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Market Choice and Effective Demand For Credit : Roles of Borrower Transaction Costs and Rationing Constraint *

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This paper proposes a new variant of two-step estimation procedure to check impacts of borrower transaction costs and rationing constraints on credit decision. This new method enables us to measure the potential interdependencies between an optimal market choice under multiple credit sources and the effective demand for credit under disequilibrium states. This procedure is as follows;(1) estimate market choice function by a qualitative choice(i.e., probit) model; and then (2) measure effective demand for credit by a truncated disequilibrium model. Potential interdependencies of error terms between two estimations and sample selection bias regarding market choice are corrected by introduction of a new regressor. Econometric evidences show that smaller borrower transaction costs in the credit market with higher nominal interest rate, rather than potential rationing probabilities in credit sources with lower nominal interest rate, plays key role for some borrowers to choose credit market.

I. Introduction

In this paper, we explore the question of why two differentiated credit markets coexist in many developing countries, and suggest a new variat of two-step estimation procedure to evaluate impact of borrower transactions costs and rationing constraints on the credit decision, i.e., choice of credit source and credit amount.

In many developing countries like India, there exist two credit

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sources with different characteristics. The regulated credit market (hereafter RM), which not only is under the direct control of the government but also has lower nominal interest rates, includes formal financial institutions such as commercial banks, insurance companies and credit cooperatives. The unregulated market (hereafter URM) refers to secondary, informal, private lending groups, such as professional moneylenders, commodities traders, commission agents and relatives which are not subject to direct government control.

The previous studies argue that the the credit rationing in the RM accounts for this coexistence; customers seek loans first from the financial institutions in the RM. Then they are forced to visit the secondary URM when they are rationed out in the RM. [see Laffont and Garcia (1977), Sealey (1979), and Bell *et al.* (1990)].

In this case, it is implicitly assumed that the credit source is exogenously determined by the given nominal interest rates along with rationing constraints. This is not necessarily the case. Hence this assumption is questioned in this paper. The farmers' choice between the RM and the URM as a source of credit may well be jointly determined not only by these two important factors, but also with others. For instance, some customers in need of urgent loans may want to avoid hassles of going through the long process of preparing for numerous documents in commercial banks in the RM. They often prefer to go to the private moneylenders in the villages as their first option for small and emergency loans, despite the higher nominal interest rates they face. Or, if a farmer alone has to bear initial borrower transaction costs and perceives a low probability of obtaining any credit, (s)he may be discouraged from entering the credit market. These initial borrower transaction costs works as a threshold for a farmer in deciding whether or not to enter credit market. If that is the case, rationing alone cannot explain why there are two kinds of credit markets in the actual economy. Here comes the role of borrower transaction costs in the credit decision process. The difference in borrower transaction costs in two segments of the credit market, such as documentation costs, application fees, and number of trips to lenders, may play a significant impacts on farmer's choice on credit source. That is, higher borrower transaction costs in the RM may induce farmers to enter the URM [see Ladman and Adams(1978) and Adams Nehman(1979.)]

These arguments state that rationing constraint along with effective borrowing rate, made by nominal interest rate and borrower transaction costs rate, jointly decide the source of credit, rather than nominal contractual interest rate alone. The goal of this paper is to investigate the impacts of these factors on farmers' decision on credit source. For this, an individual farmer's choice model is set out Section Ⅱ and a new two-step estimation procedure with corrective measures is suggested in Section Ⅲ. The econometric evidence and rationing condition are analyzed in Section Ⅳ and the concluding remarks is summarized in Section Ⅴ.

Ⅱ. The Model

We want to show that the choices of credit source and the following effective demand for credit in a rural credit markets with multiple sources may have a series of decisions by farmers to make and factors to consider. We first start with a basic model, considering an individual farmer who maximizes his or her incomey with respect to labor L and credit B:

(1) Maximize $y \mid_{L, B}$

subject to the constraints:

(1-a) $y = q(L;z) - (1+i)B - T + \overline{Y}$

(1-b) $wL - B \leq \overline{E}$

(1-c) $R \geq B$

where $q(\cdot)$ is a production function, z, other production factors, i, contractual interest rate, T, borrowers transaction costs, $\overline{y}$, other earnings, w, wage rate, $\overline{E}$, initial endowments of a household, R, rationing amounts. Constraint (1-a) is an income identity, (1-b) a budget constraint, (1-c) a rationing constraint in a credit market for a household, respectively.

Normally, borrower transaction costs T has two parts: one variable to the size of borrowing, tB, and fixed components regardless of size of credit, $\overline{T}$.

(2) $T = tB + \overline{T}$

where t is the marginal borrower transaction costs rate. Plugging (2) into (1-a), the realized income identity (1-a) can be rewritten as follows:

(1-a)' $y = q(L;z) - (1+t)B - \overline{T} + \overline{y}$, where I (=1+i) is a gross contractual interest rate.

The optimal condition for the positive borrowing without a binding rationing constraint is the following;

(3) $\frac{q_L}{w} = (I + t) \geq I$.

This condition shows that first, the marginal value product (MVP) of labor employed using the loan ($\frac{q_L}{w}$) equal to the factor price of credit, the "effective"marginal cost (MC) of borrowing (I +t), and secondly, marginal borrower transaction costs of credit, t raises the marginal cost of borrowing.[1] This means that higher borrower transaction costs may discourage farmer from borrowing (more) from that source of credit [see Figure 1]. In other words, in a credit market with multiple sources, higher borrower transaction costs in a source would dampen farmer's preerence against that source.[2]

So far, we limit our analysis to a single credit market. With coexistence of RM and URM in the same rural economy, relative sizes of terms and conditions of two potential credit packages should be compared. In order to investigate impacts of borrower transaction costs and rationing constraint on farmer's decision in the credit markets with multiple sources, we introduce an iso-income contour V(B, r; $\tilde{y}$; e) and a non-linear opportunity set Ψ(B, r; i, t; R_j; e)$\geq$0.[3] The iso-income (utility) contour is the individual farmer's preference map, showing all combination of credit B and effective borrowing rater that would yield the same income y under the optimal size of labor with borrowing from constraint (2-a).[4]

A non-linear opportunity set is the feasible area for credit, determined by the piecewise cost constraints Ψ_j with the binding

[1] This condition is obtained the assumption that the price of agricultural product is unity and dL/dB = 1/w.

[2] In case of the binding ration constraint, the condition (3) may not hold. In that case, he MUP is greater than the MC, i.e., farmer tries to get as much crdit as possible, up to the maximum of ration amounts.

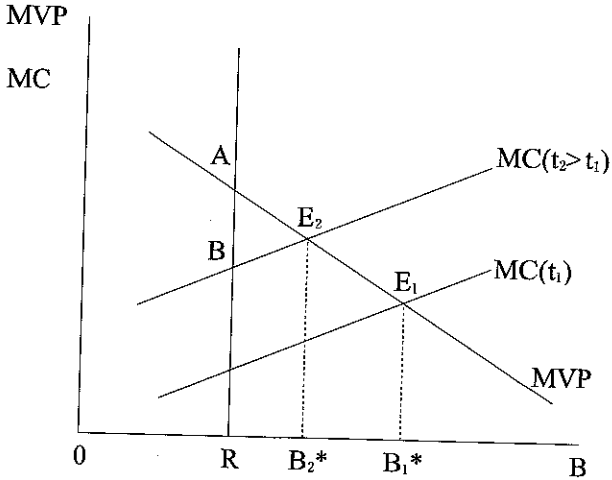
$$\frac{q_L}{w} > (I+t).$$

[3] Due to quantity-dependent non-constant price of credit and the existence of fixed borrower transaction costs, the opportunity set is a set of negative sloped hyperbola. The iso-income contour is locally concave in the neighborhood of the demand curve. For detailed interpretation of the shape of an iso-income contour, see Jaffee and Russel (1976) and Kalay et. al. (1978)

[4] The "effective" borrowing rate, as mentioned in the Introduction, is the sum of contractual interest rate and "annualized"borrower transaction cost rate.

Figure 1

Borrower Transaction Costs and Borrowing



rationing constraint, R_j to the segment j of credit markets. This feasible set is shaped by the relative sizes of borrower transaction costs and nominal interest rates of each credit market and can be a non-convex set due to the presence of fixed borrower transaction costs. These iso-income contour and a feasible set vary with a vector of households characteristics, e. Then, the optimization process under multiple sources of credit will be denoted as follows: find a credit package (B,r) which satisfies the following:

(4) Maximize $V(B, r \mid \tilde{y};\ e)$

subject to $\Psi(B,r;\ i;\ t;\ R_j;\ e) \geq 0; \qquad \forall\ j;\ j=1,\ 2,$

where subscripts 1 and 2 denote the formal (RM) and informal (URM) source of credit, respectively.

The optimal size of credit to (4) will be called as an "effective" demand for credit, the credit amount actually transacted, D^e. The "effective"demand for credit can be either (i) the "desired" demand, B*, binding only under the cost constraint, or (ii) the "rationed" demand, R_j, binding under both the cost and rationing constraints from j source of credit.

For simplicity, we define an indirect income index function $V^*_i(\cdot)$ if the tangency point of $V(\cdot)$ with an opportunity set occurs at the segment of cost constraint from j source of credit. That is;

$$(5)\ V^*_j(B^*, r^* \in \Psi) = (\tilde{y}^* \mid B^*, r^*);$$

$$\text{where } (B^*, r^* \in \Psi) = \text{argmax } V(\cdot) \text{ subject to } \Psi_j(\cdot \mid i, t);\ j=1, 2.$$

This $V^*_j(B^*, r^*)$ is the highest obtainable income y^*, through the optimal choice of B^* and r^* under the binding segment j of the overall cost constraint.

According to the general principle suggested by Hausman.(1985) in the analysis of optimization under a piecewise non-linear constraint set, the optimization is to find the maximum among the various income index functions by (5).[5] That is,

$$(6)\ \text{Max } \{V_0(\cdot), V^*_1(\cdot), V^*_2(\cdot)\}$$

The choice of credit source and the equilibrium point can occur on different segments of the opportunity set, i.e., the segment for which utility is the highest among feasible alternatives, where $V_0(\cdot)$ is the reservation level of utility (income) with self-finance (i.e., no borrowing).

A farmer has to weigh options from no borrowing to credit from either source.[6] Without the binding rationing constraint, an effective equilibrium is defined by the tangency of an iso-income contour and a cost constraint. The best option would be the best combination of interest rate and borrower transaction costs, which gives the highest income from loan with the desired segment of the market. If the tangency point occurs outside the reservation level, the farmer would not borrow at all. This means

$$(7)\qquad V_0(\cdot) > \text{Max } \{V^*_1(\cdot), V^*_2(\cdot)\}$$

This indicates that borrower transaction costs have threshold effects on

[5] The general principle used in the analysis of optimization under a piecewise non-linear constraint set is the following: (1) to have the farmer choose his/her most preferred demand point on each segment of the cost constraint, (2) to determine the corresponding income (utility) of that point, and then (3) choose at his/her maximum maximum of income (utility) across all segments of an effective alternatives. The choice of credit source and the equilibrium point can occur on different segments of the cost constraint, i.e., the segment for which utility is the highest among feasible alternatives.

[6] This means that, if there is a positive borrowing from either source, it indicates that any borrowing would be better than the self-finance, i.e., $\min[V^*_1(\cdot), V^*_2(\cdot)] > V(\cdot)$.

credit decision in a sense that the size itself would force farmers to make decision to pursue credit procedure or not and the reservation level $V_0(\cdot)$ acts as the threshold. If borrower transaction costs is too big to bear and benefit from small credit is not big enough to cover the borrowing cost, no borrowing would be the best option for farmers even though they need small amounts of credit.

In the presence of rationing constraint, the observed segment is not necessarily the most desired segment of the market. Rationing constraint from a source of credit may even cause farmers to change their sizes or source of credit from the best (i.e., desired) on to the second-best (i.e., observed, rationed) one. To examine this situation, we redefine the indirect income index function (5) under the binding ration constraint as follows:

$$(8)\ V^*_{Rj}(R_j,\ r^*_j \in \Psi) = (\tilde{y}^* \mid R_j,\ r^*_j),$$

$$\text{where}\ (R_j,\ r^*_j \in \Psi) = \text{argmax}\ V(\cdot)\ \text{subject to}\ \Psi_j(\cdot \mid B^* = R_j);\ j=1,\ 2.$$

By definition, within the j source of credit market, the optimum income level without a constraint, $V^*_j(\cdot)$, should be at least the same or larger than the optimum with any constraint(s), $V^*_{Rj}(\cdot)$, i.e.,

$$(9)\ V^*_j(\cdot) \geq V^*_{Rj}(\cdot)$$

With binding ration constraint in segment j of the credit markets, $V^*_j(\cdot)$ with a "desired"demand of credit, B^*, is not feasible and hence $V^*_{Rj}(\cdot)$ is the second-best available income for farmer to get, with (given) rationed credit with R_j and r^*_j. This condition means that the desired demand is larger than the given rationed one, and the actual credit amount would be a rationed one from this source, if this gives higher income than potential credit from other source.

The ration in a source even changes the source of credit for some farmers. The case of switching source of credit due to rationing constraint is as follows. This is, as the order of the indirect index functions indicates, $V^*_{R1}(\cdot)$ is the best available income to get in the RM due to a binding ration in that market. If income from the second source $V^*_2(\cdot)$ is greater than $V^*_{R1}(\cdot)$, then, farmer would move to the URM to get credit, even though desired credit from RM without rationing would give the most income, i.e.,

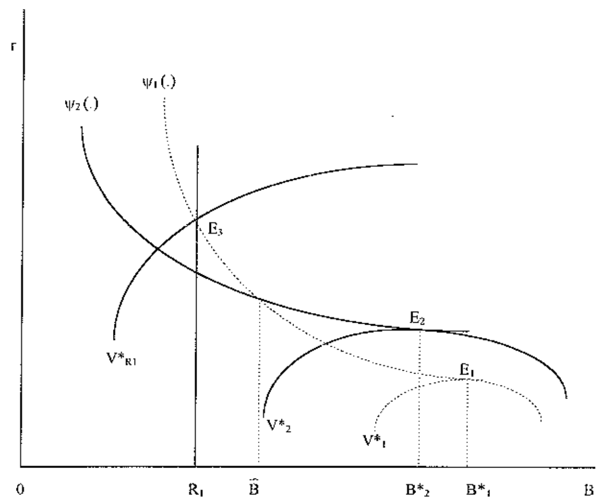
$$(10)\qquad V^*_1(\cdot) \geq V^*_2(\cdot) \geq V^*_{R1}(\cdot).$$

Farmer switches the source of credit from the "initially"most desired market 1 to the feasible second-best ("available") one, desired demand from market 2, due to the binding rationing constraint in the former market [see Figure 2-a]. The reverse situation, switching credit source from URM to RM, can be drawn, too [see Figure 2-b].

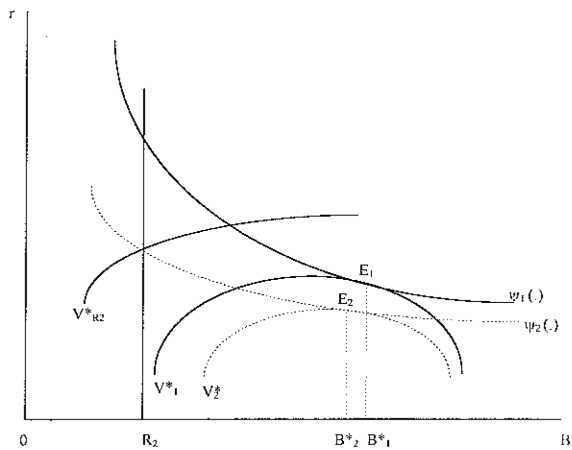
Figure 2

Impacts of Borrower Transaction Costs on Credit Decision

2-a : Rationing at the RM and Borrowing from the URM



2-b : Rationing at the URM and Borrowing from the RM



The final outcomes for the credit transaction D^e would depend upon the sizes of indirect utility function for each potential transaction, which would give highest feasible income with it, i.e.,

(11) $D^e=[(B^*UR_j)\cap r] \Leftrightarrow \mathrm{Max}(V_0, V^*_1, V^*_2, V^*_{R1}, V^*_{R2})$.

If the ration constraint is not binding in the j segment of credit market, V^*_{Rj} will be dropped out from option to choose. Accordingly, the observed positive transactions in the RM then would be under the one of the following cases:

(12) (i) $V^*_1(\cdot)\geq V^*_2(\cdot)$; or (ii) $V^*_{R1}(\cdot)\geq V^*_2(\cdot)$; or (iii) $V^*_{R1}(\cdot)\geq V^*_{R2}(\cdot)$

That is, the loan from the RM would give higher utility than those from URM, with the different combinations of terms and conditions for loan, regardless of desired one or rationed one. This all indicates that in credit process, i.e., choice of credit source and the following credit amounts, all factors including initial sunken borrower transaction costs, potential terms and conditions of credit available to farmers, rationing possibilities, socio-economic characteristics of households should be accounted for all together. These factors may affect the farmers' initial decisions to enter credit market, then the following decisions on optimal source and credit amounts, if they decide to participate.

Conditions (11) and (12) also indicate that credit amount actually transacted in the market, for example in the RM, the effective demand for credit, D^e can be formulated as:

(13-a) $$D^e=\begin{cases} B_1^* \text{ if case (i) holds and } & \text{if } 0<B_1^*<R_1, \\ R_1 \text{ if cases (ii) and (iii) hold and} & \text{if } 0<R_1<B_1^*. \end{cases}$$

This implies that only the "short" side of the market transaction is actually observed;

(13-b) $D^e=\mathrm{Min}\ (B^*,R)$.[7]

Ⅲ. Two-Step Estimation Procedure

[7] More correctly, this minimum condition implies that $D^e=\mathrm{Min}\ [\mathrm{Max}(0,B^*), \mathrm{Max}(0,R)]$. This condition would preclude the situation that B^* and R are less than zero. Therefore, there can be mass points of credit transaction at zero and that can be the point of truncation in the estimation.

The corresponding estimation procedure for the model is comprised of estimation of credit market choice function and effective demand for credit function. This two-step estimation procedure involves not only estimations of these two functions one by one, based on the qualitative choice model and a truncated disequilibrium model, but also implies the introduction of the two-step correction technique within the estimation procedur.

In its first step, we estimate a qualitative market choice function by a probit model for credit market choice decision, which is governed by the condition (12), with ample and necessary consideration to borrower transaction costs and a vector of households characteristics. Then in the second step, we estimate effective demand for credit function with a modified disequilibrium model, under the condition (13).

Two econometric issues merit mention. A correction measure to accommodate effect of potential sample selection bias on the credit market choice process was taken and a remedy to the truncation problem of the mass point of observations with $D^e=0$ in sample in the estimation procedure was also devised for the model, because we use the census survey data of rural India farmers in early 1980s. This sampling problem is often ignored or mishandled in the previous literature where the survey data on the credit market are used.

First, for the issue of the qualitative market choice decision between two segments of credit market for a credit demander *i*, we define a latent response variable I_i^* for credit market choice decision,

$$I_i^* = \beta_0 + \beta_1 TC_{i1} + \beta_2 TC_{i2} + \beta_3 z_i = Z_i'\beta + \varepsilon_i \tag{14}$$

where TC_{ij} is borrower transaction costs from the source j for an individual i; z_i is other explanatory variables; ε_i is an error term with unit variance; and Z_i is a vector of all explanatory variables, and β is a vector of coefficients. In practice, I_i^* is unobservable. What we observe is a discrete dummy variable, I_i. If we let index $I_i=1$ if farmer i participates in the RM, (i.e., $D_i^{RM}>0$), and $I_i=0$ otherwise, (i.e., one participates in the URM; $D_i^{URM}>0$). Then, the observed result will be

$$I_i = \begin{cases} 1 & \text{if } I_i^* > 0, \\ 0 & \text{if } I_i^* < 0. \end{cases} \tag{15}$$

From the estimating the univariate probit model, we can evaluate the probability that a farmer enters the RM, $\text{Prob}(I_i^* > 0) = P(I_i = 1) = \Phi(Z_i'\beta)$. The partial derivative of the probit function (14) to an explanatory variable shows the marginal changes of probability of I_i being equal to one. That is, $\frac{\partial P}{\partial Z_{ik}} = \frac{\partial \Phi(Z_i'\beta)}{\partial Z_{ik}} = \phi(Z_i'\beta)\beta_K$, where $\Phi(\bullet)$

and $\phi(\bullet)$ are the standard normal cdf and the standard normal pdf, respectively.

The second step involves the estimation of individual's effective demand function for credit he/she faces in the credit market. As mentioned in conditions in (13), B* and R are not observable, only the "short" side of the market transaction is actually observed; $D^e = \text{Min}(B^*, R)$. This provides a raison d'être for a disequilibrium econometric model which is able to deal with the "minimum" condition. Therefor, we specify a system of equations for the effective demand function for credit with a "desired" demand equation, a rationing (supply) equation, and a transaction equation, as follows:

(16-a) $\quad B^* = \alpha_1'x_1 + u_1,$

(16-b) $\quad R^* = \alpha_2'x_2 + u_2,$

(16-c) $\quad D^e = \text{Min}(B^*, R),$

where x's are vectors of independent variables, such as household characteristics and tems and conditions of credit, α's are vectors of parameters to estimate. The error terms u's are assumed to be distributed normally with mean zero and covariance matrix Σ. The maximum likelihood estimation (MLE) of a standard disequilibrium model was first suggested by Maddala and Nelson (1974) (hereafter M-N model).

Here, we then modify this M-N model to deal with the mass observations at the zero credit amount, i.e., $D^e = 0$. From our survey data on farmers in India, it is not possible to gauge whether zero credit transaction implies the individual's optimal choice or a rationed one. Treating no borrowing observations as ones either being rationed out or having zero desired demand will result in a bias in estimation, since the data was collected by simply asking whether or not farmers have ever borrowed or repaid money to or from credit markets during survey periods, not the amounts they asked.

Another source of this problem is that credit transaction observations themselves do not indicate whether those credit transactions were farmers' first choices in situations where two or more credit sources exist. In other words, the data does not indicate orders of farmers' approaches to the credit sources. Thus, there can be potentially missing observations in the sample, and we simply do not know how many observations are missing.

One way to solve this problem is to allow for a truncation in the model.[8] That is, we only use the observations with positive borrowing (i.e., $D^e > 0$), and the likelihood function from the standard M-N disequilibrium model should be corrected to allow for truncation at point zero. Hence the name of a *truncated* disequilibrium model. The modified probability density function of a truncated disequilibrium model is provided in Appendix.

When we estimate the effective demand function for credit, our estimates could be subject to the sample selection bias unless the effect of the market choice is included in the model. This is due to the fact that the individual in question has option to have credit transaction in the other source that market choice decision itself affects the demand for credit. This problem can be handled by using a similar two-step correction technique suggested by Heckman (1979). We similarly suggest that a new regressor, which is based on the probability of participation, be included in the independent variables of the truncated disequilibrium model. A new regressor, the inverse of Mill's ratio, λ_i, where $\lambda_i = \frac{\phi(Z_i'\beta/\sigma)}{\Phi(Z_i'\beta/\sigma)}$ is computed from the estimates of market choice function (14). This procedure corrects the sample selection bias and yields consistent estimates. Hence comes the second implication of a two-step estimation procedure wherein the sample selection bias correction variable, inverse of Mill's ratio from the first estimation, appears as one of regressors in the second estimation of a truncated disequilibrium model.

Ⅳ. Estimation Evidence

The data for this paper are obtained from a census survey of rural India farmers from Andhra Pradesh state. This survey was conducted as part of a study of the impact of agricultural development on employment and poverty by a joint project of the World Bank and the Indian Institute of Management (IIM), Ahmedabad, and the Agro-economic Research Centre (AERC), Waltair. In this survey, the sample of 535 households data were collected from fourteen villages in this state.[9] The initial sampling was done between June 1980 and September 1982.

The credit market participation status of the heads of households (HHDs) and their credit transactions were classified in Table 1 and 2. Among 535 HHDs of the sample, 275 HHDs participate in at least one

[8] The censoring model is not considered since we do not distinguish rationed-out farmers with those not demanding credits at all.

[9] The scheme and procedure for sampling households from the villages are explained briefly in Bell *et al.* (1990)

source of Indian rural credit markets (i.e., 221 HHDs in only one source and 54 HHDs in both ones), and the remaining 260 HHDs don't borrow at all. Among 650 credit transactions, 520 transactions come from URM by 240 heads of households and 130 cases from the RM by 89 HHDs.[10] Among

Table 1

The Status of the Sampled Households in Credit Markets

	Formal Sources		Total
	Non-borrowers	Borrowers	
Informal Sources			
Non-borrowers	260(48.6)	35(6.5)	295(55.1)
Borrowers	186(34.8)	54(10.1)	240(44.9)
Total	446(83.4)	89(16.6)	535(100.0)*

*Note:** : The first number in each cell is the number of households falling into the category of credit transaction in question and the numbers in parentheses are proportions of that category over all HHDs.

Table 2

The Source of Credit Transactions of the Sampled Households

	Formal Sources		Total
	Non-borrowers	Borrowers	
Informal Sources			
Non-borrowers	-	50	
Borrowers	417	183 (80,103)*	520
Total			

*Note:** : The first number in parenthesis is transactions in the RM and the second is in the URM.

[10] This implies that one head of households may contribute more than one observation. The unit of econometric estimation, therefore, must be the individual transaction, not individual head of household.

them, 35 HHDs only participate in RM with 50 transactions, 186 HHDs get credit from URM only with 417 loans. Furter 183 cases of credit transaction by 54 HHDs are reported for heads of households who enter both sources during the survey period. Among them, 80 cases are RM transactions and the remaining 103 cases for URM.

We first estimate a probit equation, accounting for the market choice between the RM and the URM, using the LIMDEP program. The descriptive statistics of variables and estination result of the probit function are provided in Table 3 and Table 4 respectively. Among the independent variables, including borrower transaction costs of the sources,[11] and personal, socio-economic characteristics variables, such as education level, sex, age, caste rank of the head of a household, asset

Table 3

List of Variables and Descriptive Statistics

Variables	Description	Unit of Measurement	Mean	Std. Dev.	Max	Min
AGE	Age	years	45.3	12.6	86	18
SEX	Sex	male=1	.95	.22	1	0
EDU	Education	literate=1	.52	.50	1	0
HCASTE	High Caste	high/medium=1	.36	.48	1	0
LCASTE	Low Caste	low / scheduled	.53	.50	1	0
FMSIZE	Family Size	=1	5.87	2.98	24	1
DEPEND	Dependency Ratio	persons nonworkers	.9	.72	4	0
LAND	Land Area	/workers	3.27	5.74	60.8	0
LANDVAL	Land Value	hectares	35.3	66.6	925	0
ENDR	Land Endowment Ratio	1,000 rupees hectares per	1.00	1.43	15.0	0
ASSETALL	Assets other than Land	person 1,000 rupees	18.94	32.14	456.4	.2
DVWAGE	Village Wage Rate	1,000 rupees	5.26	1.33	8.0	2.0

[11] Here, we do not observe transaction cost variables in each market unless farmers actually get loans from it. Thus, we estimate potential borrower transaction costs in two markets. For transaction costs in the RM equation of the observations which transacted in the URM market, we use the fitted values from the estimated regression model for the RM by using the observations in the URM, and we replicate the same procedure for those in the URM. We do not present the regression results for the reason of space.

Table 4

Estimation Results of a Probit Market Choice Function

Independent Variable	Coefficients	(t-statistics)
Constant	-2.91	(-2.13)
RMTC	0.1E-03	(0.07)
URMTC	2.21*	(8.92)
EDU	-0.05	(-0.22)
SEX	0.19	(0.41)
AGE	0.44	(0.90)
AGE2	-0.4E-03	(-0.81)
HCASTE	-1.86*	(-3.77)
LCASTE	-0.71*	(-2.46)
FMSIZE	0.3E-03	(0.01)
ENDR	-0.22	(-1.86)
ASSETALL	-0.2E-02	(0.23)
LANDVAL	0.04	(1.00)
DISTRICT	-0.18	(-0.41)
DVWAGE	0.19*	(2.08)
-Log-Likelihood	128.75	N=650

*Notes:** : significant at the 5% level.

Description of Variables:

RMTC: borrower transaction costs in the RM.
URMTC: borrower transaction costs in the URM.
AGE2=AGE AGE.
ASSETALL: sum of productive equipment and other physical assets in rupees.
DISTRICT: 1 for west Godavari district with a complete irrigation, and 0 otherwise

holdings, land area, and location ofthe household, we expect that *effective* borrower transaction costs such as documentation fee, convenience and promptness of credit acquisition may play an important role in determining the optimal market choice for each individual. The estimation results are mixed one: the coefficient of TC in the RM is neither correct in sign and nor significant. On the contrary, that in the URM is both positive in sign and statistically significant. That is, the higher TC in the RM, borrower would have higher probability to choose RM as the credit source.

To check the joint significance of borrwer transaction costs terms, TC_{ij} in the market choice function (14), we employ the Likelihood Ratio test for a null hypothesis that these two variables have zero coefficients. The test statistic, computed as 298.96, rejects the null hypothesis that borrower transaction costs don't have influence on farmers' choice between two sources at the 1% significance level.[12]

Among remaining independent variables, two caste rank variables and village daily wage rate are significant at 5% level. The surprising result is that caste rank variables have negative signs, implying that with higher caste ranks, farmers less enter the RM, which may look against the common perception.[13]

As the second stage of estimation, the truncated disequilibrium model choice for the effective demand for credit of farmers was estimated using the Maxlik package of Gauss software. Difficulties in estimating the disequilibrium models is well known; see a survey paper by Quandt (1988). This is also true for our model. Especially, the correlation coefficient (ρ) between two error terms is hard to estimate. It often approaches unity, a boundary value. This frequently causes breakdowns during iterations. This potential difficulty forces us to assume that ρ is zero. However, predictions of the model are seldom affected by the presence or absence of ρ. We used the Davidon-Fletcher-Powell (DFP) optimization algorithm when we obtain convergence of the model.

The estimation results are presented in Table 5. Looking at the desired demand function, the variables of SEX, village level workers wage level (DVWAGE), and the district dummy (DISTRICT) are significant at the 5 % level. Their signs are as expected. The variable of number of workers in a household (WORK) is insignificant and has an unexpected sign. The family size variable (FMSIZE) has the expected sign but is not significant at the 5% level. Asset holding variables (ASSETALL, LANDAR) have expected signs, but their t-values are unexpectedly low. Turning to the rationing equation, the land value variable (LANDVAL), has a correct sign and is significant at 5% level. This result supports the common understanding in rural credit markets that lenders closely look into potential collateral materials to credit. Caste rank variables (HCASTE and LCASTE) have correct signs, but are not significant. The dummy district

[12] Meanwhile, the probit function correctly classifies 100% of the URM and 74% of the RM, resulting in 95% overall accuracy.

Predictive performance of the probit model

		Prediction	
		URM	RM
Actual	URM	520(100%)	0(0%)
	RM	34(26%)	96(74%)

[13] The true effect of caste rank in the market choice is the difference of two caste rank variables, i.e., $\beta_{HCASTE} - \beta_{LCASTE} = -1.12$.

Table 5

Estimation Results of Effective Demand for Credit:
A Truncated Disequilibrium Model

Variable	Desired Demand Function	(t-stat.)	Rationing Function	(t-stat)
Constant	7.53	(1.72)	-2.14	(-0.96)
SEX	6.93*	(2.11)		
WORK	0.25	(0.76)		
FMSIZE	-0.24	(-1.37)		
DVWAGE	-2.44*	(-3.27)		
ASSETALL	0.18	(1.67)		
LANDAR	0.07	(1.69)		
DISTRICT	10.46*	(4.03)	-2.74	(-1.18)
HCASTE			4.93	(1.79)
LCASTE			-2.09	(-1.11)
LANDVAL			0.97*	(4.41)
LAMDA	12.26	(1.79)	-0.97	(-0.87)
σ_1	2.26*	(8.24)		
σ_2			2.54*	(5.69)
Log-Likelihood	219.33	N=130		

Notes: * : significant at the 5% level.

Description of Variables (continued from Table 4):

WORK: number of workers in a household.
LAMDA: inverse of Mill's ratio from estimates in probit function.

variable (DISTRICT) has unexpectedly a positive sign and is not significant at the 5% level.

The variable included in the second stage of estimation to correct potential sample selection bias regarding market choice, the inverse of Mill's ratio, λ_i from the probit market choice estimation (LAMDA), have mixed signs, but are not individually significant at the 5% level in both equations. However, the LR statistic testing for overall significance of these variables in two equations is computed as 7.78, suggesting that they are jointly significant. This enforces the implication that the correction measure for potential sample selection bias from market choice behavior should be accounted for in the specification of the effective demand for credit function.

An important question pursued in this paper is why two kinds of markets coexist in the actual economy. We deal with this question by examining the rationing probabilities. Specifically, if farmers with lower probability of rationing from the RM prefer the URM, then it indirectly implies that optimal choice is different from the situation without rationing threats, since the nominal interest rates are usually higher in the URM. The rationing probability is defined as the *conditional* probability that an observation belongs to the rationing equation given that the effective demand is positive:

$$(17) \qquad \eta = P(B^* \geq R \mid D>0) = P(D^e = R \mid D^e>0).$$

This probability is similar to those defined by Gersovitz (1980) and the optimal rule of Lee (1984). We estimate only the truncated disequilibrium model of the RM. Then, we will compute the predicted rationing probability of the URM observations using the estimated equations of the RM. It reflects the potential rationing probability of the URM observations if they would have had credit transactions in the RM though they actually obtained loans from the URM. We call it a cross-market rationing probability. One half(0.5) is a common choice of the threshold level for regime classification in the literature.

We now calculate the rationing probabilities of the individual credit transactions and investigate the extent of rationing in rural credit markets. For this, we first apply the rationing conditional probability in (17) to the observations in the RM. Then, we calculate the cross rationing probabilities of the URM observations, using the estimation results from the RM. The results are surprisingly suggestive. For example, the cumulative frequency of the RM observations whose rationing probabilities are less than 0.5 is 52.3%, while that in the URM from the cross rationing probabilities is 57.5% [see Table 6]. The result implies that the proportion of the URM observations who may not be subject to rationing in the RM is greater than that of the RM observations. This has an important implication that rationing cannot solely explain the existence

Table 6

Cumulative Relative Frequency of Rationing Probabilities

probability	$\leq .25$	$\leq .50$	$\leq .75$	≤ 1.0
RM	42.3%	52.3%	54.7%	100%
URM	25.8%	57.5%	80.6%	100%

of two markets. Optimal choice of economic agents regarding decisions of credit source and the amount to borrow could have been affected by size of borrower transaction costs.

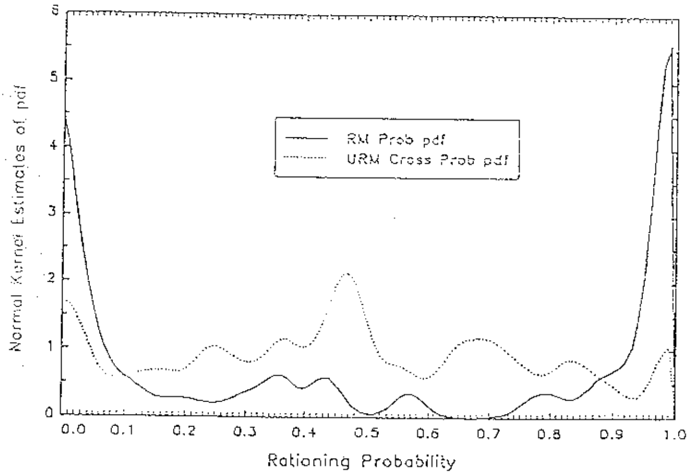
To capture the distributional perspective of rationing probabilities more precisely, we derive a kernel estimation of the pdf by using a normal kernel function. A kernel estimator with kernel function K(·) is defined as:

$$(18)\ \hat{f}(x) = (1/nh) \sum_{i=1}^{n} K[(x-X_i)/h],$$

where h is the window width; X_i are the observations; n is the number of observations. The kernel function K(·) satisfies the condition $\int_{-\infty}^{+\infty} K(x)dx = 1$. Using the normal kernel with the bandwidth, h = 0.035, we illustrate the respective distributions of the estimated pdfs of rationing probabilities of the observations in the RM and that of cross rationing probabilities of the observations in the URM [see Figure 4]. We note that these two rationing probabilities show very similar movements.[14]

Figure 3

Kernel Estimates of the pdf of Rationing Probabilities



[14] The null hypothesis that two rationing probabilities have identical distributions is rejected by a non-parametric Kolmogorov-Smirnov test. The test statistic, 2.23 is larger than the critical value at the 5% level of 1.36. However, their movements are in general similar with the exception on both ends of the spectrum.

Ⅴ. Conclusion

In this paper, we examine farmers' behavior in the rural credit markets with respect to roles of borrower transaction costs and the rationing constraints. Optimal choice could be reversed for some farmers. We investigate impacts of these constraints under the probit market choice function, and the truncated disequilibrium econometric model for the effective demand for credit. Inclusion of the inverse of Mill's ratio into the effective demand for credit function estimation, employing a two-step estimation procedure and modification of the standard disequilibrium model to the truncated one enhance to grasp the specific characteristics in fragmented rural credit markets. This paper shows that two different credit markets coexist not only by the presence of the rationing in the credit source, but also by the optimal decision of individuals caring for the effective borrowing costs, including the borrower transaction costs.

Appendix

We derive the probability density function (pdf) of the truncated disequilibrium model for its Maximum Likelihood Estimation estimates. Based on the joint normal distribution assumption of u's in (10), the unconditional probability density function of D^e, is expressed as a sum of two terms (assuming no correlation between error terms of two equations, for simplicity, i.e., $cov(u_1, u_2)=0$):

(A-1) $$h(D^e)=h(D^e \mid B^* < R) \cdot P(B^* < R)+h(D^e \mid B^* \geq R) \cdot P(B^* \geq R)$$

with

(A-2) $$h(D^e \mid B^* < R)= \frac{1}{\sqrt{2\pi}\sigma_1} \exp\{-\frac{(D^e-\alpha_1' x_1)^2}{2\sigma_1^2}\}$$

(A-3) $$P(B^* < R) = 1 - \Phi(\frac{D^e-\alpha_2' x_2}{\sigma_2})$$

(A-4) $$h(D^e \mid B^* \geq R)= \frac{1}{\sqrt{2\pi}\sigma_2} \exp\{-\frac{(D^e-\alpha_2' x_2)^2}{2\sigma_2^2}\}$$

(A-5) $$P(B^* \geq R)=1-\Phi(\frac{D^e-\alpha_1' x_1}{\sigma_1}),$$

where the first term on the right hand side of (A-1) comes from the desired demand equation and the second term comes from the rationing equation.

To allow for truncation at zero amount effective demand, we modify the equation (A-1) by dividing it by the probability of non-zero observations, $P(D^e > 0)$. The conditional pdf of the observations with positive amounts of borrowing, called a probability density of a truncated random variable $D^e>0$, is given as:

(A-6) $$H(D^e \mid D^e>0) = \frac{h(D^e)}{P(D^e>0)} = \frac{h(D^e|x_j)}{1-P(D^e=0)}$$

We obviously obtain $P(D^e > 0)=1 - P(D^e = 0)$. And, $P(D^e = 0)$ is given by plugging $D^e = 0$ into $h(D^e)$ in (A-1):

(A-7) $$h(D^e = 0) = h(D^e=0 \mid B^* < R) \quad P(0=B^* < R)+h(D^e=0 \mid B^* \geq R) \quad P(B^* \geq R = 0),$$

where

(A-8) $$h(D^e = 0 \mid B^* < R) = \Phi(\frac{-\alpha_1' x_1}{\sigma_1}),$$

(A-9) $$P(0 = B^* < R) = 1-\Phi(\frac{-\alpha_1' x_1}{\sigma_1}),$$

(A-10) $$h(D^e = 0 \mid B^* \geq R) = \Phi(\frac{-\alpha_2' x_2}{\sigma_2}),$$

(A-11) $$P(B^* \geq R = 0) = 1-\Phi(\frac{-\alpha_1' x_1}{\sigma_1}).$$

Therefore, the probability density function of the modified truncated disequilibrium model is given by the ratio of the two expressions (A-1) and (A-7). Then, the likelihood function can be accordingly given:

(A-12) $$L_T=\prod_j H(D^e \mid D^e > 0) = \prod_j \frac{h(D^e \mid x_j)}{1-P(D^e=0)}$$

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