World Bank Reprint Series: Number 341

Farrukh Iqbal

The Demands for Funds by Agricultural Households: Evidence from Rural India

Reprinted with permission from *The Journal of Development Studies,* vol. 20, no. 1, October 1983, published by Frank Cass and Company, Ltd., London, U.K.

The Demands for Funds by Agricultural Households: Evidence from Rural India

*by Farrukh Iqbal**

This study presents estimates of borrowing functions based on rural household data from India. It improves upon existing work in three key areas. First, it is shown that existing studies have used an inappropriate definition of the demand for funds, which when rectified produces quite different results. Second, the interaction between agricultural technical change and the rural finance market is examined and it is shown that farmers in a position to benefit from technical change tend both to borrow more and to face lower interest rates. Third, it is shown that farm-specific interest rates, when introduced endogenously, are quite sensitive to personal and locational characteristics and are significant determinants of borrowing.

I. INTRODUCTION

Existing studies of the determinants of the borrowing behaviour of farm-households tend to suffer from two biases: a truncation bias, hitherto unrecognised in the relevant literature [e.g. *Hesser and Schuh, 1962; Pani, 1966; Long, 1968; Lins, 1972; Ghatak, 1976*], arising from the definition of the dependent variable; and a simultaneity bias (recognised but rarely corrected for) arising from the endogeneity of the interest rate used to denote the cost of borrowing. The principal contribution of this study is the estimation of borrowing functions free from these biases.

The truncation bias is formally similar to that arising in the case of female market labour supply where non-market wages and hours are unobserved. In the borrowing case, because the conventional empirical definition of borrowing does not take into account borrowing from internal sources (e.g. savings accounts) and/or lending, the dependent variable is effectively truncated at zero and neither 'internal' borrowing nor interest rates faced by those who do not borrow in the market are observed in the sample. A number of approaches have been devised to obtain consistent estimates for

*The author, currently a staff member of the World Bank, is grateful to Surjit Bhalla, Kenneth Wolpin, Robert Evenson, Dennis DeTray, Daniel Kohler and an anonymous referee for their very useful comments at different stages in the preparation of this paper. In its present form it is a considerably revised version of a note prepared with support from Grant No. AID/OTR-G-1822 from the Agency for International Development extended when the author was a post-doctoral research fellow at the Rand Corporation. Views and errors to be found in this paper are to be attributed to the author alone.

labour supply functions under such conditions [*Smith, 1980*]. Our task is made simpler by the fact that the censoring of the dependent variable can be corrected by simply redefining it to include adjustments in both the asset and the liability positions of the household. The unobserved interest rates are imputed in accordance with a procedure suggested in Heckman [*1979*]. An additional advantage of the imputation procedure is that it allows us to account for the possibility of the simultaneous determination of the interest rate and the amount borrowed and thereby to correct for the simultaneity bias. Our results suggest that much is gained from such an exercise.

While the above considerations are of general relevance, the study is of particular importance to agricultural finance issues in less-developed countries (LDCs) where 'official' credit programmes have become important components of development expenditure. It is reported that rural credit of over $30 billion is now disbursed annually by LDC governments and that over $5 billion has been spent by international agencies over the last several decades [*Adams and Graham, 1981*]. The empirical basis of such lending programmes, however, is surprisingly weak, as can easily be gauged from a recent survey of the relevant literature [*David and Myer, 1979*]. Among others, two important relationships have received inadequate or inappropriate treatment. One is the relationship of borrowing to interest rates and the other is the link between the demand/supply of credit and the rate or possibility of agricultural technical change. Both these issues are important to LDC agriculture since concessional interest rates are the centre-piece of official credit policy and agricultural innovation *à la* Green Revolution is widely believed to be the most important means of development in such countries.

Some of the major shortcomings of earlier work are examined in Section II, and a mixed life-cycle/-permanent-income model of borrowing is proposed as a suitable theoretical foundation for the present analysis. Section III presents an empirical analysis of the demand and supply of funds. The data are obtained from a comprehensive national (panel) survey of approximately 3,000 farm households in India for the years 1968–71, conducted by the National Council of Applied Economic Research (NCAER). The empirical analysis is guided both by theory and by special characteristics of the data at hand. Pertinent details regarding the data and sample-size determination are provided in the appendix. Section IV summarises the important findings of the study.

II. SOME PRELIMINARY CONSIDERATIONS

Perhaps the most serious drawback of conventional studies is that they define the demand for credit to be simply the amount borrowed from external sources. This restricts the dependent variable to non-negative values, a feature which renders standard OLS estimation subject to bias. Such truncation bias is avoided in the present analysis by taking a flow-of-funds approach to the measurement of the demand for credit. According to this approach, the net demand for funds, B, can be expressed as the identity:

$$B = EB - EL - FA - CD + TI \qquad (1)$$

where EB, EL refer to external borrowing and lending and therefore (EB–EL) refers to the change in liabilities; FA refers to the change in financial assets, CD to the change in the household's stock of consumer durables, and TI to the net transfer of income in the form of remittance and gifts. Previous studies have used EB, rather than B, as the measure of the demand for funds. The difference between the two measures is substantial as can be seen from Table 1 where the mean level of EB is shown to be over three times the mean level of B.

The characterisation of the role of technical change in influencing the demand for funds by LDC farmers can also be improved upon. One way to approach this matter is to consider the effects of technical change on farm incomes and productivity. The experience of South Asia in the late 1960s suggests that technical change involving new seeds and fertilizers (the major components of the Green Revolution) tends to raise farm incomes and productivity. Now, the greater the value of expected future income the greater will be the tendency to borrow in anticipation of it. Similarly, the higher the rate of return on capital, the greater will be the tendency to borrow and thereby employ more capital in production. Both of these effects can be captured by the use of a measure of investment opportunity, a term defined by Fisher [*1930*] as the opportunity to shift from one 'option' or possible income-stream to another. In the case of farm households, an improvement in investment opportunities can be thought of as an outward shift of the production-possibility frontier. Thus if we can distinguish empirically between farmers who face different investment opportunities we should be able to evaluate the effect of technical change on the demand for funds. The empirical implementation of this notion is discussed in a later section.

Most existing studies assume the interest of cost of borrowing to be an exogenous variable. However, since loan size could affect both the riskiness of the loan and its administrative cost [*Bottomley, 1975*], it may be more reasonable to assume that the interest charge is endogenously determined. The usefulness of either assumption can only be determined empirically; the two-stage estimation approach taken in this paper allows us to do this.

The specification of any behavioural function depends on the underlying theoretical framework. We have adopted a mixed version of the life-cycle/permanent-income model as a guide to empirical specification. This approach is popular in the savings literature but has received surprisingly little attention in the LDC borrowing literature. Its advantages for our study lie in its ability to integrate consumption and production decisions as well as to allow for time-dependent behaviour. It yields the following determinants of the demand for borrowing (or saving, consumption and investment for that matter): age, initial endowment, current and expected input and output prices, the marginal cost of funds, and shifts in investment opportunities (denoting expected future income). Readers interested in a formal model along the above lines may turn to Iqbal [*1981a*].

III. EMPIRICAL ANALYSIS

The Structure of the Empirical Model

The empirical model consists of two equations, one representing the demand for funds and the other in the form of a function relating the interest rate to its determinants, the supply of funds.

Consider the latter function first. In a competitive market, three basic costs enter the nominal interest rate (Rn): the opportunity cost of providing a loan, the administrative cost of handling a loan, and the risk premium to be assigned to different borrowers. Thus the nominal interest-rate function can be written as:

$$Rn = r_1Z + r_2B + r_3X \qquad (2)$$

where the vectors Z and X contain variables that affect the opportunity and risk costs of lending respectively, and the variable B denotes levels of borrowing and proxies for the administrative (as well as risk) cost of lending [*Bottomley, 1975; Long, 1968*].

In the empirical analysis below, the opportunity cost of funds is assumed to vary across villages in accordance with (a) source of loan and (b) proximity of the villages to market/urban centres. The rationale for the source-of-loan variable is that farmers who get loans from official lending agencies (e.g. rural banks or co-operative credit societies) get a subsidy, because such agencies are constrained to charge interest rates much lower than the market rate. The operations of these agencies are regulated by the government and subsidised loans are offered for 'development' purposes. Even if a person does not borrow from such agencies, their mere presence in the village should reduce average interest rates (because of reduction in moneylenders' monopoly power, for example) and residents of such villages will benefit. This effect is captured through the inclusion of an additional dummy variable which registers the presence or absence of official lending agencies in the village.

Distance from market areas is a variable designed to capture lending costs incurred by village moneylenders (the source of 50 per cent of the loans in our sample) who may have to obtain their own funds from larger town moneylenders. Furthermore, distance is also likely to affect the probability of having idle funds. A moneylender situated close to a town or with easy access to one is more likely to have his stock of loanable funds placed on loan throughout the year, while those in remote locations may have idle funds in the post-harvest season [*Long, 1968*].

The administrative cost of funds is perhaps best captured through the size of loan negotiated; i.e. the larger the loan, the smaller the unit cost of administering it. However, the size of loan could also carry a risk cost, so that the risk would increase with the size of the loan. This possibility renders the expected sign ambiguous.

Village population is used as an additional proxy for both administrative and opportunity costs of lending. The larger a village, the greater the demand for funds and the easier it is to spread overhead costs and reduce per-unit expenses of lending. As far as opportunity costs are concerned, the same arguments that make such costs a positive function of village remoteness make them a negative function of village size.

The risk cost of lending is proxied by all those variables that are likely to affect repayment probability. From the lender's point of view such characteristics as quantity and quality of land owned, other assets owned, wage rate faced, age, family size and investment opportunities are likely to be good indicators of the income-earning ability and, by implication, loan repayment ability, of farmers.

These personal and locational risk characteristics also affect the amount demanded. These characteristics will be discussed in the context of the borrowing function, which may be written as

$$B = b_1Y + b_2Rn + b_3TY \qquad (3)$$

where Y is a vector of all those factors that theoretical considerations suggest ought to be determinants of the demand for funds, Rn is the nominal interest rate faced, and TY is a measure of transitory income. Among the elements of Y might be included such variables as age of farmers, initial endowment, current and expected wage, current and expected output prices and measures of investment opportunity. From this list only current and expected prices are removed from consideration, on the assumption that they are invariant in the cross-section given a competitive output market. It may appear that the same argument could be applied to input prices such as wages and interest rates. There is considerable evidence, however, that factor markets in India are geographically imperfect and reveal considerable variations in factor returns. In the case of labour markets geographical immobility seems to give rise to wage variations [*Rosenzweig, 1978*], while in the case of capital markets interest rate variations arise in response to differences in transaction, administrative and risk costs as shown below.

Our data do not contain individual wage information. Therefore, we have used the district-level average daily male agricultural wage (from *Agricultural Wages in India, 1970–71*) as our measure of the opportunity cost of household time. Of course, one could have gone in for greater refinement along the lines of sex-specific, skill-specific, and time-specific wages. Data constraints aside, such refinement was considered unnecessary to this particular study since we have not elaborated a theoretical model at a similar level of detail.

The variable that has received most attention in previous studies is what we have called 'initial endowment'. The proxy used here is a measure of the total area owned by the farm household (in hectares). Although a measure of gross or net cropped area, both owned and leased, might contain more information about the household's wealth, such a measure cannot be used here because the act of leasing involves a capital accumulation decision that is, in the context of our model, made jointly with the borrowing decision. It could be argued that land ownership itself is subject to variation and that current ownership may not reflect original endowment. However, the landownership market in rural India (as opposed to the land-lease market) is quite thin. Because of the status and security conferred by land, very few farmers are willing to part with it; hence very few transactions are generally observed in this market. In our sample, only 112 of 2,939 households reported sales or purchases of land in the reference period. Given this infrequency of change of ownership, current land owned appears to be a reasonable measure of initial endowment.[1]

Another variable used here, the district proportion of irrigated land, could provide additional and exogenous information regarding the quality of a household's land endowment. Family size may also be considered a measure of initial endowment in addition to land. The idea is to get some assessment of labour power at the disposal of the head of household. A simultaneity problem arises here also in that family size decisions may be made jointly with physical asset accumulation and borrowing decisions over the life cycle. We have, however, not pursued this point, thinking it better to refrain from burdening the empirical task further. The family-size variable can also be interpreted as a measure of life-cycle stage; in this case, however, a measure of the dependency ratio would be more pertinent. For the present we have assumed that a large family size indicates a high ratio of dependents to earners, a reasonable assumption in the case of rural LDC families.

Our proxy for those variables that reflect investment opportunity differences across regions and over time – or, to put it another way, differences in expected future income – is derived from the annual expenditure by each state and by the federal government on major crop research. This expenditure is divided by the number of community development blocks in each state. These blocks contain roughly equal numbers of farms, and they form the basic extension village development units in rural India; thus a measure of comparative research intensity is obtained which can be used as an index of investment opportunity. The underlying assumption is that research expenditures in a region produce enhanced investment opportunities there within a few years and also signify a long-term commitment by the government to continue technical improvements in agriculture.[2]

Other measures, such as proportion of irrigated land or land under high-yielding varieties of seeds, might also provide information of a similar nature. Their effect, however, might be difficult to interpret for two reasons: (a) measures pertaining to the quality of one's land could be reasonably thought of as being proxies for one's initial endowment, a factor whose relationship to borrowing is theoretically ambiguous; and (b) how is one to interpret a high score along such indices? A score of 90 per cent along the index which measures proportion of land irrigated or land sown to new seeds could reflect the exhaustion of the growth potential on that farm and thereby a levelling off of income growth expectations.

Finally, we have included a measure of transitory income in our analysis so as to account for variation in the demand for funds that arise simply because of transient and unpredictable variations in income. This variable is calculated as the difference between current income and permanent income, where the latter is calculated as a weighted average of the incomes of the past three years. The technique used to derive the weights is explained and used by Bhalla [*1980*] in his analysis of the savings behaviour of Indian farmers, using the same data base as ours.[3] Putting the demand and supply equations together we obtain the structural model defined by (4) and (5). The variables in the vector Y are identical to those in X, since those factors that affect a household's demand for funds (except Rn and TY) are also likely to affect its credit-worthiness and hence will enter the lenders' supply function. Constants and error terms have been added to the empirical model.

$$B = b_0 + b_1X + b_2Rn + b_3TY + Ub \qquad (4)$$

$$Rn = r_0 + r_1Z + r_2B + r_3X + Ur \qquad (5)$$

The model is identified by the presence of transitory income in the demand function and the 'opportunity cost' variables, distance to market, source of loan, and presence of bank, in the supply function. The borrowing function can be estimated consistently from our structural system in standard two-stage fashion: an estimate of Rn is formed by regressing it on all the exogenous variables in the system (X, Z, and TY) and this estimate can then be used in Equation (4) to obtain the parameters of the borrowing function.

TABLE 1

SELECTED SAMPLE MEANS AND STANDARD DEVIATIONS[a]

Variables and units	*All households*	*Large landholders[b] only*	*Small landholders only*	*External borrowers[c] only*
Amount borrowed per year, rupees per household	420 (2207)	453 (2467)	318 (1050)	1265 (2073)
Wage rate, rupees per day	3.23 (1.25)	3.21 (1.31)	3.26 (1.08)	3.09 (1.16)
Land owned hectares per household	11.25 (12.95)	14.33 (13.52)	1.73 (0.87)	10.59 (11.87)
Proportion irrigated land, as % of gross cropped area	33.15 (23.92)	33.32 (24.30)	32.65 (22.71)	32.25 (24.32)
Research expenditures, thousand rupees per block	25.60 (15.65)	27.58 (16.48)	19.46 (10.61)	25.97 (15.44)
Transitory income, rupees per household	371.90 (1872)	470.30 (2111)	67.30 (660)	302.10 (1741)
Age of head, in years	48.80 (12.90)	50.90 (13.20)	45.20 (11.40)	47.80 (12.20)
Family size number of live-in members	7.51 (3.74)	8.00 (3.93)	5.96 (2.51)	7.74 (3.91)
Interest rate[d]	155.40	153.40	161.70	143.50
Number of observations	1602	1211	391	1080

NOTES

(a) Standard deviations in parentheses
(b) Large landholders are defined as those owning more than three hectares of land.
(c) External borrowers are those who report positive levels of borrowing from external sources.
(d) An interest rate of y% is recorded in the data as the number 10y.

The Sample Selection Issue

An estimation issue needs to be addressed before we turn to the results. Interest rates are reported only by the 1,080 households (sample statistics presented in Table 1) who have some external borrowing. The resulting problem of missing interest rates is similar to the missing wage (for housewives) problem in the labour supply literature. A conventional solution would be to impute 'potential' interest rates for the non-reporters from an interest-rate function regressed over a set of personal and location-specific determinants of the cost of lending. Since this regression would be based only on the sub-sample reporting positive levels of external borrowing, our estimates could be subject to selection bias resulting from the confounding of the behavioural function relating the interest rate to its determinants with the sample selection function relating the probability of borrowing to its determinants. This possibility can be accounted for by using a correction technique due to Heckman [*1979*]. Essentially this technique requires the construction of a new regressor based on the probability of participation in the sample (inverse of Mills ratio) which, when included in the behavioural function of concern, corrects for selection bias and yields consistent estimates.

TABLE 2

INTEREST RATE AND SAMPLE SELECTION FUNCTIONS (ASYMPTOTIC T-STATISTICS IN PARENTHESES)

Independent variables	Sample selection equation[a]		Interest rate equation corrected for selected bias	
Constant	−1.31	(2.20)	179.53	(17.40)
Land owned	−0.003	(1.22)	−0.42	(2.11)
Wage rate	−0.11	(5.20)	14.10	(1.94)
Proportion irrigated land	0.002	(1.40)	−0.23	(2.47)
Research expenditures	−0.003	(1.14)	−0.80	(2.75)
Source of loan (1 if official, 0 otherwise)	—	—	−62.11	(11.24)
Existence of bank (1 if present, 0 otherwise)	0.005	(1.09)	−13.04	(1.94)
Distance to market	0.001	(1.32)	0.44	(2.41)
Village population	−0.00006	(3.56)	−0.009	(5.
Age	0.0001	(1.29)	−0.0004	(0.65)
Family size	0.029	(3.21)	3.44	(1.34)
Dependency ratio[a]	0.026	(2.12)	—	—
Transitory income	0.00003	(2.10)	0.0003	(0.84)
Mills ratio inverse	—	—	2.40	(0.68)
R^2	—	—	0.18	—
Log likelihood	−1880.2	—	—	—
No. of observations	2911	—	1080	—

(a) 'Dependency ratio' indicates the ratio of family size to number of earners in the farm-household.

The results of this exercise are presented in Table 2. The insignificance of the inverse Mills ratio suggests that selection is not a critical problem in our sample. Indeed, the coefficients shown for the interest rate equation are virtually unchanged from those produced by a regression (not shown here) which does not include this additional regressor.

The Interest-Rate Function

The interpretation of the interest-rate function is affected by the fact that a sizeable fraction of the loans (approximately 30 per cent) came from official sources. Such lenders may not be profit-maximisers or even cost-minimisers and may operate according to institutional rules and constraints which we have not accounted for. Thus, the negative coefficients on land owned and proportion irrigated may be consistent with one or both of two interpretations: that such variables reflect the credit-worthiness of the farmer, his ability to repay being enhanced by more and better quality assets; or that such variables simply reflect political power which is used to secure privileged access to subsidised loans. This issue, however, is not critical here because all we are after is an appropriate instrumental variable to be used in place of the reported interest rate in our borrowing equations.

Among other coefficients, our investment opportunity proxy, 'research', appears to reduce the nominal interest rate. This result could be interpreted as supporting the assertion that the spread of agricultural research and information helps to reduce the risks inherent in farming and thereby encourages lenders to reduce their risk premiums. Such a result has been anticipated in the literature [*Bottomley and Nudds, 1969*] but never empirically demonstrated before. Indeed, this result is obtained even while controlling for the existence of banks and distance from market areas, and is therefore less likely to be a spurious correlation reflecting the influence of unobserved supply-of-credit variables. While state governments probably provide more low-interest loans in special areas where they are also pushing new research and technology, this effect should be picked up by 'bank' and 'distance to market'. The partial correlation coefficient relating these to 'research' turn out to be of the order of 0.14 and −0.06, further strengthening the interpretation presented here.[4]

The wage-rate effect is a bit puzzling. On the one hand, it can be interpreted as reflecting the increase in risk associated with the increase in operating costs that a wage increase entails, especially for households that are net labour-importers. On the other hand, it should reflect the enhanced income-earning ability of smaller farmers, who are more likely to be labour-exporters and demanders of consumption loans. Since we have used the district-level wage as our measure, however, our result may simply reflect the fact that labour and capital markets can experience situations of excess demand (or supply) simultaneously. Thus, Green Revolution districts are likely to have experienced an excess demand for all inputs during the late 1960s when they were growing rapidly, a disequilibrium situation that would have resulted in an increase in the price of all inputs in the short run, i.e. wages and interest rates would have moved together. Whatever the reason, our results suggest that labour and capital markets are interlinked. However, policy implications will depend on the exact linkage mechanism that is at work.

The opportunity cost proxies all have the expected signs. Farmers lucky enough to obtain loans from banks and cooperatives pay, on average, 6.2 percentage points less than those who borrow from moneylenders and others. Some of this reduction should be attributed to the fact that such loans are typically investment loans, and some to the fact that such farmers may be less risky. The mere existence of banks reduces the average interest rate by 1.3 percentage points and village remoteness also clearly affects interest rates. These results underscore the importance of regional development and financial integration in affecting the cost of credit.

Because we are primarily interested in the instrumental variable, only reduced-form results for the interest-rate equation are reported here. Structural estimates were also obtained, however, and the results indicate that the amount borrowed, while possessing a positive coefficient, is not a significant determinant of the interest rate. This result may be a consequence of the fact that loan size carries both a positive risk-increasing effect and a negative administrative-cost-decreasing effect, which may offset each other. It could also be due to policies of formal lending agencies who are required to charge a fixed interest-rate (regardless of loan size) once a loan application is accepted.

The Borrowing Function

Table 3 shows estimated borrowing functions for two definitions of the dependent variable and two different assumptions regarding the role of the interest rate. In the 'All Households' column, the dependent variable is defined as B = EB − EL − FA, so that the sample is not stratified by the dependent variable.[5] In the 'External Borrowers Only' column, the dependent variable is defined conventionally as B = EB, where EB > 0.

The results confirm the importance of correcting both for truncation and for simultaneity. Consider the latter problem first. When the interest rate is entered as an exogenous variable, its coefficient in the borrowing function is, contrary to theoretical expectation, positive. When it is entered as a predicted variable the coefficient sign becomes negative and all other coefficients remain stable. Thus adjusting for the simultaneity bias succeeds in improving the sign of the interest rate. Going one step further and correcting for the truncation bias succeeds in raising considerably the degree of precision with which the interest rate effect is measured – it becomes statistically significant at the 99 per cent level of confidence now. The truncated and full-sample estimates differ sharply with respect to the coefficients and *t*-statistics of almost all the independent variables. There is a clear tendency for all coefficients to be biased toward zero in the truncated case and for some variables to have sharply reduced *t*-statistics. The results of the conventional truncated model become even more awkward if the sample is increased to include cases where EB = 0. In this case (results not shown) the interest rate coefficient becomes positive, a fact especially damaging to

TABLE 3

BORROWING FUNDTIONS (ASYMPTOTIC *T*-STATISTICS IN PARENTHESES)

Independent variable	*External borrowers only*		*All households*
Constant	−601.76 (2.64)	−358.68 (1.12)	+772.61 (2.57)
Land owned	51.63 (9.27)	50.07 (8.71)	−13.65 (2.99)
Wage rate	149.53 (2.09)	172.87 (2.32)	−131.34 (1.83)
Proportion irrigated land	6.38 (2.29)	5.27 (1.78)	−4.93 (1.83)
Research expenditures	9.68 (1.85)	8.83 (1.67)	23.96 (5.41)
Transitory income	−0.09 (2.48)	−0.09 (2.53)	−0.23 (7.74)
Family size	48.93 (3.08)	48.82 (3.08)	61.64 (4.18)
Age	0.32 (0.66)	0.37 (0.82)	0.89 (1.01)
Interest rate	0.33[a] (0.55)	−1.34[b] (0.82)	−3.87[b] (2.67)
R^2	0.14	0.14	0.08
F-ratio	24.76	24.76	18.10
N	1080	1080	1062

(a) The interest rate is the rate actually reported by borrower; that is, it is being treated as an exogenous variable.

(b) The interest rate is predicted from the corrected equation shown in column 2 of Table 2. Note that y% rate is recorded in the data as the number 10y.

the conventional approach since theory leads us to expect an unambiguously negative relationship here. Clearly, the definition of the dependent variable strongly affects the results.

In the all-households case, the wage rate is negatively related to the amount borrowed. The complexity of theoretical inter-relationships here disallows an unambiguous prediction. We have made no attempt to disentangle the various effects of changes in current and expected wage rates, net labour importing or exporting status, or the relationship between leisure and on-farm work, so we cannot offer a definitive interpretation for this result.[6]

The initial endowment proxy, land owned, appears to have a negative effect on borrowing. Although there is no unambiguous theoretical prediction for this effect, the expectation is that the relationship should be negative. It is worth noting that none of the earlier studies concerning India [e.g. *Long, 1968; Pani, 1966; Ghatak, 1976*] obtain this result: rather, they obtain a positive relationship between their measures of land or assets and the demand for credit. They ascribe this generally to multicollinearity and to scale effects. Our result indicates that the choice of an inappropriate proxy for initial endowment or, as argued above, improper definition of the dependent variable might be the real source of their awkward result.

The variable for which an unambiguous positive effect is expected, 'research' (investment opportunity), turns out to have the expected sign and to be quite significant. While the fact remains that we are making do with a rather crude proxy, the strength of the result is encouraging. Other proxies yield similar results. The ones tried (but not reported) include proportion of area sown to high-yielding varieties of seeds by district and proportion of farmers who report sowing such seeds on their land.

The link between the capital market and the rate of technical change in agriculture presumably goes both ways. On the one hand, the availability of funds could determine the rate of innovation; on the other hand, the pace of technical change itself might influence the demand and supply of funds. The first link has been the focus of much discussion in the past decade [*Schluter, 1974*] and while a definitive study has yet to appear, the consensus seems to be that insufficient credit has hampered the spread of the Green Revolution. The present study sheds no light on the first link but examines the reverse link quite closely. Our results indicate that the capital market is affected by the rate of technical improvement on both the demand and the supply side: a higher rate of technical change increases the demand for funds and reduces the nominal interest rate. Apparently, such technical development offers the prospect of higher future earnings to farmers and thereby encourages them to borrow. The interest-rate effect can be interpreted as arising from the risk-reducing nature of technical change generated by agricultural research. Districts that are the beneficiaries of government-sponsored research appear to lenders to be less risky, *ceteris paribus*, and hence residents of such districts face lower nominal interest rates. This risk-reducing effect of agricultural research and, by implication, of the Green Revolution technology, has now become generally accepted [*Roumasset, 1976; Lipton, 1978*] in contrast to earlier pessimistic views which stressed the potentially greater risk associated with the new technology in explanations of farmers' resistance to innovation.[7]

Transitory income turns out to be, as expected, negatively and significantly related to the demand for funds. This result may be compared with that presented in Long [*1968*], the only other study which includes this variable. His measure of transitory income, the ratio of gross output to value of land, turned out to be statistically insignificant. As Long also noted, this result could be due to the crudeness of his proxy. The elasticity of borrowing with respect to transitory income is 0.20, indicating an important role for this variable. The marginal propensity to lend out of increases in transitory income is 0.23. When considered in the light of a marginal propensity to save out of transitory income of 0.4 [*Bhalla, 1980*], this suggests that over 50 per cent of the extra saving is in the form of reduced liabilities.

The interest rate is significantly and negatively related to the demand for funds, as expected from theory. The high level of significance stands in contrast to the generally inconclusive results obtained by other studies – neither Long [*1968*] nor Pani [*1966*], for example, find uniformly significant relationships between their measures of borrowing and interest rates. The borrowing response derived here is quite elastic, at 1.4 – this indicates that an increase in the nominal interest rate of 1 percentage point (say, from 15.5 to 16.5 per cent) would reduce amount borrowed by 8.4 per cent. This estimate is likely to be on the low side: other versions of the model where slight changes were made in the specification of the equations resulted in higher elasticities.

Of the two life-cycle variables included, family size is a significant and age an insignificant determinant of borrowing. While such variables have not been used in previous studies of LDC rural borrowing functions, the present results are consistent with their role in LDC rural savings functions – age is typically found not to matter [*Kelley and Williamson, 1968; Iqbal, 1981c*], while family size is found to reduce household savings. Thus one would expect family size to increase the demand for borrowing since it appears to increase consumption needs without adding proportionately to income generation – the estimated relationship is indeed positive.

While the *F*-ratio and *t*-statistics warrant confidence in the behavioural relationships estimated, the very low R^2 indicates that our model has been unable to capture the bulk of the variance in the dependent variable. This does not, of course, affect the main empirical point of the paper, which is that truncation and simultaneity problems bias the results of conventional studies. Still, it is cause for concern and necessitates an examination of alternatives.

One reason for the low R^2 could be inappropriate specification. Unfortunately the R^2 is not sharply improved by alternative functional forms (e.g. semi-logarithmic) nor by alternative proxies for the investment opportunity effect. When regional (state) dummies are tried, the R^2 is raised to 0.16 but new problems arise. First, in the absence of specific information about each state, it is difficult to explain what each dummy is measuring. Second, the significance levels of the wage and research coefficients decline. This may be due to the fact that these variables are measured at an aggregate level, and may be picking up part of the same effect that state dummies also pick up. It seems preferable, therefore, to retain the specification reported in Table 3. It might also be noted here that trying to explain the variance of B is much more difficult than trying to explain that of EB. As Table 1 shows, the standard deviation of B is over five times the mean of B whereas that of EB is less than twice the mean of EB.

Borrowing Functions by Farm Size

The low degree of explanation afforded by our model might also be due to the lumping together of groups of farmers who, because of their socio-economic position in the rural system, may have widely divergent borrowing behaviour. Since land ownership is widely believed to be a good indicator of the socio-economic situation of farmers, stratification by land size promises to yield further insights into the borrowing process. We have arbitrarily selected a limit of three hectares to separate 'small' farmers from 'large' ones. Sample means for the two groups are presented in Table 1, and borrowing (lending) functions are reported in Table 4.

Some interesting patterns emerge. Apparently, initial endowments play

TABLE 4

BORROWING FUNCTIONS BY FARM-SIZE[a] (ASYMPTOTIC t-STATISTICS IN PARENTHESES)

Independent variables	*Large landholders*		*Small landholders*	
Constant	1143.83	(2.97)	−427.03	(1.16)
Land owned	−15.80	(2.90)	33.39	(0.53)
Wage rate	−141.01	(1.67)	−83.43	(1.57)
Proportion irrigated land	−6.69	(1.95)	2.21	(0.81)
Research expenditures	26.70	(4.32)	9.66	(1.89)
Transitory income	−0.23	(6.72)	−0.27	(3.35)
Family size	60.23	(3.40)	76.13	(3.64)
Age	1.21	(1.25)	0.22	(0.63)
Interest rate[b]	−5.86	(2.92)	1.63	(1.27)
R^2	0.08	—	0.09	—
F-ratio	14.30	—	5.30	—
No. of observations	1211	—	391	—

(a) Large landholders are defined as those owning more than three hectares of land. The rest are considered small landholders.

(b) The interest rate is predicted from the corrected equation shown in column 2 of Table 2. Note that y% rate is recorded in the data as the number 10y.

different roles for large and small farmers. Land is related to borrowing; positively (but not significantly) for small farmers, but negatively for the large. While this result may suggest a non-linear relationship between initial endowment and borrowing, it might also be due to the stratification procedure which reduces the variation in land for small farmers. If the former interpretation is valid, we could read these results as showing that a transfer of land from larger to smaller farmers would increase the demand for funds. It has been shown elsewhere that a redistribution of rural income (through land reform, for example) would result in a drop in aggregate rural savings [*Bhalla, 1980*]. Combined with our result, this suggests that the increased demand for funds would have to be met from an inflow of funds from outside the farm sector. For a land reform programme not to have disastrous consequences for rural investment, therefore, the authorities should ensure that such an inflow of funds is indeed forthcoming.

Research expenditures appear to have a larger impact in elasticity terms (1.6 versus 0.6) on the borrowing behaviour of *larger* farmers. This suggests a certain amount of complementarity between farm size and the ability to use or procure agricultural research information. However, an interaction term relating these two variables was not found to be significant (results not presented here).

The fact that the interest rate is not significant in the case of small farmers might be indicating that the estimated interest rate does not adequately measure the true cost of funds for small landholders. There is some evidence to this effect in the literature [*Adams and Nehman, 1979*], the general impression being that small farmers have to pay unobserved extra costs (e.g.

bribes, fees to scribes and other intermediaries who assist in loan applications) and that such costs are typically greater than pure interest costs for them. Interest elasticities of loan demand also vary across farm size, with the relationship being positive (but insignificant) for small farmers. Since the interest coefficient for this group is not estimated with conventionally desirable precision this result should be viewed with reservation. However, an alternative version of the model, where an interaction term relating land owned to interest rate faced was introduced as an additional regressor, produced essentially the same results. The coefficient on the interaction term was significantly negative, thereby suggesting that an increase in the interest rate reduces borrowing more for larger than for smaller farmers. Evidence of a low interest elasticity of credit demand among smaller, poorer farmers is also provided by some other studies. Kumar *et al.* [*1978*], calculate that a 10 per cent increase in interest rates decreases the demand for credit by only 1–3 per cent (for different seasons) among marginal farmers (i.e. those cultivating less than a hectare) in a district of Uttar Pradesh state. This result has strong policy implications. It appears to confirm the assertion of many economists that artificially low interest rates set by formal lending agencies are responsible for inequality in the distribution of formal credit across large and small landholders. Setting higher interest rates would achieve the twin goals of improved efficiency in the allocation of formal credit and greater participation of small farmers in the formal loan market.

IV. SUMMARY AND CONCLUSIONS

This study has investigated the borrowing behaviour of farmers in less developed countries. Borrowing functions are estimated on a set of variables suggested by a life-cycle/permanent-income model using data from a large survey of farmers in India. The major findings of our study are related to the following special features of our approach which distinguish it from previous work: (1) an improved definition of what constitutes the demand for credit; (2) an examination of the interaction of technical change in agriculture with the rural finance market; and (3) an explicit formulation of the supply side of the market through an analysis of the determinants of farm-specific interest rates.

As far as the first feature is concerned, our study departs from previous ones in defining the demand for credit so as to include the lending and other financial-asset management activities of farmers. It is argued that not doing so renders empirical estimates subject to bias. It is shown that this bias is empirically quite important and may account for some anomalous results encountered in previous studies.

The interaction of technical change and the rural finance market is captured through two equations, the one showing how technology characteristics of farmers and their environment are related to the demand for funds, and the other showing how they are related to the rate of interest charged by lenders and thereby to the supply of funds. It is shown that such characteristics are important on both the demand and supply sides of the market. Specifically, farmers who are in a position to benefit from the information generated by agriculture research tend to borrow more and also to face a lower interest rate. This is consistent with an interpretation that stresses the income-augmenting and risk-reducing nature of this sort of technical change. An important policy-implication of this finding is that the generation and diffusion of improved investment opportunities provides the government with an additional instrument with which to influence developments in the rural finance market.

The third special feature of our study consists essentially of defining the interest rate as a function of variables that reflect the opportunity, administrative, and risk costs of lending. This procedure allows us to account for the possibility of a simultaneous determination of the interest rate and the amount borrowed, as well as to predict potential interest rates for the many farmers in our sample who do not report any external borrowing. Our results confirm the sensitiveness of the interest rate to personal and locational characteristics of borrowers. Perhaps more importantly, we find that the demand for funds is quite sensitive to variations in the interest rate. This result suggests an unexpectedly strong role for monetary policy in rural India. Furthermore, the sensitivity of borrowing to changes in the interest rate varies across farm size in a manner that suggests that one of the causes of the higher relative participation of large farmers in the formal loan market has been the policy of setting official interest rates artificially low.

final version received January 1983

NOTES

1. It is also possible that the use of a physical measure of initial endowment rather than a monetary one may introduce some error. The quality of land varies so much in India that a 10-hectare plot in, say, the Punjab area may reflect a different endowment position than a plot of the same size in, say, remote Madhya Pradesh. A monetary measure would capture differences in land quality, whereas a physical one does not. To the extent that the value of land is affected by choices regarding irrigation and fertilizer use among other such endogenous land improvement measures, however, a monetary measure might introduce simultaneity bias in the sort of life-cycle framework we are using here. For this reason, we have retained the physical measure in spite of its possible disadvantages. As mentioned above, the proportion of irrigated land is introduced as an independent regressor proxying for soil quality. To some extent, this mitigates the shortcomings of using a physical rather than a monetary measure in initial endowment.
2. The research figures used here pertain to 1968 and are taken from Evenson and Kislev [*1975*].
3. The equation for permanent income, Yp, is:

$$Yp = 0.43\ Y3 + 0.32\ Y2 + 0.25\ Y1$$

where Y3 refers to current income and the others to past incomes. Bhalla [*1980*] reports that the role of Yp in savings behaviour is not greatly affected by the choice of discount rates.

4. It is possible, of course, that the relevant correlation is between the amount of loanable funds available through banks and cooperatives and the provision of agricultural research and extension activities. This is not picked up by our dummy variable, which records only the existence or absence of formal lending agencies. However, preliminary results from a related study of the determinants of moneylender interest rates [*Iqbal, 1981b*] indicate that even these are strongly and negatively affected by the technological characteristics of districts: the higher the level of research, or the higher the number of progressive farmers, the lower the level of the interest rate charged by moneylenders to residents of the district.

5. Our empirical calculation of B does not exactly match the identity presented in the text: It reflects the limitations of the data available to us on the sources and uses of funds and judgements regarding the liquidity of certain assets. For example, it is not a complete accounting of the flow of funds to the extent that changes in transfer incomes, gold and jewelry holdings and consumer durable stocks are not included. Net income transfers in the form of gifts, where reported, form a very small proportion of the total flow of funds. They are not, however, uniformly reported and are therefore omitted. No data were collected on the holdings of gold and jewelry. This omission could result in a severe measurement error problem. However, in the absence of information about the distribution of the error, there is no reason to expect coefficient estimates to be biased. As far as consumer-durable stocks are concerned, two measures of B were calculated, one inclusive and the other exclusive of changes in such stocks. The results for the two measures were broadly similar, so only those for the latter definition are reported, on the basis that such stocks are not normally used to make liquidity adjustments.
6. The wage rate turned out to be highly correlated with the level of research expenditures and its coefficient varied considerably across specifications. Consequently, the reported wage coefficients should be viewed with some scepticism.
7. The arguments in the paragraph are consistent with some other studies of the relationship between innovation and production risk [*Roumasset, 1976; Lipton, 1978*]. Lipton [*1979*] has, however, argued that the more typical LDC farming situation is characterised by rather risky innovations at rather modest returns. This highlights the need for distinguishing sharply between the types of investment opportunities available to different farmers in different regions. Our data only permit a rather broad differentiation between farmers facing 'Green Revolution'-type opportunities, and our results must, therefore, be interpreted as suggesting only that innovations of this type (e.g. use of high-yield variety seeds, chemical fertilizer and irrigation) appear to be associated with less production risk than traditional farming.

REFERENCES

Adams, D.W. and D.H. Graham, 1981, 'A Critique of Traditional Agricultural Credit Projects and Policies', *Journal of Development Economics*, Vol. 8, No. 2.

Adams, D.W. and G.I. Nehman, 1979, 'Borrowing Costs and the Demand for Rural Credit', *The Journal of Development Studies*, Vol. 15, No. 1.

Bhalla, S.S., 1980, 'Interest Rate Determination in Underdeveloped Rural Areas', *American Journal of Agricultural Economics*, Vol. 57, No. 2, May.

Bottomley, A., 1975, 'Interest Rate Determination in Underdeveloped Rural Areas', *American Journal of Agricultural Economics*, Vol. 57, No. 2, May.

Bottomley, A. and D. Nudds, 1969, 'A Widow's Cruse Theory of Credit Supply in Underdeveloped Rural Areas', *Manchester School*, No. 2.

David, C.C. and R.L. Myer, 1979, *A Review of Empirical Studies of the Demand for Agricultural Loans*, Economics and Sociology Occasional Paper No. 603, Department of Agricultural Economics and Rural Sociology, Ohio State University.

Evenson, R.E. and Y. Kislev, 1975, *Agricultural Research and Productivity*, New Haven: Yale University Press.

Fisher, I., 1930, *The Theory of Interest*, New York: Macmillan.

Ghatak, S., 1976, *Rural Money Markets in India*, New Delhi: Macmillan of India.

Government of India, 1973, Agricultural Wages in India: 1970–71, New Delhi.

Heckman, J., 1979, 'Sample Selection Bias as a Specification Error', *Econometrica*, Vol. 47, No. 1.

Hesser, L.F. and G.C. Schuh, 1962, 'The Demand for Agricultural Mortgage Credit', *Journal of Farm Economics*, Vol. 44, No. 5.

Iqbal, F., 1981*a*, 'The Demand and Supply of Funds Among Agricultural Households', unpublished doctoral dissertation, Yale University.

Iqbal, F., 1981*b*, *Dualism, Technical Change and Rural Finance Markets in Developing Countries*, Rand Note N-1723-AID, The Rand Corporation, Santa Monica, California.

Iqbal, F., 1981*c*, *Rural Savings, Investment and Interest Rates in Developing Countries:*

Evidence from India, Rand Note N-1763-AID, The Rand Corporation, Santa Monica, California.

Kumar, P., P.K. Joshi and M.A. Muralidharan, 1978, 'Estimation of Demand for Credit on Marginal Farms – A Profit Function Approach, *Indian Journal of Agricultural Economics*, Vol. 23, No. 4.

Kelley, A.C. and J. Williamson, 1968, 'Household Saving Behaviour in Developing Economies: The Indonesian Case', *Economic Development and Cultural Change*, Vol. 16, No. 3.

Lins, D.A., 1972, 'Determinants of Net Changes in Farm Real Estate Debt', *Agricultural Economic Research*, Vol. 24.

Lipton, M., 1978, 'Inter-Farm, Inter-Regional and Farm-Non Farm Income Distribution: The Impact of the New Cereal Varieties', *World Development*, Vol. 6, No. 3.

Lipton, M., 1979, 'Agricultural Risk, Rural Credit and the Inefficiency of Inequality' in *Risk, Uncertainty and Agricultural Development*, J. Roumasset *et al.* (eds.), Agricultural Development Council, New York.

Long, M.G., 1968, 'Why Peasant Farmers Borrow', *American Journal of Agricultural Economics*, Vol. 50, No. 4.

Pani, P.K., 1966, 'Cultivator's Demand for Credit: A Cross-Section Analysis', *International Economic Review*, Vol. 7, No. 2.

Rosenzweig, M., 1978, 'Rural Wages, Labor Supply and Land Reform: A Theoretical and Empirical Analysis', *American Economic Review*, Vol. 68.

Roumasset, J., 1976, *Rice and Risk: Decision-Making Among Low-Income Farmers*, Amsterdam: North-Holland Publishing C ›.

Schluter, M.G., 1974, *The Interaction of Credit and Uncertainty in Determining Resource Allocation and Income on Small Farms, Surat District, India*. Occasional Paper No. 68, Employment and Income Distribution Project, Cornell University.

Smith, J. (ed.), 1980, *Female Labour Supply: Theory and Estimation*, Princeton: University Press.

APPENDIX

Data and Sample

In 1968–69, the National Council of Applied Economic Research (NACER) undertook a national survey, known as the Additional Rural Incomes Survey, of approximately 5,000 agricultural households in India. This survey was repeated in 1969–70 and 1970–1 on the same households, but in the final year a core group of approximately 3,000 cultivating households were asked additional questions regarding borrowing, lending, interest rates, and interaction with formal lending agencies. The sampling design of the survey resulted in over-sampling of rich households.

The present analysis is based on the core sample of households who were cultivators in 1970–71. Some exclusionary restrictions were applied to this group. households with savings rates greater than 75 per cent were excluded to eliminate some cases of logical inconsistency (savings greater than income, which implies negative consumption) and also to eliminate some cases where transcription errors appeared to be highly probable. These restrictions reduced the working sample to 2,912 observations.

Three categories can be distinguished within this group; the first and second comprising those households reporting positive (1,080) and zero (511) levels of external borrowing, and the third those for whom the relevant information is missing (1,310). The present analysis is based on a sample size consisting of only the first two categories. Since the exclusion of the third category could have involved censoring problems, we also ran regressions over a larger sample by assuming that the third category also consisted of zero-level borrowers. The results obtained were roughly similar in terms of signs and t-statistics to those reported here. However, some elasticities changed a lot: in particular, the interest elasticity of borrowing was found to be much greater in the larger sample.

Definitions

Savings (S): The savings of a household are defined as the change in net worth and computed as the difference between the change in the value of assets and the change in liabilities from year to year. They are adjusted for capital transfers through gifts, inheritances, and the like. A separate estimate of the value of consumer durables is also reported. Savings in the form of gold and silver and currency are not included, nor is any adjustment made for capital gains or losses and depreciation.
Income (Y): The income of a household is defined as the sum of the earnings of all members of the household during the reference period. This includes farm income, wages, rents, interest and dividends on financial investments, pensions, and non-farm business income.
Borrowing (B): See note 5.