. Equation 6 will hold if a household received less than its desired amount of credit given the terms of contracts available in the market. In identifying supply-side constrained households from survey data, it is useful to distinguish three separate groups. The first group consists of unsatisfied borrowers. These individuals received a loan, but the loan amount was less than their effective demand. To identify this group, we use the response to question 11 in Figure 1, "Would you have wanted a larger loan at the same interest rate?" There are two details to note in the formulation of this question. First, the

borrower is asked to compare the amount she received to the amount that she *wanted*. While it might seem more intuitive to compare the amount received with the amount *applied for*, this would be problematic inasmuch as the borrower may know the lender's supply rule and thus have only applied for the amount she qualified for. Second, the question emphasizes that the desired amount is conditional upon the interest rate. In practice, when asked without conditioning on the interest rate, respondents often interpreted the question as asking for their total working capital needs under an interest-free loan. Finally, although not essential for our present purpose of discrete categorization of constraint status, question 11 is followed by a question that asks the desired loan size. This identifies a point on the borrower's demand curve and is thus useful to analyze continuous loan demand and estimate the shadow value of liquidity.

The second group is rejected applicants, who have positive effective demand but a zero credit limit. As this group did not borrow, they are identified using the credit market perception module. In Figure 2, this group responds "Yes" to question 2 which asks if they have applied and were rejected. A specific issue is the time frame specified in this question. If a household's credit limit were time invariant, then the appropriate question would be whether or not the household has ever been rejected. If, as is more likely, the credit limit changes over time, then a shorter recall period is preferable. Questions 3, 4, and 5 are not necessary for the constraint classification; however, they provide quantitative information on loan demand as well as qualitative information on perceived reasons for loan rejection.

The final supply-side constrained group is "certainly-rejected" non-applicants, who had positive effective demand but did not apply for a loan because - based on past experience or their perceptions of lenders' supply rules - they were certain their loan application would be rejected. As these are non-borrowers, we again use the perceptions module (Figure 2) to classify their constraint status. Given that they did not apply for a loan, they are filtered to question 6 which asks if they believe the lender would offer a loan if they applied. If yes, then

we know that the household is not supply-side constrained. If no, the enumerator continues with question 8: "If you were certain that a lender would approve your application, would you apply?" If yes, then the household is classified as constrained.[5]

3.2.2 Identifying demand-side constrained households

As in the case of supply-side constraints, demand-side constrained households can be either borrowers or non-borrowers. In both cases these households' effective demand is reduced by transaction costs or risk. Our discussion here will focus on how to identify demand-side constrained non-borrowers who completely withdraw from credit markets.[6]

Begin at question 6 in Figure 2 which asks "would a bank lend to you if you applied?" Demand-side constrained non-borrowers are found among both those with and without perceived access. Households that answer "yes" to question 6 and thus believe they have credit access are then asked why they did not apply (question 7). Their response to this question, as discussed below, allows their classification as unconstrained or constrained and, if constrained, as transaction cost rationed or risk rationed. Households that answer "no" to question 6 and thus believe they have no credit access are then asked in question 8 whether they would want a loan if they were certain the lender would approve their application. As discussed above, those who say "yes" are the certainly-rejected non-applicants and are classified as supply-side rationed. Those who say "no" are then asked why not in question 9 and classified as unconstrained or constrained and, if constrained, as transaction cost rationed or risk rationed.

[5]One specific issue to be aware of is the wording of question 8. Notice that we do not ask "would you accept a loan if you were offered one?" The reason is that the word "offered" may imply that the respondent need not incur the costs of application.

[6]Ignoring demand-side constrained *borrowers* is likely to have little impact on the evaluation of the performance of credit markets for two reasons. First, since transaction costs typically have an important fixed component, they should have relatively little impact on effective demand for those who borrow. Second, the scope for borrowers to reduce risk by taking smaller loans is limited because collateral assets are typically lumpy and cannot be marginally adjusted, and many agricultural lenders offer boilerplate loan contracts in which loan size is a fixed multiple of area cultivated.

As is hopefully clear by now, one of the main objectives of this method is to gather additional information on the credit market perceptions of non-borrowers. In particular, determining constraint status requires learning why some households choose not to borrow even though they believe they qualify for a loan. In Figure 2, questions 7 and 9 elicit this information. Table 1 provides typical responses to these questions and the subsequent classification of households. Recall that unconstrained non-borrowers have zero notional demand and no profitable projects that require outside financing. This group can be highly diverse, including households with large endowments of productive assets and liquidity as well as endowment-poor households with limited investment opportunities. Response C "Farming does not give enough to repay a debt." is a common response from this latter type of unconstrained household. Other frequent responses suggesting that the household is unconstrained include "The interest rate is too high" and "I don't need a loan." Some responses do not lend themselves to an unambiguous classification. For example, the response D "I prefer working with my own liquidity" could be consistent with both price rationing and risk rationing.[7] For these responses, we suggest following a conservative approach and classifying the household as unconstrained.

A demand-side constrained household, in contrast, has a profitable investment beyond its own liquidity that it forgoes due to risk or transaction costs. Rows E-H of Table 1 provide examples of responses associated with risk rationing. Of these, the most common response in each of the surveys we conducted was "I don't want to risk my land."[8] Rows I and J are common responses indicating that the household was discouraged from borrowing by transaction costs. It is important to note that we interpret responses E-J as indicating that

[7]This response could be given by high liquidity households that are unconstrained, as well as by households with investment opportunities requiring funds beyond their own liquidity but that chose not to borrow because of risk.

[8]The surveys we have conducted were carried out in regions where banks exist and tend to require titled property as collateral. In areas where banks do not operate or where land cannot be used as collateral,risk rationing can still occur but is likely to manifest itself via different responses. For example, risk rationing may be quite common in villages dominated by a stereotypical moneylender who requires the borrower to put up his reputation or "knee-caps" as collateral.

households have a profitable use for credit (i.e. have positive notional demand) and have considered taking a loan, but decided not to because of risk or transaction cost.[9]

3.3 Issues and Challenges in Classification via Direct Elicitation

Several important issues and challenges arise when using the DEM. We discuss what we consider to be the four most important. The first two involve choices about how to define units of analysis when designing the questionnaire. The second two are more conceptual and are related to the DEM's partial reliance on hypothetical and counter-factual questions - as opposed to observed actions - to identify the constraint status of respondents who do not participate in the credit market.

3.3.1 Issue 1: Definition of Loan Sectors

The first issue to consider in designing the perception module is how the lender is defined to the respondent. In practice, rural credit markets are composed of a group of heterogenous lenders including commercial banks, state banks, NGO's and a wide range of informal lenders. Both the access rules and contract terms facing a given household may vary widely across these lenders. As a result, a household may be unconstrained with respect to one type of lender but constrained with respect to other lenders that offer more favorable contracts, for example with longer maturity or lower cost. In this case, the constraint would be binding and adversely affect the household's resource allocation. Given this concern, lenders should be grouped into distinct sectors, or segments, of the credit market, and the language of the qualitative questions in the perceptions module should be cast with respect to these sectors.

Another reason to define distinct loan sectors is to test sector specific hypotheses. For

[9] An alternative way to identify unmet notional demand is to ask what the household would do with additional liquidity. Under this approach, followed for example by Paulson and Townsend (2004), households that say they would expand productive enterprizes (business or farm) or invest in working capital are classified as credit constrained. This question, however, does not provide sufficient information to distinguish between supply and demand-side rationing.

example, we might be interested in evaluating a policy that affects a certain type of institution. Mushinski (1999) uses the direct elicitation approach to evaluate the impact of market oriented reforms implemented by credit unions in Guatemala on the prevalence of non-price rationing in the credit unions. We also might be interested in testing the existence of a preference hierarchy across loan sectors. Until recently, most theoretical and empirical models assumed that the formal loan sector is strictly preferred by all borrowers (Bell et al., 1997). Several authors have challenged this assumption, arguing that informal contracts may be preferred because of lower cost (Kochar, 1997; Chung, 1995) or lower risk (Boucher and Guirkinger, forthcoming). Appropriately defining sectors allows testing of these hypotheses.

3.3.2 Issue 2: Household versus Individual Constraints

The second definitional issue is whether the credit constraint classification should be defined at the household or individual level. Until now, we have couched the discussion at the household level. This approach is appropriate if we believe household resource allocation is consistent with a "unitary" household model in which endowments and income are pooled amongst household members. The qualitative questions of the perceptions module would then be addressed to the household head, who would respond for the overall household. We assume that the head can, given the endowments and opportunities available to the household, assess the effective and notional demand of - as well as the supply available to - the entire household.

If, in contrast, resources are not pooled within the household or information is not shared, then individual characteristics - including whether or not individuals are credit constrained - may impact the household's resource allocation. In this case, each individual's constraint status needs to be elicited and thus the perception module is applied to each adult in the household. This individual approach, while costly, is useful for testing hypotheses related to gender bias in credit access and intra-household resource allocation processes. It has been

used by Diagne et al. (2001) in an exploration of credit markets in Malawi.

3.3.3 Issue 3: Use of Respondents' Perceptions of Lender Supply Rules

In order to classify non-borrowers as constrained or unconstrained, the perceptions module relies on several hypothetical questions. Identification of supply-side constraints hinges on question 6, which asks non-applicants if they believe a bank would lend to them if they were to apply. There are two potential concerns associated with the use of this question. First, the respondent may not understand the question. Until this point in the survey, the respondent has been bombarded with "factual" recall questions such as the reconstruction of farm revenues and costs. Question 6 requires the respondent to change gears and think about the outcome of a loan application that was not made. Clearly communicating this type of question is a non-trivial task. Beyond a clear phrasing of the question itself, effective use of this type of hypothetical question requires careful selection and training of enumerators, who may need to step outside of the literal question in order to convey the idea.

The second issue is that identification of a binding supply constraint relies on the respondent's perception of the lender's willingness to offer them a loan. This perception may be incorrect. For our objective of gauging the impacts of credit constraints on resource allocation, however, respondents' misperceptions of a lender's 'true" supply rule is not problematic. Consider two individuals with positive ~~effective~~ demand that are identical except in their perceptions of the lender's supply rule. The first correctly believes he faces positive supply and thus ends up taking a loan and carrying out the investment project. The second incorrectly believes he faces zero supply. As a result, he does not apply and forgoes the project. These two households would be classified as credit unconstrained and constrained, respectively. The difference in their resource allocations is determined by the difference in their perceived supply rule, which is captured by the DEM, rather than the "true" supply rule. Next consider non-applicants who incorrectly believed that a lender would offer them

a loan. ~~This misperception also would not cause classification error.~~ Since they believe they could get a loan but did not apply, the lender's "true" supply rule does not constrain these respondents. Instead, they are either unconstrained or demand-side constrained, as indicated by their response to question 7 in Figure 2.[10]

3.3.4 Issue 4: Identifying Notional Demand of Non-Borrowers via Subjective Questions

Use of the DEM requires that it accurately captures the "true" rationing mechanism of respondents. Identifying the rationing mechanism of loan applicants is straightforward; the joint outcome of the respondent's action (loan application) and the lender's action (approval or rejection) allows the researcher to sort applicants into those that are price rationed versus those that are quantity rationed. Non-applicants pose a greater challenge because the fact that they did not apply for a loan does not imply zero notional demand. The DEM proposes identifying notional demand for these respondents by understanding the underlying reasons fro their lack of effective demand; i.e., why thee respondents did not, or would not, apply for a loan. This is accomplished via question 7 and 9 in Figure 2.

The question, and perhaps the central concern of the DEM, is how certain are we that the answers respondents give to these two questions capture their true motivation for not applying? Consider, for example, a farmer who says that he did not apply for fear of losing his land. Can we be certain that this individual is risk rationed? Or might this response instead reflect low quality land and a lack of productive opportunities? If so, then the respondent should be classified as price rationed (unconstrained). Ideally, we would observe whether or not this respondent applies for a loan in a counter-factual world in which loans

[10] While misperceptions of lenders' supply rules do not imply errors in the DEM's classification scheme, gauging the accuracy of non-borrowers' perceptions is relevant for policy. If households refrain from borrowing because they systematically underestimate lenders' willingness to lend or overestimate the interest rate, risk or transaction cost of contracts that are available to them, then policies that increase the flow of information to rural households would be more appropriate than policies that seek to change the contract terms themselves.

carried less contractual risk. Ultimately, the DEM requires a sufficient degree of certainty that the line of direct questions in the survey accurately capture the true motivations for non-application. Given the centrality of this issue, we provide evidence on the ability of the DEM to effectively distinguish between demand-side constrained versus unconstrained non-borrowers in the next section.

4 How Reliable is the DEM? Evidence from Peru

In this section we address the final, an most important, issue raised in the previous section. We do so by using survey data from Peru to provide evidence on the degree to which the DEM effectively distinguishes between constrained versus unconstrained non-borrowers. We use these same data in the next section to demonstrate the importance of including both supply and demand-side constraints when evaluating the performance of a credit market.

4.1 Data Description and the Frequency of Credit Rationing

The data come from a panel survey of farm households in the department of Piura, on Peru's north coast. In 1997, a random sample of 547 farm households was drawn from the comprehensive lists of farmers maintained by the irrigation commissions. In 2003, we found and resurveyed 499 of the original households, of which 442 were still farming.

The sample is representative of the irrigated, commercial agriculture of Piura's coast. The descriptive statistics in table 2 provide an overview of these households. The median farm size in the sample is 3 hectares; with over 90% of households farming less than 10 irrigated hectares. This predominance of small farms is a legacy of Peru's agrarian reform of the 1960's and 1970's. Property rights reform was a pillar of the economic liberalization program of the 1990's. In Piura, this is reflected in the increase from 49% to 70% of sample households with a registered property title over the study period.

The survey was designed to measure the incidence and impacts of credit constraints in the formal credit sector which, in Piura, consists of commercial banks, municipal banks (*cajas municipales*), and rural banks (*cajas rurales*). A non-borrower perceptions module similar to the one in Figure 2 was repeated for each type of institution to which the household did not apply for a loan. A loan characteristics module captured details of all loans taken from both formal and informal sources. Based on the method described in section 3, we used these two modules to identify each household's rationing mechanism.

Table 3 shows the frequency of each type of rationing mechanism among sample households. Using the comprehensive definition of credit constraint, which includes quantity, risk and transaction cost rationing, the fraction of households that are constrained in the formal credit sector fell from 57% in 1997 to 44% in 2003. Risk and transaction cost rationed households account for a significant fraction of the sample. If we instead use the restrictive definition and only include quantity rationed households as constrained, these numbers would fall to 37% and 10%. The table also shows that (under the comprehensive definition) credit constraints become less prevalent over time. The reduction in credit constraints is driven primarily by a decrease in quantity rationing. This is consistent with a relaxation of supply-side constraints due to the advances of the land titling program in the period between surveys. The reduction in quantity rationing is partially offset, however, by an increase in risk rationing. One interpretation of this finding is that, in a context such as Piura where formal insurance markets are inexistent, land titles are necessary but not sufficient to relax credit constraints as some households are unwilling to put their land at risk as collateral.

4.2 Evidence on the Reliability of the DEM

Use of the DEM requires that the subjective questions at the heart of the approach accurately distinguish between those non-applicants that are constrained versus unconstrained. In this section we use the Peru data to provide initial evidence on the accuracy of the DEM's

classification of non-borrowers. Our strategy is to examine correlations between observed rationing categories and various factors that are likely to affect credit supply, the size of transaction costs, and the risk preferences and of background risk faced by sample households. We expect, for example, that risk rationing should be more likely among households that are more risk averse. We begin by comparing means of these factors across rationing categories. To control for likely correlations across these factors, we then estimate a multinomial logit regression of households' observed rationing mechanism against various explanatory variables underlying credit supply and demand, including our proxies for background risk, risk preferences, and transaction costs. As several of the variables we use were only collected in the 2003 survey, the analysis in the remainder of this section is restricted to the 2003 cross-section.

Table 4 compares the means of the seven correlates across rationing categories. The variable TITLE is the fraction of the household's farm area with a registered property title and is included as a control for credit supply. Titled land is the most common form of collateral used by formal lenders in Piura. In addition, even when a formal mortgage is not established, lenders frequently require the borrower to hand over their title until the loan is repaid in order to prevent borrowers from simultaneously taking loans from other lenders. Economic theory suggests that property titles may also have investment (and thus credit) demand effects, in particular via reducing tenure insecurity (Besley 1995). In the study context, however, tenure security effects of title are likely to be minimal because the primary beneficiaries of the titling programs did not suffer from insecure property rights prior to the program.[11]

[11]Two distinct groups were the primary beneficiaries of this program: members of the ex-agrarian reform cooperatives (*parceleros*) and members of peasant communities (*comuneros*). The de-collectivization of cooperatives that concluded in the early 1990's was carried out without cadastral surveys of the individual parcels granted to the *parceleros*. As a result, although *parceleros* had a high degree of tenure security they could not acquire a private property title. A primary aim of the first wave of the government's titling program of the mid-1990's was to demarcate these plots and provide titles to *parceleros*. *Comuneros* were in a similar situation as they possessed inheritable usufruct rights to individual parcels, however all land within the community was formally owned by the peasant community itself. A 1997 amendment to Peru's

The next two variables are proxies for the transaction costs associated with loan application. DISTANCE gives the travel time in public transportation to the nearest formal lender, which is likely to be positively correlated with transaction costs. The variable INFORMED takes value one if the respondent correctly identified the Economics Minister and serves as a proxy for the household's knowledge of formal economics institutions. As the loan application process may require the applicant to interact with formal institutions such as notaries and the Property Registry, this variable is likely to be negatively correlated with transaction costs.

The final three variables are proxies for environmental risk, risk preferences and risk bearing capacity. The variable CV is the coefficient of variation of yields in the district of the household's farm.[12] Other things equal, we expect the probability of risk rationing to be increasing in the production risk associated with the household's farm location. Holding constant the risk environment, we also expect risk rationing to be more likely for more risk averse individuals. The variable RA is an individual specific measure of risk aversion computed using a set of questions included in the 2003 survey.[13] Finally, the variable MAX-INFORMAL is the maximum amount of money the household said it could receive from family and friends in case of an emergency. This variable is included as a proxy for the strength of informal insurance networks and is expected to be negatively related to the probability of risk rationing.

A comparison of variable means suggests that the classification delivered by the DEM is

land law provided peasant communities the option to privatize and title individual parcels. Providing titles in peasant communities was a major goal of the second wave of the titling program carried out in the late 1990's through 2005.

[12]In Peru, "district" corresponds to the third level of political dis-aggregation after Department and Province and is the most disaggregated level for which the Ministry of Agriculture provides historical yield data. Our sample is spread across twelve separate districts.

[13]The questions were framed in reference to a common form of lottery in Peru called a *rifa* in which a fixed number of individuals contribute a fee into a common pot. A single winner is then randomly drawn. Sample households were asked how much they would be willing to pay for a *rifa* ticket with a 10 players, each of whom contributed 100 Soles. Their response, R, indicates the expected return required to make them indifferent between participating or not. Using a second order approximation, the coefficient of absolute risk aversion can thus be computed as $RA = \frac{(10-R)}{0.5(10-R)^2}$

roughly consistent with expectations. Recall that our first concern is separating constrained from unconstrained non-borrowers. Compared to unconstrained non-borrowers, transaction cost rationed households live in villages that are further away from formal lenders and they are less likely to correctly identify the current economics minister. Turning to risk rationed households, we see that they tend to live in districts with greater background risk and are more risk averse compared to both unconstrained non-borrowers and transaction cost rationed households.

The likely correlations across our different explanatory variables require that we move to a multivariate analysis. The framework we use is the single equation multinomial logit model. Let Y_i be a categorical variable that takes values $0, 1,...,J$ and that represents the observed credit market rationing outcome of household i. Define Y_{ij}^* as the unobserved "propensity" of household i to be in rationing category j. Y_{ij}^* is modeled as the following linear function:

$$Y_{ij}^* = \beta_j' X_i + \epsilon_{ij} \tag{9}$$

where X_i is a vector of household characteristics; β_j is a vector of parameters associated with the j'th category; and ϵ_{ij} is the unobserved component of the i'th household's propensity to be in category j. The observed category is the one with the highest propensity. The probability that household i is in the j'th rationing category is thus:

$$Pr(Y_i = j) = Pr(Y_{ij}^* > Y_{ik}^*) \quad \forall k \neq j \tag{10}$$

The model is operationalized by assuming that the $J + 1$, ϵ_{ij} terms are independent and identically distributed with Weibull distribution.

The regressors and their means are summarized in table 5. The first four variables are measures of the household's productive endowments including farm-land, non-farm wealth, education and the amount of family labor available to work on the farm. These variables

are included to control for the quality of the household's investment opportunities and potential demand for credit. The remaining variables are the correlates of transaction costs, background risk and risk aversion discussed above.

4.3 Results of Multinomial Logit

Table 6 reports the marginal impacts of each regressor on the probability of the "median" household being observed in each rationing category. As discussed above, our primary concern is the ability of the DEM to effectively distinguish between non-borrowing households that are constrained versus unconstrained and, secondarily, to identify the underlying source of the constraint for constrained households.

Consider first transaction cost rationing. As expected, the probability of transaction cost rationing is increasing in distance to the nearest lender and decreasing in the household-level information variable, although the impact of these variables is not significantly different from zero. Having a registered land title is associated with a significantly lower probability of transaction cost rationing. One possible explanation for this result is that eligibility for a land title requires that individuals provide a series of documents such as the national identity card, utility receipts and receipts for payment of water rights. Many of these documents are also required by formal lenders, so that households that did not meet the documentation requirements for titling are more likely to say that they did not apply for a loan because providing documents would be too expensive.[14]

Next consider risk rationing. As anticipated, both an increase in background risk as proxied by the coefficient of variation of district yield and an increase in individual specific risk aversion significantly raise the probability of being risk rationed. Having access to larger potential transfers from family and friends, as expected, decreases the probability of

[14]One might suspect that housheolds in villages farther from lenders and thus facing higher transaction costs were also less likely to receive title. This spurious correlation would not be picked up by the title variable, however, as we have controlled for distance from lender.

risk rationing, however the marginal impact is not significantly different from zero.

Finally, consider the quantity rationing regime. Property title has a strong and significant negative impact on the probability of a household facing a binding supply-side constraint. This is expected as formal lenders in Piura are increasingly requiring borrowers to post real collateral.

Taken together, these results provide evidence that the DEM is capturing meaningful differences across non-borrowing households. The results with respect to the risk-related variables are particularly encouraging. The district-level coefficient of variation and the individual specific risk aversion parameter, both of which are arguably exogenous, are strong predictors of risk rationing. These results suggest that the DEM indeed allows the researcher to distinguish individuals whose credit demand is most affected by risk. The results are less informative with respect to transaction cost rationing. It is not clear, however, whether this reflects an inability of the DEM to effectively detect those households deterred by transaction costs or instead a lack of strong instruments for transaction costs in the multinomial logit regression. We will return to these issues and suggest several options for strengthening the DEM in the final section.

5 The Impacts of Credit Constraints on Agricultural Production in Peru

One of the advantages of the direct elicitation approach is that it accounts for the multiple forms of non-price rationing that, as we argued in section 2, are likely to exist in rural credit markets. Each form restricts household participation in the credit market and adversely affects investment; thus each should be accounted for in any evaluation of the performance of rural credit markets. In this section we use both years of the Peru data to illustrate how the consideration of demand side constraints affects our estimation of the impact of credit con-

straints on agricultural production. Table 7 compares mean productivity levels by rationing mechanism for the pooled data set. Compared to price rationed households, the value of production per-hectare is significantly lower for quantity, risk and transaction cost rationed households, suggesting that each form of non-price rationing adversely affects farm resource allocation. Failure to consider risk and transaction cost rationing would result in a significant under-estimate of the frequency of credit constraints. In this example, the under-estimation would be 26%, the combined frequency of risk and transaction cost rationing in the sample. In addition, the low productivity of risk and transaction cost rationed households suggests that in more aggregate terms, the restrictive definition would also result in a significant under-estimation of the efficiency and income loss due to credit constraints. Whether or not we can attribute these impacts to credit constraints per se, however, is not certain since we have not controlled for other factors that affect farm productivity and that may be correlated with households' credit constraint status. This section develops an econometric model that controls for both observed and unobserved determinants of farm productivity and thus allows us to isolate the impact of credit constraints.

5.1 Econometric Model

Consider the following linear specification of farm productivity:

$$y_{it} = \alpha + \beta C_{it} + \gamma Z_{it} + \eta_i + \varepsilon_{it} \tag{11}$$

The dependent variable, y_{it}, is the per-hectare value of farm output for household i in period t. The binary variable C_{it} takes value one if the household is constrained in the formal sector in period t and zero if unconstrained. Z_{it} is a vector of time varying household and farm characteristics that impact productivity. Included in Z_{it} are: the household's endowments of land, liquidity and labor; the household's dependency ratio; the availability of regular

wage earners; the size of the household's cattle herd, and dummy variables indicating the household's crop mix. The definitions, means and standard deviations of all variables are reported in Table 8. The household fixed effect, η_i, captures the impact of time invariant household characteristics affecting productivity, while α, β, and γ are parameters to be estimated. Finally, ε_{it} is a mean zero error term.

We are primarily interested in β, which gives the impact of being credit constrained on farm productivity. In order to see how the definition of the credit constraint influences β we estimate equation 11 twice - first using the restrictive definition then using the comprehensive definition. In estimating β, we face two potential sources of bias. First, the household fixed effect is unobserved and potentially correlated with the other regressors. We estimate equation 11 using first differences and thereby eliminate this potential source of bias. Second, unobserved time varying factors such as shocks to land quality or health may be correlated with both productivity and the household's credit constraint status. To address this potential source of endogeneity, we use an instrumental variable approach. We use two instruments for the household's credit constraint status. The first, T_{it}, is the property title variable from Section 4, defined as the proportion of the household's owned land that has a registered property title. As discussed above, titled land is the primary form of collateral required by formal lenders so that this variable should reduce the probability of being constrained but is unlikely to have any direct effect on productivity via enhance tenure security because non-titled farmers possess alternative documents recognized by local authorities. The second instrument, N_{it}, is a network variable that measures 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 costs associated with loan application and the uncertainty resulting from an incomplete understanding of contract terms.[15]

[15]The network variable is constructed using a weighting matrix where the weights are inversely proportional to the distance between households in the sample. Neighbors are defined as households living within 10km

The estimation is carried out using two-stage least square (2SLS) with robust standard errors. For each estimation the instruments are jointly significant in the first stage and pass the Hansen J test of overidentification. It suggests that our instruments are valid in the sense of being strongly correlated with the probability of being constrained and being orthogonal to the disturbance term ε_{it}.[16]

5.2 Estimation Results and Discussion

Table 9 presents results of the estimations. The first column reports the results under the restrictive definition of credit constraints, while the second column reports the results under the comprehensive definition.

Under both definitions, credit constraints have a negative and significant impact on farm productivity. The parameter estimate $\hat{\beta}$ is similar when the comprehensive definition of credit constraints is used instead of the restrictive definition. Under both definitions, relaxing credit constraints would raise the value of production per hectare by $685 on average. As many more households are classified as constrained under the comprehensive definition, the regression results suggest that the overall impact of credit constraints is much larger when the comprehensive definition is used.

These results can be used to generate an estimate of the percentage increase in total value of agricultural production if all credit constraints were relaxed in the region. To do so, we compute Δ, defined as follows:

$$\Delta = \frac{\sum_j [E(y_j|C=0) * \text{land}_j - E(y_j|C=1) * \text{land}_j]}{\sum_i \sum_t y_{it} \text{land}_{it}} = \frac{-\hat{\beta} \sum_j \text{land}_j}{\sum_i \sum_t y_{it} \text{land}_{it}} \tag{12}$$

where $j \in J$, and J is the set of credit constrained observations in the pooled sample. The

of the household considered.

[16]Results of the F-test of joint significance and of the Hansen test are reported in the two last row of Table 9. The null hypothesis of the Hansen test is that the instruments are independent of ε_{it}, failing to reject the null hypothesis therefore suggests that the set of instrument is valid.

numerator gives the predicted change in the total value of production if the credit constraints of households observed to be constrained were relaxed. The denominator gives the total observed value of production for all households in the sample. We find that alleviating credit constraints would raise regional output by 15.1% under the restrictive definition and by 32.6% under the comprehensive definition.[17] In this example, accounting for transaction cost and risk rationing leads to a measure of impact that is over twice as large as that obtained under the restrictive definition. This sharp increase reflect the fact that transaction cost and risk rationed households control 24% of sample land. When they are included in the constrained group, the percentage of land controlled by constrained farmers increases from 20% to 44% of total land in the sample.

6 Conclusion

Asymmetric information and enforcement problems can give rise to multiple forms of non-price rationing in credit markets. Quantity rationing has received the bulk of the attention in the economics literature. Yet transaction cost rationing and risk rationing are also consequences of lenders' efforts to mitigate information and enforcement problems. Just like quantity rationed households, transaction cost and risk rationed households have unmet notional demand and find their resource allocation adversely affected by their terms of access to the credit market. We found that neglecting constraints deriving from transaction cost and risk rationing would result in a significant underestimation of both the frequency and impacts of credit constraints in rural Peru.

Empirical evaluation of the relative importance of the different forms of non-price rationing is crucial for the design of effective policy. Examples of policies that may relax the

[17] We generated bootstrapped confidence interval for these estimate by drawing with replacement 1000 sample from the original data and computing the estimates of the regional impacts in each sample (after estimating the model on each sample). The 95% confidence intervals for loss in regional output with the restrictive definition is [14.5%,15.8%] while with the comprehensive definition it is [31.2%,34.1%].

binding supply-side constraint facing quantity rationed households include land titling and property rights reforms that make households' assets more valuable to lenders as collateral and investment in credit bureaus or other institutions that enhance the flow of information so that lenders can more easily identify high quality borrowers. These policies, however, would do little to relax the constraints facing transaction cost and risk rationed households. Instead, policies that streamline legal processes for registering collateral and enforcing loan contracts or that provide a means of insuring households against production, price or health risk would be more appropriate.

We outlined a survey methodology to determine whether or not a household is credit constrained and, if so, to identify the rationing mechanism at play. This classification relies on two stages of questions that elicit different types of information. The first stage collects information regarding the respondent's actions and the outcomes of those actions: Were any loan applications made? To which lenders? Were they approved? An additional set of questions is required to determine the constraint status of non-applicant. These "interpretive" questions are designed to understand the reasons that these respondents did not seek a loan, as well as the actions they would take in counter-factual situations, such as whether or not they would borrow if offered a loan. While these subjective questions are second-best in the sense that they do not rely on observed actions of respondents, we presented evidence suggesting that they can provide a reliable method of separating constrained versus unconstrained non-borrowers.

We conclude by suggesting two directions of methodological improvement for tackling the challenging issue of separating constrained from unconstrained non-participants in the credit market. The first offers refinements to the DEM, while the second builds on the randomization methodology discussed in the introduction.

Fine tuning of non-borrower perceptions module:

Consider again question 7 in Figure 2, which asks individuals who believe they qualify

for a loan to explain why they did not apply. One means of strengthening the DEM is to follow-up question 7 (and 9) with two additional lines of questioning. If the respondent indicates that transaction costs are the primary reason for not applying, the enumerator would then ask the respondent to identify the specific sources of the transaction costs and to estimate the associated monetary and time costs. The second follow-up question would be an additional counterfactual: "Would you seek a loan if these transaction costs (but not the interest rate) were eliminated?' Similar questions would be asked to apparent risk rationed individuals who would first be asked to describe what actions the lender would take if the loan was not repaid. They would then be asked if they would seek a loan if the default consequences (i.e. the contractual risk) were eliminated. These additional questions would serve two purposes. First, identification of the specific components and quantification of transaction costs can help inform policy. Second, responses to these two follow-up questions would allow for more accurate classification of the respondent's rationing mechanism. For example, consider a respondent who gave "fear of losing land" as the reason for not applying in question 7. If this respondent then indicated that he would still not seek a loan even if the risk of losing land were eliminated, the researcher would conclude that the lack of demand is due primarily to lack of a profitable investment project and not to contractual risk. This respondent would then be classified as price rationed (unconstrained) instead of risk rationed.

A second refinement, still within the spirit of the DEM, that would help distinguish constrained from unconstrained non-borrowers is to ask all non-borrowers what they would do with a grant of a given size. Theory suggests that non-price rationed individuals have a higher shadow value of liquidity and so should be more likely to say that they would invest the money in their farm or business than price-rationed individuals. Again consider a farmer who is apparently risk rationed based on question 7. We could more confidently classify this farmer as risk rationed if he then states that he would use the entire grant

to purchase fertilizer than if he instead states that he would put the money in his savings account. Conditional on this latter response, the researcher may re-classify the farmer as price rationed.

Randomized Field Experiments:

Field randomizations, by exogenously varying the control variable of interest in a real-life environment, offer a highly attractive method of testing hypotheses relating to the extent of and underlying causes of credit constraints. In the introduction to this paper we mentioned several innovative research projects using randomizations. The randomizations of both Karlan and Zinman (2006) and De Mel and Woodruff (2006) relax a supply-side constraint and thus focus on the extent and impacts of quantity rationing.

Randomizations may also be used to examine the prevalence and impact of demand-side constraints. Gine and Yang (2007) have taken an innovative step in this direction. In their work in Malawi, they randomized the offer of a production loan linked with a rainfall insurance contract to maize farmers. The control group was instead offered only the credit contract. In contrast to expectations, they found that the availability of insurance negatively impacted loan demand. This research is also illustrative of the challenges and limitations of field randomizations. In particular, great care must be taken to ensure that the exogenous treatment provided in the field coincides with the theoretically intended treatment. This is especially challenging when the treatment involved modifying contractual risk. Gine and Yang suggest, for example, that their surprising results may be due to the "high cognitive cost of evaluating insurance" (page 4). In other words, the authors suspect that farmers did not perceive the insurance made available in the way that the authors designed.

We have argued that demand-side constraints are likely to be important barriers to agricultural development, especially where insurance markets are weak. Unfortunately, transaction cost and especially risk rationing have received little attention in academic and policy circles. Identifying and distinguishing the multiple forms that credit constraints take is thus

an important, although challenging task. The direct elicitation methodology offers one approach to do so. As we hope is clear, we do not advocate the DEM to the exclusion of other empirical methodologies. Instead we view it as a complement to other methods including randomizations as well as others we have not discussed here such as qualitative case studies. Ideally, researchers will "circle the wagons" around this critical question of the performance of rural credit markets by bringing to bear multiple and complementary methods so that policy can move forward in the most informed way possible.

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Table 1: Common answers to question 7 and question 9 in Figure 2

	Why did (would) you not apply for a formal loan?	Constraint Status
A	I do not need a loan.	
B	The interest rate is too high.	Unconstrained
C	Farming does not give me enough to repay a debt.	(Price Rationed)
D	I prefer working with my own liquidity.	
E	I don't want to put my land at risk.	
F	I do not want to be worried, I am afraid.	Constrained
G	Formal lenders are too strict, they are not as flexible as informal ones.	(Risk Rationed)
H	Formal lenders do not offer refinancing.	
I	The branch is too far away.	Constrained
J	There is too much paperwork; the costs associated with loan application are too high.	(Transaction Cost Rationed)

Table 2: Descriptive Statistics of Sample Households

	1997	2003
% with:		
Less than 1 ha	3.8	4.3
Between 1 and 5 ha	74.3	77.0
Between 5 and 10 ha	13.3	11.7
More than 10 ha	8.6	7.0
Median farm size	3.0	3.0
% that own tractor	0.9	1.6
% with registered land title	49.4	70.0
% living in peasant community	43.1	43.1
Mean age of hh head	52.0	56.4
Mean schooling of hh head (years)	4.5	4.8

Table 3: Frequencies of rationing mechanisms

	1997	**2003**
unconstrained		
price rationed borrower	28.2	27.8
price rationed non-borrower	16.5	28.7
constrained		
quantity rationed	36.6	10.4
risk rationed	8.6	22.4
transaction cost rationed	10.2	10.8

Table 4: Comparison of Means of Key Correlates across Rationing Mechanisms

	Unconstrained		Constrained		
Variable	Borrowers	Non-borrowers	Quantity Rationed	Risk Rationed	Transaction Cost Rationed
TITLE	0.785	0.611	0.508	0.736	0.449
DISTANCE	17.8	26.4	31.3	30.7	30.9
INFORMED	0.913	0.818	0.754	0.822	0.830
CV	0.552	0.555	0.562	0.569	0.542
RA	0.013	0.013	0.016	0.015	0.013
MAXINFORMAL	1.07	0.54	0.452	0.578	0.825

Table 5: Definitions and Means of Variables Used in Multinomial Logit

Variable Name	Definition	Mean
Wealth	Household wealth excluding farm land (*1000 Soles)	4.22
Labor	Available family labor = Adult male equivalents that do not hold a permanent job.	1.68
Educ	Completed years of education of household head	4.57
Land	Farm size (hectares)	4.19
Title	Proportion of farmland with registered property title	0.66
Distance	Distance in public transportation to nearest formal lender (minutes)	26.30
Informed	=1 if correctly identified the minister of economics	0.84
CV	Coefficient of variation of yields in district	0.56
RA	Absolute risk aversion of household head	0.01
Maxinformal	Maximum transfer the household could receive from family or friends in an emergency (*1000 Soles)	0.72

Table 6: Marginal Impact of Regressors on Probability of Rationing Regimes

Variable	Price rationed borrower	Price rationed non-borrower	Transaction cost rationed	Risk rationed	Quantity rationed
Wealth	0.011**	−0.002	0.000	−0.008	−0.002
	(0.004)	(0.004)	(0.002)	(0.005)	(0.003)
Labor	0.035	−0.003	−0.025*	−0.015	0.007
	(0.023)	(0.020)	(0.013)	(0.021)	(0.010)
Educ	0.010*	−0.007	−0.000	−0.005	0.002
	(0.006)	(0.006)	(0.003)	(0.006)	(0.003)
Land	−0.012*	0.004	−0.001	0.009**	0.000
	(0.007)	(0.005)	(0.003)	(0.004)	(0.003)
Title	0.190**	−0.104**	−0.067**	0.045	−0.062**
	(0.065)	(0.044)	(0.018)	(0.053)	(0.020)
Distance	−0.004**	0.000	0.001	0.002**	0.001*
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
Informed	0.134**	−0.056	−0.026	0.016	−0.073*
	(0.060)	(0.061)	(0.036)	(0.055)	(0.044)
CV	−0.977	−0.290	−0.414	1.316**	0.365*
	(0.600)	(0.485)	(0.295)	(0.427)	(0.217)
RA	−4.016	−5.514**	−1.652	7.158**	4.024*
	(3.313)	(2.781)	(1.351)	(3.730)	(2.421)
Maxinformal	0.022	−0.012	0.008	−0.006	−0.012
	(0.015)	(0.020)	(0.006)	(0.018)	(0.016)

Marginal effects are estimated at sample median of regressors.

Standard errors are reported in parentheses.

**Indicates the marginal impact is significant at the 5% level.

*Indicates the marginal impact is significant at the 10% level.

Table 7: Productivity by rationing mechanism

Rationing Mechanism	% of sample	Output per hectare ($)
Price	51	1,350
Quantity	23	887*
Risk	16	700*
Transaction Costs	10	843*

*: Statistically different (at 5%) from the mean for price rationed households.

Table 8: Definition and Summary Statistics of Variables included in Estimation 2

Variable	Definition	Mean	Std. dev.
y	revenue per ha ($)	1087.59	1002.64
land	farm size (ha)	4.48	5.48
liquidity	saving and credit (1000 $)	1.38	3.60
adult	# of adults	4.15	1.96
dep	(# of children)/(household size)	0.19	0.20
reginc	# of adults with salaried job	0.13	0.38
herd	head of cattle	1.58	4.23
rice	1 if cultivates rice	0.53	0.50
cotton	1 if cultivates cotton	0.21	0.41
banana	1 if cultivates banana	0.21	0.41
corn	1 if cultivates corn	0.35	0.48
time	1 if year is 1997	0.5	0.5
durables	value of durable goods (1000 $)	0.53	1.22
T	proportion of titled land	0.58	0.69
N	proportion of neighbors with formal loan	0.28	0.26

Table 9: Parameter estimates and standard errors (in parentheses)

variable	restrictive definition	comprehensive definition
C	−682.97*	−684.48**
	(351.17)	(340.51)
land	−195.75***	−200.62***
	(41.19)	(44.14)
liquidity	10.44	8.21
	(14.22)	(14.17)
adult	10.65	5.93
	(28.21)	(27.5)
dep	275.56	182.8
	(244.86)	(220.77)
reginc	71.9	81.68
	(123.06)	(126.15)
herd	25.18**	33.17***
	(11.71)	(11.35)
rice	518.33***	456.87***
	(119.43)	(112.89)
cotton	−259.56***	−216.14*
	(100.4)	(113.26)
banana	−103.88	−42.65
	(209.1)	(202.79)
corn	−44.13	−89.43
	(96.59)	(85.4)
durables	49.41	36.84
	(34.13)	(40.21)
time	−455.15***	−357.98***
	(106.72)	(66.36)
Hansen J stat χ^2	0.086	0.008
p value	0.769	0.931
F-test IV first stage	5.84	7.07
p value	0.003	0.001

***, **, *: parameter estimate significant at 1%, 5% and 10%, respectively

list of loans	2. Name of the lender	3. Type of lender *See below*	4. Which household member received the loan?? *Individual code*	5. What was the loan used for? *See below*	6. For what crop did you request the loan?	7. How was the loan disbursed? *1.Only in cash >> 11* *2.Only in kind>> 8* *3.Both in cash and kind>>8*	8. What was the value of inputs you received?		9. If you would have bought these inputs in cash, would you have paid : *1.More >> 10* *2.Less >> 10* *3.The same >> 11*	10. What would be the % difference if you would have bought them in cash?	11. Would you have wanted a larger loan at the same interest? *1.yes >> 12* *2.no>>14*	12. How much more would you have wanted?		13. Why did you not receive what you wanted? *See below*
							Amount	Mn *1.S/.* *2. $*				Amount	Mn. *1.S/.* *2. $*	
01														
02														

Codes

Question 3

Formal
1.Commercial bank
2.Rural bank
3.Municipal bank

Semi-Formal
5.Government programo
6.Cooperative
7.Producer association
8.NGO

Informal
9. Input supplier
10.Rice mill
11.Textile company
12. Grain trader
13. Grocery store
14. Relative, friend
16.Other_____

Question 5

1.To buy inputs >> 6
2. To install perenial crops>> 6
3 .To buy agricultural material. >> 7
4. Other agricultural investment _____>> 7
5.Start a new business>> 7
6. Spending related to the business>> 7
7. To buy material for the business>> 7
8.Education>> 7
9.Consumption>> 7
10House improvement>> 7
11Buy or build a house>> 7
12.Other_____ >> 7

Question 13

1. Lack of collateral
2. Project not profitable enough
3. Lending policy of the instiution
4.other_____

listo f loans	14. Do you have to pay interest on this loan? *1.Yes>> 15* *2.No>> 16*	15. What is the interest rate?			16. When did you recieve this loan?		17. How often do you pay installments? *1daily* *2.weekly* *3.monthly* *4.annualy* *5. once at the end>>20* *6. it is not fixed>>20*		18. How much do you pay in each installment?		19. How many installements will you pay in total ?	20. In total, how much will you pay to cancel this loan?		21. When will you finish paying?	
		rate (%)	time period *1.daily* *2.weekly* *3.monthl y*	 *4.Annualy* *5.Other* _____	month *(1-12)*	year			Amo unt	Mn. *1.S/.* *2. $*		Amoutn	Mn. *1.S/.* *2. $*	Month *1-12*	Year
01															
02															

Figure 1: Sample loan characteristic module (first 21 questions)

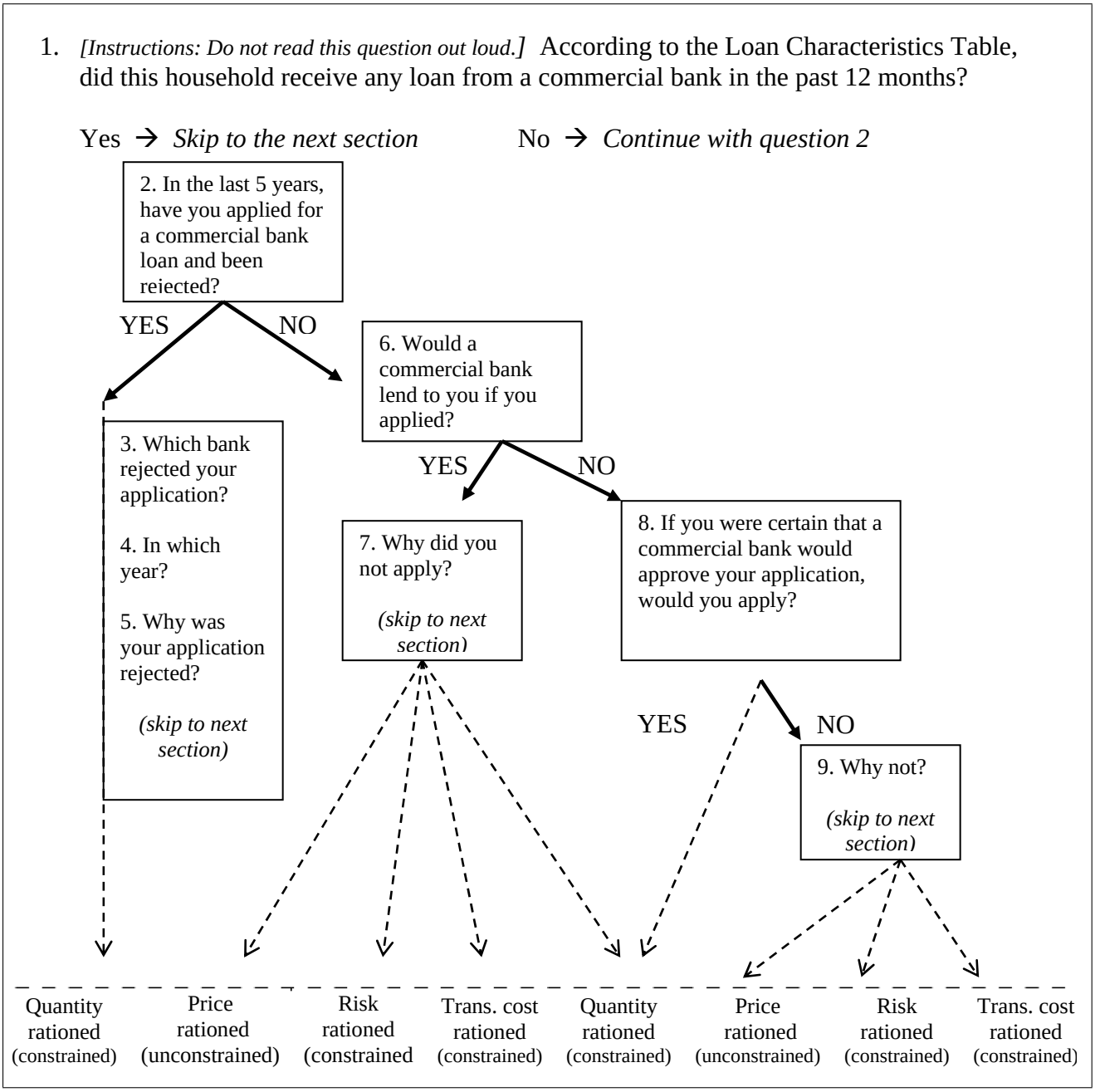

Figure 2: Sample non-borrower perceptions module