Direct elicitation of credit constraints: Conceptual and practical issues with an empirical application to Peruvian agriculture

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1. Introduction

Credit market imperfections are frequently cited as a primary impediment to efficient resource allocation in developing economies. As described by Petrick (2005) and Diagne, Zeller and Sharma (2000), two broad methods have been employed to empirically identify the importance of credit rationing. In the "indirect" method, researchers use assets or some other measured variable to divide the sample into groups that are more and less likely to be rationed. An Euler equation is then estimated. The dependence of consumption patterns on transitory income shocks is taken as evidence of imperfect access to (consumption) credit (Zeldes 1989). Thus in this indirect method, consumption and resource allocation decisions are used to "back-out" the incidence of credit rationing. The "direct" method, in a sense, reverses the order of analysis. Researchers first attempt to directly measure whether or not a household is credit rationed and then evaluate the impact of the constraint by estimating a second stage equation (for example restricted profit or yield) that provides a household specific measure of the shadow value of capital (Feder et. al. 1990, Petrick 2004).

While this method is perhaps more attractive because a broad range of "impact" questions can be addressed via the second stage estimation, its validity is crucially dependent upon both the conceptual definition of the credit constraint and the accuracy with which constrained households are identified in the first stage. In addition, data requirements are steep as both traditional survey data on consumption, production, and costs as well as non-traditional data on individuals' perceptions of credit markets must be collected. Currently, there is little agreement in the literature regarding either how credit rationing should be defined or how to empirically identify rationed households.

The primary contribution of this paper is methodological. The specific goals of this paper are three-fold. 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 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. Most empirical studies limit their definition of constrained households to those facing quantity rationing – which is essentially a binding supply-side constraint. We argue, however, that this definition is incomplete as the consequences of asymmetric information may take the form of demand-side constraints associated with transaction costs and risk rationing. Second, we describe and suggest strategies for dealing with the empirical challenges associated with identifying an individual's, a household's, or a firm's rationing mechanism and constraint status. Third, we use a unique data set from Peru to estimate the determinants of credit rationing. The data set allows us to use different methods for classifying households as rationed and thus allows us to test the sensitivity of parameter estimates to choice of classification method.

2. Non-price Rationing: A Conceptual Framework

In this section we develop a simple model of a credit market and activity choice. The goal is not to develop any new theoretical result, but instead to introduce and motivate the conceptual categories of non-price rationing we use in the empirical sections that follow.[1]

Consider the following stylized model of credit demand and activity choice. A farmer owns T acres of land and produces with a Leontief style technology requiring a fixed investment

[1] For recent reviews of the theoretical literature on quantity rationing see Ghatak, Mookherjee, and Ray (2002) and Udry and Conning (2005).

per-acre which, for simplicity, we will 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. To introduce uncertainty, we assume 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 a certain rent of w per unit land. Risk neutral lenders operate in a perfectly competitive market and have an opportunity cost of capital equal to $1+\gamma$. Assume that $pY > 1 + \gamma + w$ so that, in a first-best world, the farmer would always seek a loan and undertake production.

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 moral hazard or adverse selection. A credit contract then specifies the borrower's repayment obligation under each state. Letting i denote the interest rate and k the per-unit land collateral requirement, the borrower repays $(1+i)T$ under success and Tk under failure. The borrower's consumption in state j, C_j, is thus:

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

In turn, the lender's return per-hectare, R_j, is:

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

In a world of symmetric information the optimal contract ($1+i^*, k^*$) solves the following program:

$$(3) \quad \underset{1+i,k}{Max} \quad EU(C_j)$$

$$Subject\ to:$$

$$(3a) \quad 1+i \geq \frac{1+\gamma}{p} - \frac{1-p}{p}k$$

$$(3b) \quad kT \leq A$$

where the first constraint ensures that the lender earns non-negative profits and the second constraint acknowledges that, at most, the borrower can post collateral worth A. Using equation (1) in the above program, it is easy to show that the optimal contract in a first-best world would allow the borrower to earn the entire surplus (constraint (3a) binds) and allow the borrower to equate marginal utility – and thus 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 this first best world, risk neutral lenders are willing to trade higher interest rates for a reduction in a collateral at a constant rate of $(1-p)/p$. Efficient risk sharing is thus 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 will be made if credit markets are 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 theory literature, the presence of asymmetric information between borrower and lender may significantly alter our vision of the credit market. We

incorporate asymmetric information into our stylized model by assuming that lenders require that borrowers post a minimum of $\underline{k}$ units of collateral per-unit land. In addition, we assume that posting any amount of collateral implies a fixed cost of F to the borrower.[2] As discussed elsewhere, collateral provides incentives for borrowers to take costly actions that reduce the probability of failure and thereby addresses moral hazard (Hoff and Stiglitz, 1990). Collateral may also serve as a mechanism for sorting borrowers of unobservable types (say project riskiness) and thereby may also address adverse selection (Bester, 1985). While a complete model would endogenize $\underline{k}$, that is beyond the scope of this paper. Instead, we simply assume $\underline{k}$ exists and is the same for all borrowers.[3]

The presence of asymmetric information has immediate implications for the performance of our stylized credit market. In terms of our optimization program, we must 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, Japelli 1990) the availability of credit is necessary but not sufficient for a farmer with positive notional demand to have positive

[2] 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 implies a trip to the property registry and a fee.
[3] See Boucher and Carter (2002) for an example of a model that endogenizes the collateral requirement in a model of moral hazard.
[4] Note that this constraint is essentially an incentive compatibility constraint in a model of moral hazard.

effective demand, defined as the demand for contracts available in the "actually existing" or asymmetric information world. 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 $pY > 1 + \gamma + w + F/T$. Since transaction costs are assumed fixed, the expected income per unit land earned by the borrower from a given contract is increasing in farm size. Thus – holding constant productivity and risk preferences – small farmers will be more likely to voluntarily withdraw from the credit market due to transaction costs. A farmer who has positive notional demand but zero effective demand because of the size of transaction costs is called *transaction cost rationed*.

Finally, even if transaction costs were negligible, the existence of an expected income enhancing contract is still not sufficient to guarantee a positive effective demand. To see this, return to the minimum collateral requirement. Another way to think about the collateral requirement is that it forces the borrower to bear a minimum amount of risk.[5] Thus even though available contracts raise the borrower's expected consumption (compared to the reservation activity), they may lower the borrower's expected utility because they force the borrower to bear too much risk. 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.

If we assume zero transaction costs, then there will exist an agent with assets $A^*(T)$ who – for a given farm size -- is indifferent between his credit contract and the reservation activity. Let $r(A^*)$ denote this borrower's risk premium (per unit land) associated with the minimum

[5] Indeed this is the intuition behind incentive compatibility under moral hazard. By requiring collateral, a lender forces borrowers to internalize the consequences of actions they take that influence the probability distribution of project returns.

collateral contract. Then, by definition, $r(A^*) = pY - (1+\gamma) - w$. Any farmer with a lower risk premium would strictly prefer the minimum collateral contract while those with a higher risk premium would instead prefer the reservation activity. Thus if we assume farmers' risk preferences are described by decreasing absolute risk aversion, we conclude that, holding farm size constant, poorer borrowers – those with $A < A^*$ -- will be more likely to be risk rationed.[6]

To summarize, we have seen that asymmetric information can give rise to three types of non-price rationing. The first, quantity rationing, is perhaps the most obvious and has been emphasized in both the theory and empirical literature. Quantity rationing is solely a supply side phenomenon. In our simple model of fixed investment, it is defined by an empty feasible contract set. In general, quantity rationing occurs when a borrower's effective demand exceeds supply. In contrast, both transaction cost and risk rationing, which are defined conditional on a non-empty contract set, bring in the demand side. Any evaluation of the performance of credit markets should thus attempt to account for all three forms of non-price rationing. How to classify households into the appropriate rationing category is the task to which we now turn.

3. Measuring Credit Constraints – a Practical Approach

In this section we discuss the issues involved in classifying households as unconstrained (price rationed) versus constrained (non-price rationed) and, how we can further distinguish between supply-side (quantity) versus demand-side (risk or transaction costs) rationing mechanisms among constrained households. The discussion here essentially outlines variants of the strategy used in several household surveys, including the survey in Peru which will be the basis for the empirical analysis of section 4.

[6] Note that if we allow for full endogeneity of contract terms to borrower wealth, this need not occur. As shown by Newman (1995) and Thiele and Wambagh (1999), the relatively wealthy may be more likely to be risk rationed.

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 maximum amount of credit a formal 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:

$$(C1) \qquad D_i^E = D_i^N \leq S_i$$

While asymmetric information may imply that lenders impose a credit limit, this limit will not be binding for unconstrained households. Depending on their endowments and opportunities, unconstrained households may be either borrowers ($D_i^E > 0$) or non-borrowers. Resource allocation decisions of unconstrained households are unaffected by information asymmetries.

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

$$(C2) \qquad S_i < D_i^E \leq D_i^N$$

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 an expression of excess demand in the real world. We will deal with the question of how to capture this expression in the next section.

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

$$(C3) \qquad D_i^E < D_i^N \qquad and \qquad D_i^E \leq S_i$$

The risk sharing rules of the contract or the transaction costs associated with loan application drive a wedge between their notional and effective demand so that they are demand-side rationed. The primary empirical challenge is thus to distinguish demand-side constrained from unconstrained households. Neither expresses any excess demand, yet the former group's effective demand – and thus also their resource allocation – is adversely affected by asymmetric information in credit markets.

3.2 Operationalization of Constraint Categories

Our overall goal is to identify whether or not a given household is constrained in the credit market. The discussion above indicates that the binding constraint may derive either from the supply or the demand side. In either case, the mechanism by which the household is rationed in the credit market is *not* price. In the case of a supply-side constraint, the rationing mechanism is quantity while in the case of a demand-side constraint the mechanism is either transaction costs or risk.

We now turn to operationalizing the classification scheme described above. We begin with supply-side constrained households. Essentially, condition (C2) will hold if a household received less than its desired amount of credit given the available contract terms. In identifying these supply-side constrained households from survey data, it is useful to distinguish three separate groups. The first supply-side constrained group is unsatisfied borrowers, who apply for

and receive a loan, however the loan amount is less than their effective demand. The second group is rejected applicants, who have positive effective demand but a zero credit limit. The final supply-side constrained group is certainly-rejected non-applicants, who have positive effective demand but do not apply for a loan because – based on past experience or their perceptions of lenders' supply rules – they are certain their loan application would be rejcted.

Although each of these three groups is supply-constrained, given the typical structure of household surveys, their identification relies on different sets of questions. Figures 1 and 2 provide examples of the types of questions required to identify these three groups. Figure 1 shows several questions from the loan characteristics table. Note that the unit of observation (i.e. the row) is the received loan itself. The response to question 5 allows us to identify unsatisfied borrowers. There are two details to note in the formulation of this question. First, the borrower is asked to compare the amount received to the amount that he/she *wanted*. While it might seem intuitive to compare the amount received with the amount applied for, this would be problematic since the borrower may know the lender's supply rule and thus only ask for the amount they qualify for, even though this amount is less than their effective demand. The second thing to note is that the question must emphasize that the desired amount is conditional upon the interest rate available. Finally, although not essential for our present purpose of binary categorization of constraint status, question 5 can be followed by a question that asks the desired loan size. This would then identify a point on the borrower's demand curve and is thus useful for answering a different set of question such as the shadow value of liquidity.

Since neither rejected applicants nor certainly-rejected non-applicants received a loan, the information from the loan characteristics table (Figure 1) provides no information about their constraint status. Instead, we turn to Figure 2, which describes non-borrowers' experience in and

perceptions of the loan market of interest. After completing the loan characteristics table, enumerators determine whether or not the household had any loans from the sector of interest and, if not, the enumerator would apply the survey module depicted in Figure 2. The primary objective of this module is to sort all non-borrowers into their constraint category. Question 2 differentiates rejected applicants from non-applicants. Our second group of supply-side constrained households is thus identified by their response to this question. 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 again not necessary for the binary constraint classification, however they provide quantitative information on loan demand as well as qualitative information on perceived reasons for loan rejection.

The third supply-side constrained group was the certainly rejected non-applicants. As these are non-borrowers, we again use this module to classify these households' constraint status. To do so, the enumerator first asks question 6 to see if the household believes it could get a loan. If yes, then we know that the household is *not* supply-side constrained. If no, the enumerator continues with the hypothetical question 9: "If you were certain that a lender would approve your application, would you apply?" If yes, then the household is classified as constrained. One specific issue to be aware of is the wording of question 9. 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.

We now turn to identifying demand-side constrained households. We begin by noting that, as in the case of supply-side constraints, demand-side constrained households can be either

borrowers or non-borrowers. In line with the conceptual discussion of section 2, there are two main reasons why a borrower's effective demand may be less than his or her notional demand, namely transaction costs and contractual risk. Since transaction costs associated with loan application tend to have an important fixed component, we expect that, among borrowers, risk is likely to be more important than transaction costs in impacting effective demand.

In practice, it is very difficult to distinguish risk rationed (demand-constrained) borrowers from unconstrained borrowers. To do so requires capturing how the amount demanded would be affected by changes in risk sharing rules while holding constant the borrower's expected monetary return from the contract. Essentially, this would require asking if loan demand would increase if collateral were reduced as interest rate was increased. This approach is problematic since collateral is difficult, if not impossible, to adjust at the margin (i.e. it is not feasible to put up only nine-tenths of a farm parcel). As a result, this then requires asking about demand under a contract with zero collateral and a relatively high interest rate. Our experience has shown that responses to this type of approach do not capture the desired information. Farmers were highly skeptical (and rightly so!) about banks that might offer a zero-collateral loan. One respondent summed up this problem as follows: "I'd be crazy to take a loan from a bank that doesn't ask for my land…that would not be a serious institution so who knows what problems I might get into?" In our judgement, then, attempting to identify the group of risk rationed borrowers may not be worthwhile. While the cost of doing so is high, the benefit is likely to be low in the sense that the resource allocation of risk rationed borrowers is likely to differ little compared to unconstrained borrowers. On one hand, as pointed out by several theoretical models, when contract terms are endogenous to borrower characteristics, smaller, less risky loans are not made available by lenders because lenders require the borrower to bear a certain amount of risk to

overcome moral hazard in borrower effort or project choice (Newman 1995). In addition, and as mentioned above, collateral assets are typically very lumpy and cannot be marginally adjusted. Thus by taking a slightly smaller loan, the borrower cannot reduce their loss under default. Finally, in practice, there may be little scope for varying loan size as many agricultural lenders offer boilerplate, or formulaic, loan contracts in which loan size is a fixed multiple of area cultivated.

The second type of demand-side constrained households, and the ones we focus on here, is demand-side constrained non-applicants. Again Figure 2 provides information to classify these non-applicant households. Non-applicants are first divided into those who believe they would be offered a loan if they applied (answer "Yes" to question 6) and those who would not be offered a loan (answer "No" to question 6). We classify this first group into demand-side constrained versus unconstrained by following up with question 7 which asks why – given that they could get a loan – they did not apply for one. Table 1 provides a sample of the most common responses to this question and their subsequent classification as constrained or unconstrained. Households are classified as unconstrained if their response indicates that the expected rate of return to their investment or use of funds is less than the expected monetary costs of the loan. Households are classified as constrained if their response indicates that either risk or transaction costs were the primary reason that dissuaded them from borrowing. The second group, those who believe the lender would not approve their application, are then asked in question 9 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 who are classified as supply-side rationed. Those who say "no" are then asked why. The same

types of responses as are outlined in Table 1 are then used to classify them as constrained or unconstrained.

3.3 Issues and Challenges in Classification via Direct Elicitation

As suggested above, use of the direct elicitation approach requires a significant amount of information not typically collected in multi-purpose household surveys. Thus the time and resources required to successfully implement the approach are non-trivial. In this section we raise and discuss three general issues that arise in utilizing the method.

Issue 1: Definition of Loan Sectors

There are two main reasons to define distinct sectors or segments of the credit market and to then cast the language of the qualitative questions in Figure 2 with respect to these sectors. First, if the terms of credit contracts differ systematically across types of lenders, then households may have a clear preference ordering with respect to loan source. A household could then be constrained with respect to their preferred loan source but unconstrained with respect to less preferred sources. To classify this household as constrained, we need to dinstinguish between the two loan sources. In general, if there exists a clear hierarchy across lender types, at a minimum we should apply the classification methodology to determine constraint status with respect to the most preferred sector. For example, in a study of rural credit markets in India, Bell, Udry and Srinivasan (1997) assume that loans from the formal sector (agricultural cooperatives) are, if available, strictly preferred to informal loans from traders. As such, any household observed with an informal loan can be classified as constrained with respect to the formal sector.

The second, and perhaps more obvious, reason to define and refer to loan sectors is that the researcher may have sector (or even institution) specific hypotheses. For example, we might be interested in evaluating a policy that affects a certain type of institution. Mushinsky (1999) evaluates 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. Kochar (1997), for example, questions the assumption that the formal loan sector is the most preferred sector. A sector specific application of this method would be useful in this case.

The most common sectoral definition are "formal" and "informal." The distinction between formal versus informal sectors may be based on many alternative lender characteristics. Common criteria include: Is the lender regulated? Does the lender lend for profit? Is the lender specialized in financial intermediation? Of course the classification need not be binary. In our study of credit markets in rural Peru, we distinguish amongst four types of regulated lending institutions: commercial banks, municipal banks, rural banks, and finance companies. While each of these institutions is regulated by the central bank, there are differences in the specific rules and regulations that apply to each type. No matter what sectoral definition is chosen, the researcher needs to formulate clear rules so that the enumerators consistently assign lenders into the appropriate sector, enabling them to correctly apply the sequence of questions described above (for example, see question 3 of Figure 1).

Issue 2: Use of Hypothetical Questions

As described above, the classification of non-applicants' constraint status relies upon hypothetical questions. All non-applicants are asked if a lender would approve their loan

application if they were to apply. This question is potentially problematic for several reasons. First, this question introduces a change in the tone of the survey. Until this point in the survey, the respondent is likely to have been bombarded with "factual" recall questions. The enumerator now asks the respondent to change gears and think about the outcome of a loan application that was not made. Clearly communicating the idea behind this question is thus a non-trivial exercise. 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.

Assuming the question is clearly conveyed and understood, we face an additional issue. We want to establish whether or not the household has a strictly positive credit limit. Since we rely on the respondent's perception of the lender's decision, error is introduced into the data. The consequences of this error regarding hypothetical supply are less problematic, however, than might first appear. There are two types of potential errors. Consider first overly-pessimistic non-applicants who incorrectly believe they would be rejected. If they have no effective demand, they will not be incorrectly classifies as supply-side constrained. On the other hand, if they have positive effective demand, they will appear as supply-side constrained even though a lender would approve their application. However, we do not consider this a mis-classification because the household's behavior is indeed determined by the *perception* of the constraint and not the "actual" constraint. Overly optimistic non-applicants, who incorrectly believe the lender in question would offer a loan, have no effective demand and thus would never be classified as supply-side constrained.

A related issue is that in order to classify non-applicants as constrained or unconstrained we need to know whether or not they have positive effective demand which, in turn, depends

upon the household's perception of contracts available in the market. Since these non-applicant households are not participating in the credit market, they may be unfamiliar with existing terms. In pre-liberalization Peru, for example, the primary formal lender was the state development bank (Banco Agrario) which offered loan contracts with subsidized, and sometimes negative, real interest rates and did not require collateral. Many farmers have not borrowed from the formal sector since the state bank shut down in 1992. Consequently, the market conditions that these farmers have in mind when answering the question about their willingness to accept a formal loan may still be those of these highly subsidized loans. In the phrasing of the questionnaire it is essential to precisely define which institutions are included in the formal sector. The researcher may also use auxiliary information to gauge the accuracy of the respondent's perceptions. The quality of data analysis may be raised by controlling for the household's integration into the formal financial market. Useful controls include: the coverage of the formal sector in the zone, individual farmer/household credit history, general access to information at the household level, and whether or not the household has friends or family with a formal loan. A potential strategy which does not require making the assumption that farmer have strong familiarity with "relevant market conditions" is to add precision about a given credit product in the hypothetical questions. This solution has a fundamental drawback, however, as credit terms may differ both across borrowers and lenders so that the given contract may not reflect the contracts available to the household.

Issue 3: Household versus Individual Constraint?

The final issue we take up is whether the credit constraint classification should be made at the household or individual level. Up until now, we have couched the discussion at the

household level. This approach is consistent if we believe the household behaves in line with a "unitary" household model in which endowments and income are pooled amongst household members. Under this assumption, we would direct the qualitative questions of Table 2 to the household head, who would respond for the overall household. We implicitly 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, we would need to elicit the constraint status at the individual level. This individual approach, while costly, is useful for testing hypotheses related to gender bias in credit access and intra-household resource allocation processes.

In sum, while there are many potential pitfalls in implementing the direct approach, we feel that with sufficient training and fieldwork preparation, the approach can yield reasonable classification of households' (or individuals') constraint status. In the next section we demonstrate the importance of the means used to directly elicit constraint status by carrying out an econometric exercise that examines two hypotheses regarding the determinants of credit rationing.

4. Empirical Application: Determinants of Non-Price Rationing in Piura, Peru

In this section we use a data set that used the direct elicitation approach to analyze how the inclusion of demand-side constraints impacts our evaluation of the determinants of credit rationing. We will explore two particular determinants of constraint status that have been the

focus of much of the empirical literature, namely the household's wealth and the possession of a land title.

Our empirical exercise compares the determinants of credit constraints across our two alternative definitions of credit constraint. The first definition – which we will call the restrictive definition – classifies as credit constrained only those households that are supply-side constrained. According to this restrictive definition, a household is classified as constrained if and only if condition C2 holds (i.e. the household's effective demand exceeds available supply). The second – and we feel more appropriate – definition classifies a household as constrained if it is constrained either from the supply or demand side. This definition, which we call the comprehensive definition, classifies a household as constrained if either condition C2 or C3 holds. Our objective is not to separate the impact of explanatory variables on credit supply and on credit demand, but instead to evaluate their effect on the probability that a household is credit constrained under the alternative constraint definitions. Therefore, we estimate a reduced form logit equation with the binary credit constraint status as the dependent variable. We carry out the estimation twice – first constructing the households' constraint status using the restrictive definition and then using the comprehensive definition.

The analysis of the determinants of credit constraints answers important questions in and of itself. It also corresponds to the first stage of many studies aimed at evaluating the impact of credit constraints on household-specific outcomes. Indeed, in order to control for potential selection bias in the estimation of the "impact equation," a selection model needs to be estimated. Feder et. al. (1992), Carter and Olinto (2003) and Foltz (2004) provide examples of this general approach in studies analyzing impacts of credit constraint on investment or

productivity. We focus on two determinants of credit constraints that have been the focus of the empirical literature: household wealth and the possession of a land title.

4.1 Title, Wealth, and Credit Constraints

We first examine the relationship between the probability of being credit constrained and the possession of a land title. As summarized by Besley (1995), there are two main mechanisms by which gaining access to a title may affect a household's credit market participation. First, titled land may be offered as collateral and thus may loosen a binding supply-side constraint. Second, by enhancing tenure security and reducing the transaction costs of land transactions, a title may increase a household's investment demand. A household that was previously discouraged from borrowing by risk or transaction costs, may – upon receipt of a title -- seek a loan so that their constraint status may change. In our context of northern Peru, land tenure is secure and independent of title. We anticipate, then, that – at least in our context – the primary mechanism by which title may affect a household's credit constraint status is via relaxing supply-constraints. As such, we expect that while possession of a land title will reduce the probability of being credit constrained under both the restrictive and comprehensive constraint definitions, the impact will be larger using the restrictive (supply-side) definition.

The second explanatory variable we focus on is household wealth. As in the case of title, there are multiple mechanisms by which a household's wealth (holding title constant) may impact its constraint status. If household wealth is observable to lenders, it may be taken as a positive signal of capacity to repay both because high current wealth is likely to be positively correlated with the household's ability and the quality of their investment projects. Wealthier households are also likely to be less affected by demand-side constraints. If total wealth is

positively correlated with the size or scale of a household's productive activities – as is certainly the case in rural areas where farmland is the most important asset – then fixed transaction costs are less likely to deter wealthier households from applying for loans than poor households. Under the assumption of decreasing absolute risk aversion, wealthier households would, holding constant the risk-sharing rules of credit contracts, be less likely to be risk rationed than poorer households.[7] Given that lower wealth households are more likely to be demand-side constrained, this discussion suggests that the impact of using the restrictive instead of comprehensive constraint definition on the estimated probability of credit rationing is likely to be decreasing in household wealth.

4.2 Econometric model

We examine the relationships discussed above by estimating a reduced form logit model. Let C_i indicate the credit constraint status of household *i*, taking value 1 if the household is constrained and 0 otherwise. The probability that a household is constrained is:

$$(4) \qquad \Pr(C_i = 1) = \frac{e^{\underline{\beta}'\underline{X}_i}}{1 + e^{\underline{\beta}'\underline{X}_i}};$$

where:

$$(5) \qquad \underline{\beta}'\underline{X} = \alpha_0 + \alpha_1 * TITLE_i + \alpha_2 * WEALTH_i + \underline{\gamma}'\underline{H}_i + \underline{\lambda}'\underline{Z}_i + \varepsilon_i$$

$TITLE_i$ is a dummy variable that takes the value one if the household owns at least one parcel with a registered property title. $WEALTH_i$ is the value of household's wealth and includes the value of residential land, farm and business assets, household durables, and financial assets. $\underline{H}_i$

[7] If, however, contract terms are endogenous to borrower wealth, then it is possible that wealthier households are more likely to be risk rationed than poor households. This general theoretical point is made by Thiele and Wambaugh (1999). Boucher and Carter (2003) show this result in the case of credit contracts.

is a vector of household characteristics including the area of owned farm land, household size, education of the household head, and the dependency ratio. $\underline{Z_i}$ is a vector of geographic and year variables. Finally, α_0, α_1, α_2, $\underline{\gamma}$, and $\underline{\lambda}$, are parameters to be estimated.

As will be described shortly, the data used for estimation come from a panel of household surveys. This allows us to estimate the model in two ways: a logit on the pooled sample with cluster robust standard errors; and a conditional – or fixed effects -- logit. The main advantages of the pooled estimation are that it: uses information from the full sample; allows the estimation of the coefficients associated with time invariant variables; permits the estimation of predicted probabilities and marginal impacts of the regressors. The pooled estimation, however, does not fully address the potential endogeneity problems that arise in our context. In particular, we are concerned about a potential bias in our estimates of α_1 *and* α_2 – the coefficients associated with title and wealth – that may arise if unobserved characteristics such as land quality, past credit history or the aptitude to deal with loan paperwork impact both the probability of being constrained and the household's wealth.

While we partially address this issue by including regressors that capture some aspects of credit history (one dummy to indicate whether the household ever used formal credit and another to indicate if the household ever defaulted) and farmer ability (education and farm experience), unobserved heterogeneity remains a concern as we do not have controls for land quality. The fixed-effect logit estimation produces parameter estimates that are robust to biases introduced by time invariant unobserved factors and therefore addresses the issue of the endogeneity of title and wealth as long as the source of this endogeneity is time-invariant. The fixed-effect logit, however, has two drawbacks. First, since parameter estimates are identified by the subset of households that change rationing status over time, the sample size is reduced. If the cross-

sectional sample size is small – as in our case – the inability to use the full sample information may be costly. Second, because consistent estimates of the household fixed effect cannot be computed, neither marginal effects nor predicted probabilities of being constrained can be calculated.

4.3 Data and context

The data come from a survey administered to farm households in 1997 and again in 2003 in the department of Piura, on Peru's north coast. The sample was drawn from the comprehensive lists maintained by the irrigation commissions (*comisiones de regantes*) and is representative of irrigated, commercial agriculture in the department.[8] Of the original 547 households surveyed in 1997, 499 were resurveyed in 2003. The empirical analysis in this paper is based on these 499 households. In addition to conventional demographic and production modules, the survey contains a section, similar to the one described in Section 3, that explores in-depth borrowers' and non-borrowers' experiences in and perceptions of the credit market. The survey thus permits the classification of households as constrained or unconstrained according to both the restrictive and comprehensive definitions of credit constraint.

Table 2 provides descriptive characteristics of sample households. The mean farm size is just over 4 hectares . This reflects the unique agrarian structure of Peru. As a result of the agrarian reform of the 1960's and 1970's, the large landholding class was eliminated so that the vast majority of high quality, irrigated farm land is controlled by small-holders. Farmers in Piura produce a variety of annual and perennial crops. While historically, cotton has dominated the local economy, falling cotton prices and rising input costs have led to a large-scale substitution

[8] Boucher (2000) provides a detailed description of the sample design.

away from cotton and into rice and corn in recent years. Piura's tropical climate and relatively good port access also favor the production of perennial exports such as bananas and mango.

Until 1992, the state's agricultural development bank – Banco Agrario – held a monopoly over formal credit delivery to the agricultural sector in Peru. This changed dramatically when the government of Alberto Fujimori (1990 – 2000) implemented a financial liberalization program that shut down the Banco Agrario in 1992 and eliminated interest rate controls. The banking law was also rewritten in order to create a secure environment for commercial banks to lend and to promote rural and municipal banks (*Cajas Rurales* and *Cajas Municipales*). These latter two institutions were expected to attend to the needs of the sector of small commercial producers that would likely by neglected by commercial banks. In the post-liberalization period, growth of formal lending to agriculture was truncated by a series of crises in the late 1990's. In 1998, Peru – and particularly Piura – experienced a severe El Niño occurrence and the lagged impacts of the Mexican Peso crisis. This was followed by a serious political crisis culminating in the fleeing of Fujimori to Japan in 2000. With the agricultural sector severely depressed, the re-establishment of an agricultural development bank was placed back on the political agenda in the presidential election of 2000. Indeed in 2003, current president Alejandro Toledo made good on his campaign promise by opening Agrobanco – a new state bank operating primarily as a second-tier institution. As of 2003 – the year of the second survey – Agrobanco was not yet an important source of loans.

Table 3 describes credit market participation of sample households in the two survey years. Consistent with the formal sector crisis, the fraction of sample households borrowing from the formal sector fell slightly from 26% in 1997 to 24% in 2003. Borrowing from informal sources

decreased more, with the percentage of sample households with an informal loan decreasing from 49% to 39%.

Table 4 compares the percentage of households that are classified as constrained when using the restrictive versus comprehensive definitions. Two results merit comment. First, use of the restrictive constraint definition leads to a significant underestimate of the prevalence of credit constraints. In 1997, 20 percent of the sample was demand-side constrained (of which 11% was accounted for by transaction costs and 9% by risk) while in 2003 this percentage increased to 36 percent (of which 13% was accounted for by transaction costs and 23% by risk). Second, there is a marked decrease in the overall frequency of credit constraints, and this result holds independently of the constraint definition. While the decrease in constraint frequency could result from households accumulating wealth, experience and perhaps a credit history, this view is overly optimistic. As mentioned above, the frequency of formal loan receipt actually declined from 1997 to 2003. This decrease in formal loan use appears to have been accompanied by a decrease in both notional and effective demand. A more likely explanation for this decrease is the general crisis of the agricultural sector and the lower profitability of the agricultural sector.

4.4 Econometric Results

Table 5 presents parameter estimates from the pooled and fixed-effect logits.[9] As mentioned earlier, since the fixed effect estimation does not generate estimates of the household fixed effect, marginal effects of the independent variables on the probability of being non-price rationed cannot be computed. However the magnitude of the coefficients can be interpreted by converting them to odds ratios. To enable a comparison of coefficient magnitudes across

[9] We also estimated a random effect logit. The results are virtually identical to those of the pooled logit and are thus not reported here.

estimations we report all coefficients in this form.[10] Note that for both definitions of credit constraint, the pooled and the fixed effect estimations yield similar results in terms of the coefficient significance and their size.

We begin by examining the role of title on the constraint probability. Under both constraint definitions, the coefficient on the title variable is significant and the odds ratio is smaller than one so that, in line with our expectation, the possession of a title decreases the probability of being credit constrained. Furthermore, the odds ratio is smaller when the restrictive definition is used. The coefficient estimates under restricted and comprehensive definitions are 0.38 and 0.58 respectively. This suggests that, owning a title reduces the odds of being constrained by more than 60% when the restrictive constraint definition is used but only by about 40% when the comprehensive definition is used. Even if the point estimates are outside of each other's confidence intervals, those confidence intervals overlap so that there is weak statistical evidence that the point estimates are different. In conclusion, owning a title significantly reduces the odds of being constrained under both definitions of credit constraint, and the point estimates suggest that the effect is stronger when the restrictive definition is used.

We now turn to the role of household wealth. While we have no prior about the relative *size* of the coefficient on wealth across definitions, we do expect that the *difference* in the predicted probability of being constrained -- Pr(C=1|Restricted Definition)-Pr(C=1|Comprehensive Definition) -- is decreasing in wealth.

As we already mentioned, we cannot generate these probabilities using the fixed effect logit estimation. We will therefore rely on the parameters generated by the pooled logit estimation

[10] The odds ratio represents the estimated factor by which the independent variable impacts the odds of the outcome. The odds ratio equals e^{β} so that the absence of effect corresponds an odds ratio of 1 ($e^0=1$). Odds ratios greater than one indicate a positive effect of the independent variable on the response while odds ratios smaller than one are equivalent to negative impacts.

with cluster robust standard errors. Figure 3 graphs – for the two constraint definitions -- the predicted probabilities of being constrained as a function of household wealth along with 95% confidence bands.[11] Figure 3 shows a significantly lower constraint probability using the restrictive definition for wealth levels less than $40,000. The difference for higher wealth levels is not statistically significant. Of course the lower probability of being constrained under the restrictive definition is not surprising. By definition, the restrictive definition delivers a higher frequency of credit constraints. The more important question is whether or not this difference varies by household wealth. Figure 4 confirms our hypothesis. This figure plots the difference in predicted probabilities (the vertical difference between the two curves in Figure 3) using the two classification methods. At the lowest wealth levels, the comprehensive rationing definition yields nearly a 50% higher probability of non-price rationing than the restrictive definition. This difference then falls to less than 10% as wealth reaches the top wealth decile (over $100,000). As in the case of title, the estimated relationship between the probability of being credit constrained and the household's wealth is significantly impacted by the choice of how we define a household as credit constrained.

5. Conclusion

Given the prevalence of financial market liberalizations throughout the developing world in the last two decades and the continued concentration of poverty in rural areas, much attention has been focused on evaluating the "health" or performance of rural credit markets. A key indicator of the health of a credit market is the frequency by which individuals, households, or

[11] All other regressors, except dummy variables, are set equal to the sample mean. With respect to the dummy variables, Figure 1 is drawn for a farming household (nofarm=0) in 2003 that has no title for his land, did not dealt with formal institution in the past and did not report having ever defaulted. These choices are not critical to the shape of the curves.

firms find themselves constrained in their access to credit. As such, classifying households as credit constrained or unconstrained has become an increasingly important empirical exercise.

In this paper, we have argued for a careful and comprehensive conceptual definition of constraint based on the potential for information asymmetries to manifest themselves not only via familiar quantity rationing, but also through what we term "demand-side" constraints associated with risk and transaction costs. Based on this more theoretically complete constraint definition, we described the "direct elicitation" approach to identifying credit constraints in household surveys. While the costs of implementing the direct approach are non-trivial, we feel they are warranted.

In particular, this approach allows the researcher to identify the relative importance of the different underlying causes of credit constraints. Our empirical analysis showed, for example, that if we relied only on the restrictive supply-side constraint definition, we would have concluded that credit market conditions improved considerably between 1997 and 2003 since the frequency of supply-side constraints decreased from 45% to 13%. However, once we account for risk and transaction cost induced constraints, we see that the frequency of constraints, while also declining (from 65% to 49%), remains quite high. This result also highlights the importance of understanding the underlying source of credit constraints in order to alleviate them. Again, for example, our results suggest that attention to risk mitigation is potentially as important as faciliting households' ability to offer collateral via titling projects.

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Tables and Figures

Table 1. Common answers to qualitative rationing questions

"Why did (would) you not apply for a formal loan?"	Constraint Status
I do not need a loan	Unconstrained (Price Rationed)
Interest rate is too high	
Farming does not give me enough to repay a debt	
I don't want to risk my land	Constrained (Risk Rationed)
I do not want to be worried, I am afraid	
Formal lenders are too strict, they are not as flexible as informal ones	
Formal lenders do not offer refinancing	
The branch is too far away	Constrained (Transaction Cost Rationed)
The is too much paperwork, too much costs associated with application	

Table 2. Characteristics of Sample Households

Sample Mean (n=499)	1997	2003
Farm size (hectares)	4.32	4.13
Household wealth (thousand $)	6.58	4.02
Education of head (years)	4.58	4.87
% of households with:		
Corn	48.3	27.5
Cotton	31.3	9.4
Rice	48.1	50.7
Banana	22.0	28.9
Lemon	37.9	15.0
Mango	10.2	8.8

Source: UC-Davis/BASIS survey.

Table 3. Participation of Sample Households in Credit Market

% of Households with:	1997	2003
Only Formal Loan	19.3	18.8
Only Informal Loan	42.2	34.7
Both Formal & Informal	6.6	5.8
No loans	31.8	41.7

Source: UC-Davis/BASIS survey.

Table 4. The Frequency of Credit Constraints According to Two Classification Methods

Classification method	1997		2003	
	Constrained	Unconstrained	Constrained	Unconstrained
Restrictive (Supply-Side Constrained)	45%	55%	13%	87%
Comprehensive (Supply or Demand-Side Constrained)	65%	35%	49%	51%

Table 5. Coefficient Estimates: Determinants of Non-Price Rationing

	Rationing status using C2		**Rationing status using C2 or C3**	
Variable	**fixed effect**	**Pooled**	**fixed effect**	**pooled**
Title	0.3803**	0.3567**	0.5818*	0.4541**
Wealth	0.9107**	0.9411**	0.9575*	0.9573**
Household size	1.2263**	1.0065	1.0774	0.9853
Time	0.1654**	0.2513**	0.5969**	0.6731**
Area owned	0.8216	1.015	0.9102	1.0087
No farming dummy	0.3024	1.3496	0.4102	1.1778
Experience		0.9981		1.0145**
Education		1.0074		0.968
Default dummy		2.4368**		1.3876*
Loan history		0.9779		0.8108**
Constant		0.9995		3.0508**

*: significant at 10% **: significant at 5%

Figure 1. Sample Loan Characteristic Table

1. Loan Number	2. What is the name of the individual or institution that you borrowed from?	3. What type of lender was this? (*see code A below*)	4. What was the value of this loan?	5. Would you have wanted a larger loan at this same interest rate?
1				
2				
3				

CODE A

Formal	Semi-formal	Informal
1.Commercial bank	5.Government program	10.Input supplier
2.Rural bank	6.Ag-cooperative	11.Rice mill
3.Communal bank	7.Farmers' cooperative	12.Cotton gin
4.Edpyme?	8.Farmers' Association	13.Other ag-enterprise
	9.NGO	14.Grain trader
		15.Shop
		16.Friend / Family
		17.Other

Figure 2. Structure of qualitative credit constraint survey module

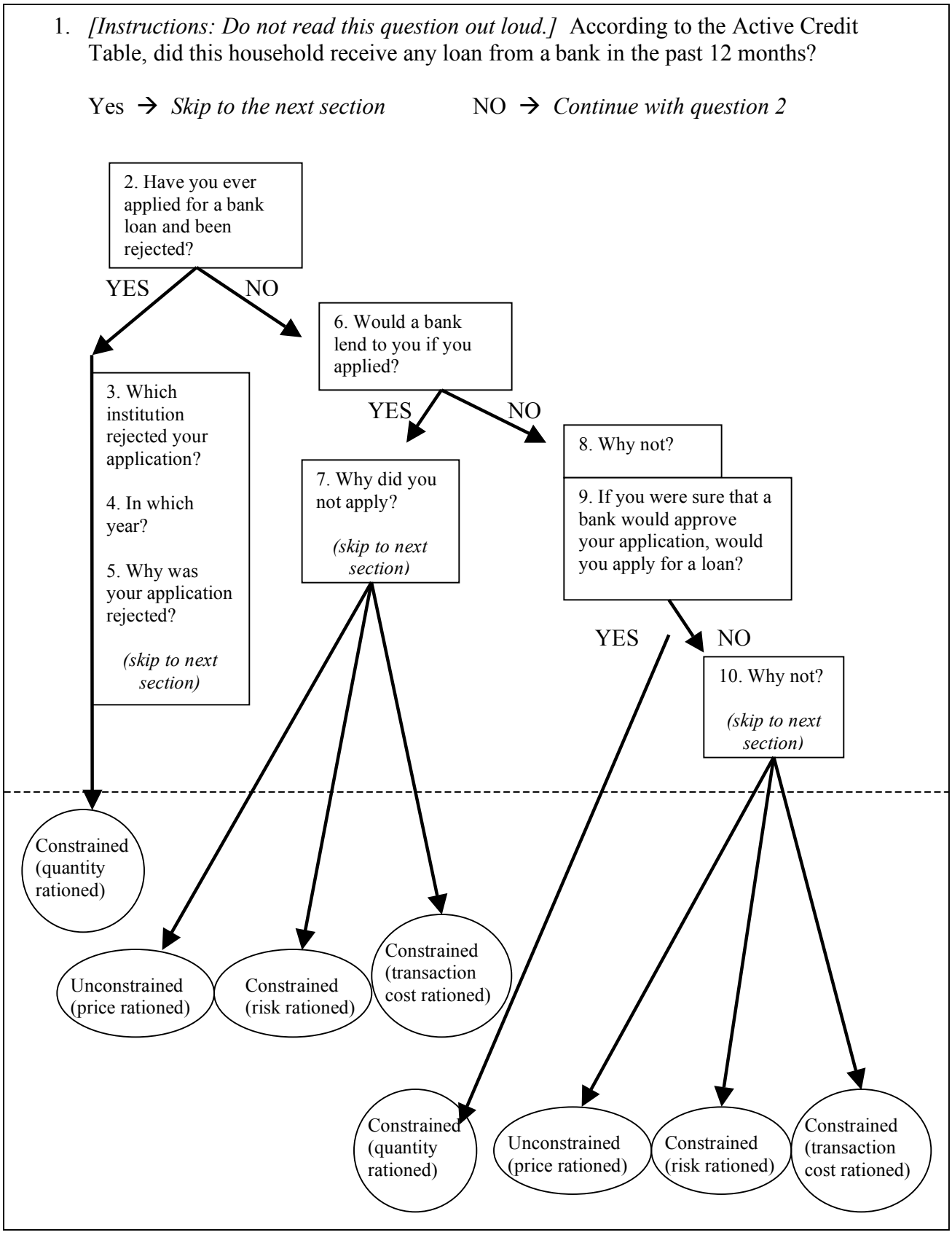

Figure 3. Predicted probability of being constrained for the two constraint definitions

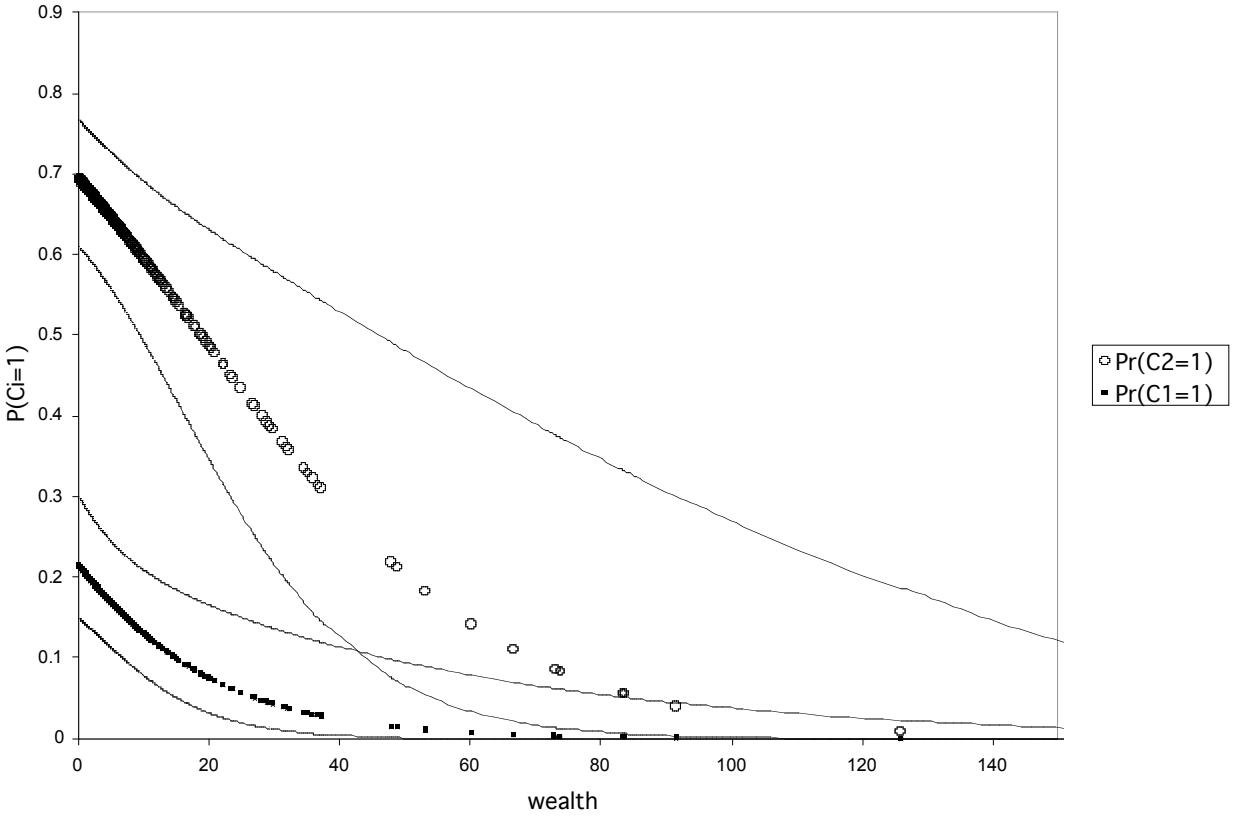

Figure 4. Difference in predicted constraint probabilities across definitions