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**IS TARGETED SMALL FARM CREDIT NECESSARY?
A MICROECONOMETRIC ANALYSIS OF CAPITAL
MARKET EFFICIENCY IN THE PUNJAB**

by

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ABSTRACT

Does the autonomous operation of the rural capital market leave small farmers tightly constrained with shadow prices of capital in excess of opportunity costs? Using data on participants and non-participants in a small farm credit program from the Pakistani Punjab, this paper estimates the economic effects of small farm credit. Endogenous switching regressions techniques are employed to control for the likely heterogeneity of borrowers versus non-borrowers. Results indicate that an individual selected at random from the population of small farmers would experience a 74% rate of return on the first rupee borrowed from the small farm credit program, indicating a high shadow price of capital and a *prima facie* case for small farm credit programs. At the same time, the program loans appear to be too large, as marginal returns fall slightly below the interest rate at the average loan size.

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Is Targeted Small Farm Credit Necessary?
A Microeconometric Analysis of Capital Market Efficiency in the Punjab

Small farmers in developing countries are often hypothesized to face liquidity or working capital constraints which limit their adoption of cash-intensive, productivity enhancing technologies (Binswanger 1980, Binswanger and Sillers 1983). Targeted small farm credit programs have been designed to relax these perceived capital constraints, and to rectify the hypothesized inefficiency of rural capital markets. But do these programs work? Are they in fact needed?

Criticism of targeted small farm credit ranges from the view that informal rural credit markets are in fact fundamentally efficient and that no intervention is necessary, to concerns about faulty program design (unsuccessful targeting, weak repayment incentives) and its impact on the viability of the rural financial network. While both lines of criticism are obviously important, they have rather different policy implications. The first line of criticism motivates a *laissez faire* attitude to the rural capital market. The second, or institutional, criticism motivates the design of more effective credit programs (e.g., a more jaundiced eye toward interest rate subsidies, or promotion of Grameen Bank-like efforts which enlist local information in an incentive compatible way).

This study addresses this first line of criticism--the need for small farm credit programs--leaving aside issues of institutional design. Using data on a cross-sectional sample of small farmers in the Pakistani Punjab, the goal of this analysis is to estimate the economic impact of the additional liquidity afforded by targeted small farm loans. Economic impacts are considered both in the neighborhood of the observed average loan size, as well as at the margin where loan size is zero. An estimated shadow price of liquidity at this zero loan margin provides a window into the efficiency of the rural capital market.

Controversial though they are, small farm credit policies are unfortunately difficult to evaluate empirically. Adams (1988: 355) points out that "*loans will help those selected to capitalize on their opportunities more easily, but it is likely that those selected would have stood as exceptional economic performers without loan.*" The problem of separately identifying the effects of a program from the attributes of those who participate in it, confronts any programs (e.g. agricultural extension) where participant selection

is not random. Evaluation studies which do not take into account the selection process might over or underestimate the effect of such program. In addition, recognition of the heterogeneity of program participants versus non-participants raises a conceptual question about the *type* of individual for which the program's impact should be measured.

In Pakistan, small farms constitute a predominant proportion of all farms while the distribution of land is skewed toward large farmers. According to the 1980 Agricultural Census, farms under 5 hectares (small farms) constituted 73% of all private farms and contain 34% of the total cultivated land (Government of Pakistan, 1983). Responding to the increasing demand for food as population has increased, the government of Pakistan placed major emphasis on increasing domestic food production, mainly through increasing output per unit of land. The introduction of green revolution technologies during mid-1960's provided a great opportunity to meet this objective. In some recent theoretical work dealing with agricultural credit, it has been argued that poor access to credit is one of the constraining factor in the adoption of modern technology particularly for the small farms, (Binswanger, 1980), and that varying access to credit may be a critical factor in shaping the organizational structure in agrarian production (e.g Eswaran and Kotwal, 1986). Various empirical studies in Pakistan have shown that one of the major constraints in the adoption of modern technologies was the lack of capital by the farmers, especially the smaller ones (Kadri, 1983; Ali et al., 1982; Ali et al., 1983).

Since the early seventies, the government has been very active in providing liberal credit to small farmers on the hypothesis that because small farmers are credit-constrained, a formal credit program will lead to greater use of modern inputs and higher yields per-acre. Over the 1971 to 1987 period real formal agricultural credit grew at an average rate of 17.14% per-annum between 1971 to 1987)¹. If the capital market inefficiency hypothesis of binding small farm credit constraints is correct, then output supply and net farm income should, *ceteris paribus*, be higher for loan recipient than for non-loan recipient farms. If this maintained hypothesis is incorrect, and small farmers are not in general credit constrained, then the additional liquidity afforded by the loan program should have no systematic impact on farm productivity and income. The goal of this paper is to empirically evaluate the maintained hypothesis of the Pakistan credit

program. As such, it is a test not only of the Pakistan program as implemented, but also an indirect test of the efficiency of rural capital markets. Note that this test of the impact of targeted credit is distinct from measuring the impact of additional farm liquidity as Feder *et al.* (1990) do. These two tests become identical only when the maintained hypothesis of the credit program that small farmers are always capital constrained is correct.

Measurement of the impact of the credit program is made complex by the violation of the *ceteris paribus* condition noted above--other things rarely are equal between loanee and non-loanee farms. Loanee farmers are likely to have outperformed non-loanee farmers even in the absence of a credit program, as noted above. While conventional multiple regression analysis can control for differences in observable among loanee and non-loanee farms, the prospect of differences in *unobservable* attributes presents a more complex econometric challenge. As will be detailed below, the prospect of heterogeneity between loanees and non-loanees raises an important issue about the comparative basis on which to measure the impact of the credit program.

The remainder of this paper is organized as follows. Section 1 below briefly presents the status of Pakistan rural credit and a preliminary analysis of small farm credit program in southern Punjab. The econometric model used in the estimation of credit effect is given in Section 2, while Section 3 presents the econometric results. Finally, section 4 gives the summary, conclusion and implications of study.

1. DESCRIPTIVE ANALYSIS OF AGRICULTURAL CREDIT IN PAKISTAN

Before 1972, the main sources of institutional credit in Pakistan were the Agricultural Development Bank of Pakistan, Credit Cooperatives and *Taccavi* loans.² These institutions did not extend significant formal credit in rural areas, particularly to small farmers. According to an all Pakistan rural credit survey conducted in 1972-73, 89 percent of all rural household borrowing were provided by non-institutional sources. However, the high interest rates typical of these loans led many to conclude that informal credit was an

inadequate vehicle to finance the widespread adoption of the fertilizer-responsive varieties made available by the green revolution of the 1960s.

Operating under a maintained hypothesis of capital market inefficiency (meaning that both formal and informal sources were seen to leave small farmers tightly capital-constrained), the government of Pakistan enacted a loan scheme in 1972 which instructed commercial banks to increase the flow of credit to small farmers. Furthermore, the Federal Bank for Cooperatives (FBC) was established in 1976 to revitalize the activities of village credit cooperatives societies. In 1980, the government enacted another scheme under which nationalized commercial banks and cooperatives were directed to advance interest free production loans to small farmers. In nominal terms the institutional credit grew at 27.5 percent per annum with Rs.121 million (\$25.4 million)³ in 1971-72 to over Rs.15.8 billion (\$979.6 million)⁴ in 1986-87 (Scott and David, 1988). The share of small farmers in total institutional credit also increased to a great extent. For example during the year 1987-88, the share of small farmers in institutional lending was 51 percent as compare to 39 percent in 1972-73 (Government of Pakistan, 1982 and 1989).

While these various programs did increase formal credit within the small farm sector, it is uncertain whether these programs actually enhanced small farm productivity over what it otherwise would have been. Increases in formal credit would only enhance small farm liquidity and productivity to the extent that the maintained hypothesis of capital market inefficiency was true. A micro-level evaluation of the maintained hypothesis that small farm are credit constrained is the goal of this paper. The rest of this section presents a descriptive analysis of small farm credit and addresses the issue of farm heterogeneity.

A number of researchers have employed descriptive statistical analysis to identify the impact of credit programs in Pakistan (e.g., Garg et al., 1979; Jain and Jain, 1979; Jodha, 1977; Qazi, 1978). While useful for displaying the differences which exist on average between loanee and non-loanee farms, this method cannot be used to identify what proportion of those differences is the result of differential credit access, and what proportion is the result of other characteristics which systematically differ between loanee and non-loanees.

Table 1 compares the descriptive statistics for loanees and non-loaneees on the aggregated values for output, input use and profitability from wheat plus cotton on a sample of small farms in the southern plains of Punjab for the crop year 1987-88⁵. The Appendix gives the data and survey methodology. Mean output, intermediate inputs, traction input and net revenue per-acre are respectively 38%, 37%, 15% and 35% higher on farms producing with credit than on those producing without credit. These differences are all statistically significant at the 5% level.

At first glance, these descriptive statistics seem to imply that the absence of formal credit was a major hinderance in achieving high productivity on non-loanee farms, ratifying the maintained hypothesis of the credit program regarding the inefficiency of the rural credit market. However, such an inference from these statistics would have the serious weakness that it attributes all the variation detected in variables studied to the use of credit. Other attributes of farms and farmers in the two sub-samples may be responsible for the differences in mean resource allocation and production.

In an effort to control for the influence of other variables correlated with credit status, some prior studies (e.g Raju et al, 1971; Schluter, 1974; Taylor *et al.*, 1986; Rana and Young, 1988) employ single equation econometrics to estimate the effect of credit conditional on, or controlling for, some of these variables. However, the reliability of this conventional econometric approach ultimately depends on the ability to measure and control for *all* differences between loanee and non-loanee farms and farmers. One reason for questioning the standard single equation econometric approach is that a farmer's use of credit is likely to be positively related to unmeasurable factors like farmer entrepreneurial ability and technical know how, and farm soil quality. Inference from the single equation approach would again be subject to the same sort of bias which confronts simple unconditional descriptive statistical analysis.

This problem of omitted variable bias confronts analysis of any program where an individual's participation is a selective, not a random process. Note that the potential heterogeneity of individual farmers raises a further conceptual question about the measurement of credit's effect: *For what type of individual do we want to measure the impact of the credit program: For an average individual selected at random from the population at large? For the type of individual who currently participates in the program? Or, perhaps for the*

type of individual who is not yet appeared as a program participant? Following suggestions in Carter (1989) on the definition and measurement of credit's effect, the next section presents a selectivity model to disentangle the effects of credit from those generated by difference in the observable and latent attributes of loanees versus non-loanees.

2. OUTPUT SUPPLY AND THE DEFINITION AND MEASUREMENT OF CREDIT PROGRAM EFFECTS

Let $\pi^*(L)$ and $G^*(L)$ respectively define *anticipated*⁶ net-farm income and output supply as a function of small farm credit program loan size "L" and controlling for other characteristics. Note that these specifications are not the same as specifying income and output supply as functions of working capital (as Feder *et al.* 1990 do). Program loans translate into increments in working capital only under the hypothesis of credit market inefficiency discussed above. If this hypothesis is incorrect, then program loans may have no impact on output supply and net-farm income. The goal of this section is to provide a general framework for defining and measuring the impact of program loans, and for indirectly testing the credit market inefficiency hypothesis.

2.1 The Capital Market Inefficiency Hypothesis and the Relation Between Credit, Output Supply and Net Farm Income

Figure 1 displays possible relationships between program credit, L, and π^* and G^* . The dotted line in Figure 1 has a slope equal to $1+r$. Under the credit market inefficiency hypothesis, the slope of the supply function should exceed $1+r$ at $L = 0$, indicating that the additional output obtainable with an incremental increase in credit exceeds the full repayment costs of that credit. Note that the slope of the supply function (minus one) equals the shadow price of capital. Assuming diminishing returns in production, there exists a loan size "M" beyond which marginal returns fall below $1+r$. A loan larger than M (used to purchase additional inputs) would decrease net-income as each additional rupee of loan would produce less than $1+r$ rupees in increased output. Beyond M credit is no longer a binding constraint on farm income maximization at interest rate r .

A configuration of output supply and corresponding net-income relationships consistent with the capital market inefficiency hypothesis is shown by the two solid curves, G and π , in Figure 1. Solid curves G and π assume full repayment of program loan. In reality some farmers might consider a program loan as a grant from the government and take it as an addition to their farm income. Assuming full default, a curve for "default net income" (net farm income plus the loan amount) could be added to Figure 1 and would obviously lie above the net farm income curve.

If the credit market inefficiency hypothesis is incorrect, and farmers are not in general credit constrained, then one of two possibilities could describe the functions shown in Figure 1. First, the functions output supply and net-income functions could be completely *flat* if individuals who obtain credit do something with it other than invest it in agricultural production. Alternatively, the individuals could invest the loan funds into agricultural production, obtaining marginal output returns, $\partial G/\partial L < 1+r$ for $L > 0$ and therefore, decreasing full repayment net-income, π . This latter possibility illustrated in Figure 1 by dashed curves G' and π' . Note that net farm income (π') is decreasing in loan size. However, in this case, default net income (as defined above) could well be increasing in loan size.

2.2 Defining the Impact of Credit in the Presence of Heterogenous Individuals and Non-Experimental Data

Estimation of the output supply and profit relations displayed in Figure 1 would be straightforward if there were multiple observations on a sample of farms in which each unit was observed both with and without credit. Estimation would be similarly straightforward if a single cross-section of farms had been randomly sorted between those receiving loans ("experiments") and those not ("controls") such that loanees and non-loanees had, on average, the same characteristics.

Within the Punjab study area of this paper, a single observation is available for each farm, and a purposeful, rather than a random, sorting process determined each farm unit's credit status, making it unlikely that loanees and non-loanees are the same on average. Simple statistical inference from this data will misstate the true impact of the credit program if the factors which influence credit status also

systematically affect output and income. As pointed out by Adams in the passage quoted above, farmers receiving credit are likely to have outperformed non-loanees even without the credit program. This hypothesized "Adams Gap" between the zero loan performance of loanee and non-loanee farmers suggests that producers are heterogenous in that loanees are intrinsically more productive than non-loanees.⁷ As will be developed below, this farmer heterogeneity confounds simple inference in the available non-experimental, cross-sectional data.

In addition to the potentially problematic "Adams Gap," the impact of loans may be different for different types of farmers. Better trained, or more highly skilled farmers may be able to make more effective use of additional liquidity. If correct, this "Heterogenous Impact" hypothesis indicates that it is necessary to specify for what kind of farmer one wishes to measure the impact of credit. Under endogenous credit status sorting, loanees may well be those for whom the heterogenous credit impacts are greatest, suggesting a further problem of statistical inference.

In order to statistically confront the "Adams Gap" and "Heterogeneous Impact" problems, consider the following switching regressions specification of *anticipated* output supply for individual "i":

$$(1) \quad G_i^* = \begin{cases} G_{i0}^* = \beta_0' \underline{Z}_i + \tau_0 V_i & \text{if do not receive loan;} \\ G_{i1}^* = \beta_1' \underline{Z}_i + \alpha' \bar{L}_i + \tau_1 V_i & \text{if receive loan,} \end{cases}$$

where $\alpha' \bar{L}_i$ is a non-linear function of the loan amount L_i (admitting diminishing returns in L_i) which is linear in its parameters α (e.g., the vector \bar{L}_i could be loan amount, loan amount squared, etc.). The other independent variables are partitioned into two orthogonal components, the observable \underline{Z}_i and a latent variable V_i . The vector \underline{Z}_i includes observed variables like prices, wage rate, loan amount, and fixed factors of land, capital and family labor. The latent heterogeneity represented by the V_i includes unobservable farm and farmer characteristics such as farming skill and managerial abilities. V_i is normalized to have zero unconditional expectation--i.e., for an individual randomly selected from the population at large, $E(V_i)=0$. The parameters β_k and τ_k ($k=0,1$) respectively give the impacts of the observable and latent variables on output supply. Under the switching regression specification in (1), the full parameter vector (β_k, τ_k) is permitted to be different between the two regimes to allow for the possibility that a relaxed capital constraint

may permit an individual to earn higher returns from a given level of market opportunity, fixed factor, or managerial skill.

Finally, note that given the available data, only one of the two equations in (1) is observed for individual "i" based upon a non-random sorting process. The suspicion of Adams, and the hypothesis to be tested below, is that the sorting of individuals between loanee and non-loanee status is systematically related to the latent heterogeneity represented by the variable V_i . Using the notation in (1), the Adams Gap can be written as $\tau_0(V^l - V^n)$, where V^l and V^n respectively are the latent productivity attributes of endogenously selected loanee and non-loanee type farmers. (Throughout this paper, superscripts "l" and "n" will be used to denote loanee and non-loanee *type* farmers as determined by the operative selection regime. Subscripts "0" and "1" will be used to index *parameters* which determine the returns which a farmer of *any* type would receive if he or she produces with or without credit, respectively.)

Using the equations in (1), the impact of credit can be defined for three types of heterogenous individuals:

- (1) An individual selected at random from the overall population for whom $V_i = 0$ by definition;
- (2) An individual who receives credit under the non-random sample sorting process and for whom $E(V_i) = V^l$; and,
- (3) An individual who does not receive a loan under the non-random process and for whom $E(V_i) = V^n$.

For each type of individual, the impact of credit can be defined as the difference in anticipated output which *that* individual would produce with and without credit: $G_{i1}^*(V_i) - G_{i0}^*(V_i)$. Substituting from (1), the following three credit effect measures can be defined for a common level of observable attributes Z :

Random Credit Effect

$$(2a) \quad \Delta G^r(L) = G_{i1}^*(L|V=0) - G_{i0}^*(L|V=0) = \underline{\delta Z} + \underline{\alpha} \bar{L},$$

Counterfactual Credit Effect for Loanees

$$(2b) \quad \Delta G^l(L) = G_{i1}^*(L|V=V_l) - G_{i0}^*(L|V=V_l) = \underline{\delta Z} + \underline{\alpha} \bar{L} + (\tau_1 - \tau_0)V^l \\ = \Delta G^r(L) + (\tau_1 - \tau_0)V^l$$

Counterfactual Credit Effect for Non-Loanees

$$(2c) \quad \Delta G^n(L) = G_{i1}^*(L|V=V_n) - G_{i0}^*(L|V=V_n) = \underline{\delta Z} + \underline{\alpha} \bar{L} + (\tau_1 - \tau_0)V^n \\ = \Delta G^r(L) + (\tau_1 - \tau_0)V^n$$

where $\underline{\delta} = (\underline{\beta}_1 - \underline{\beta}_0)$. The latter two measures are "counterfactual" because each compares the output anticipated by an individual under his or her actual credit status with the output level which would be anticipated for that same individual were he or she observed in their counterfactual state. Conceptually, these counterfactual measures are like before and after comparisons. Note that both counterfactual measures are the sum of the Random Credit Effect plus the additional gains or losses the individual would anticipate given his or her latent characteristics.

For illustrative purposes, Figure 2 depicts the three credit effect measures assuming that $V^l > 0 > V^n$, that $\underline{\beta}_1 > \underline{\beta}_0$, and that $\tau_1 > \tau_0$. At a loan size of L^a , the Random Credit Effect is given by the distance "A," while the Counterfactual Credit Effect for Loanees is given by the distance "D." The difference between random and counterfactual credit effects ("B") represents the additional effect of observed and unobserved factors on output. The Counterfactual Credit Effect for Non-Loanees (not illustrated in Figure 2) would be less than the distance "D" under the assumption that non-loanees have less favorable than average endowments of latent characteristics.⁸

Which of the three credit effect measures is "correct" depends on the question being asked. The Random Credit Effect measure would be appropriate for estimating the output supply effects of a generalization of the loan program which managed to achieve a widespread credit allocation. The Counterfactual Credit Effect for Loanees is would be appropriate for measuring the aggregate output impact of the credit program as implemented under the operative sorting regime.

While useful for evaluating the financial and social viability of credit programs, these credit effect measures do not address the question of the distributional impact of institutional credit program within the small farm strata. That is, do these program overall help improve the lot of small farmers and bridge the gap between small and large farmers, or do they initiate or accentuate a process of differentiation within small farm strata in which a more skilled sub-group takes advantage of such a public program. One way to

begin to understand the distributional impact of credit is to decompose the gross output supply gap between loanees and non-loaneees who have the same observable characteristics, \underline{Z} :

$$(3) \quad \Delta G^{l-n}(L) = G^*_1(L|V_l) - G^*_0(L|V_n) = \underline{\delta}'\underline{Z} + \underline{\alpha}'\bar{L}_i + \tau_1 V^l - \tau_0 V^n$$

Adding and subtracting $\tau_0 V^l$ and substituting from (2a) above and rearranging terms, this expression can be rewritten as:

$$(4) \quad \Delta G^{l-n}(L) = \tau_0(V^l - V^n) + \Delta G^r(L) + (\tau_1 - \tau_0)V^l.$$

In words, the anticipated supply gap between loanees and non-loaneees is the sum of the "Adams Gap", plus the Random Credit Effect, plus the added gains loanees achieve to their latent attributes when they use credit. The first and the last terms in (4) reflect pre-existing differentiation among small-holders, and the differentiation effect of the credit program itself, respectively. In Figure 2, the distance "E" measures this gross output gap.

2.3 Consistent Estimation of the Credit Effect Parameters

This section proposes an endogenous switching regressions procedure to consistently estimate the parameters in (1) given the available non-randomly sorted data. The *realized* output supply functions which correspond to the functions in (1) can be written as:

$$(5a) \quad G_{i0} = G^*_{i0} + \epsilon_{i0}$$

$$(5b) \quad G_{i1} = G^*_{i1} + \epsilon_{i1}$$

where the random errors ϵ_{ik} are the difference between producer "i's" realized and anticipated output supply.

It is assumed that the ϵ_{ik} have zero expectation for all samples and subsamples of producers. Substituting from (1), these equations can be rewritten as:

$$(5a') \quad G_{i0} = \underline{\beta}_0'\underline{Z}_i + \bar{V}_{i0} + \epsilon_{i0}$$

$$(5b') \quad G_{i1} = \underline{\beta}_1'\underline{Z}_i + \underline{\alpha}'\bar{L}_i + \bar{V}_{i1} + \epsilon_{i1}$$

where $\bar{V}_{i0} = \tau_0 V_i$ and $\bar{V}_{i1} = \tau_1 V_i$. The $\tau_k V_i$ terms are compressed at this time into a single \bar{V}_{ik} term

because it will not be possible to econometrically identify both the parameter τ_k and the latent variable V_i .

As discussed earlier, in the data available for this study, individuals have not been randomly sorted into either loanee, or non-loanee status. Loanee status is shaped by supply and credit demand factors which determine whether an individual applies and qualifies for a loan. Let D_i be the binary indicator variable which equals one if individual "i" is a loanee, and equals zero otherwise. D_i can be modelled as the result of a latent creditworthiness variable, L_i^* , which is scaled such that an individual becomes a loanee when $L_i^* > 0$.⁹ Formally,

$$(6a) \quad \text{Prob}(D_i = 1 | Z) = \text{Prob}(L_i^* > 0 | Z); \text{ and,}$$

$$(6b) \quad \text{Prob}(D_i = 0 | Z) = \text{Prob}(L_i^* < 0 | Z).$$

A reduced form specification for latent creditworthiness can be written as

$$(7) \quad L_i^* = \gamma' M_i + \eta_i$$

where M_i is a vector of variables which influence credit-worthiness, γ is a vector of parameters and η_i is an error component reflecting random and latent factors which influence credit-worthiness. Combining (6) and (7), the sample separation process can be rewritten as:

$$(8) \quad D_i = \begin{cases} 1, & \text{if } L_i^* = \gamma' M_i + \eta_i > 0, \text{ or } \eta_i > -\gamma' M_i \\ 0, & \text{otherwise.} \end{cases}$$

Utilizing (5) and (8), the *econometrically* expected output supply conditional on the sample separation regime and observable characteristics, can be written as:

$$(9a) \quad E(G_{i0} | D_i=0) = \beta_0' Z_i + E(u_{i0} | \eta_i < -\gamma' M_i)$$

$$(9b) \quad E(G_{i1} | D_i=1) = \beta_1' Z_i + \alpha' \tilde{L}_i + E(u_{i1} | \eta_i > -\gamma' M_i)$$

where the notation indicating conditioning on the Z_i has been suppressed, and $u_{i0} = \tilde{V}_{i0} + \epsilon_{i0}$ and $u_{i1} = \tilde{V}_{i1} + \epsilon_{i1}$. Under the assumption that the ϵ represent unanticipated production shocks uncorrelated with farmer attributes, the conditional expectations in (9a, 9b) can be rewritten as $E(\tilde{V}_{i0} | \eta_i < -\gamma' M_i)$ and $E(\tilde{V}_{i1} | \eta_i > -\gamma' M_i)$.

The problem of intrinsic productivity differences between loanees and non-loanees which underlies the hypothesized Adams Gap can now be clearly seen in (9). If latent productivity attributes are systematically related to credit status, then the conditional expectations terms on the right hand sides of (9a)

and (9b) will not be zero. For example, a key latent attribute is farmer skill. Greater skills are likely to directly increase realized output supply (via \tilde{V}_{i1}) as well as to raise the probability of obtaining credit under non-random sorting (via η_i), implying that $E(\tilde{V}_{i1}|D_i=1) > 0$. Under these circumstances, OLS estimate of (9) will yield inconsistent estimates of the structural parameters, attributing the *direct* output effects of latent farmer skill to credit status with which it is correlated. However, while OLS is unable to separately identify the impact of credit and skill, it does give the best linear estimate of the (gross) output supply gap between non-randomly sorted loanees and non-loaneees in expression (3) above. As will be seen momentarily, an estimate of this gross output supply gap will prove quite useful.

The problem of non-random sorting which underlies the inconsistency of OLS fortunately suggests a resolution of the estimation problem. The problematic correlation between \tilde{V}_{ik} and η_i indicates that the latter in fact provides information on the latent variable \tilde{V}_{ik} . The techniques presented in the subsequent paragraphs recover and use that information to control for the latent \tilde{V}_{ik} so that the parameters of interest can be consistently estimated.

Following the assumption popularized in the related sample selection bias literature, it is assumed that the error vector (η_i, u_{i0}, u_{i1}) is multivariate normally distributed with zero expectations and positive definite covariance matrix. Under these specifications, the conditional expectations in (9) may be written as (e.g., see Madalla 1983):

$$(10a) \quad E(\tilde{V}_{i0} | \eta_i < -\gamma' \underline{M}_i) = \rho_0 E(\eta_i | \eta_i < -\gamma' \underline{M}_i) = \rho_0 \lambda^n$$

$$(10b) \quad E(\tilde{V}_{i1} | \eta_i > -\gamma' \underline{M}_i) = \rho_1 E(\eta_i | \eta_i > -\gamma' \underline{M}_i) = \rho_1 \lambda^l$$

where $\rho_0 = \text{Cov}(\eta_i, \tilde{V}_i^n) / \text{Var}(\eta_i)$ and $\rho_1 = \text{Cov}(\eta_i, \tilde{V}_i^l) / \text{Var}(\eta_i)$ are the population regression coefficients relating the V to η_i ; and, $\lambda_1^l = \phi(C_i) / \Phi(C_i)$ and $\lambda_1^n = \phi(C_i) / 1 - \Phi(C_i)$ are the estimates of η_i given loanee status (and $C_i = \underline{\rho}' \underline{M}_i / V(\eta_i)$, $\phi(\cdot)$ and $\Phi(\cdot)$ are the standard normal, density and cumulative distribution functions respectively defined over observable variables which determine credit status).¹⁰

Substituting from (10), the full endogenous switching regressions system can be rewritten as:

$$(11a) \quad D_i = \begin{cases} 1, & \text{if } \eta_i > -\gamma' \underline{M}_i \\ 0, & \text{otherwise} \end{cases}$$

$$(11b) \quad E(G_{i0}|D_i=0) = \beta_0'Z_i + \rho_0\lambda_i^n$$

$$(11c) \quad E(G_{i1}|D_i=1) = \beta_1'Z_i + \alpha'\bar{L}_i + \rho_1\lambda_i^l$$

Consistent estimates of the parameters in (11) may be obtained using a two step "Heckman" procedure to estimate (11b) and (11c) separately using the appropriate loanee and non-loanee subsample data (Madalla, 1983: 223-8). Alternatively, for the ease of hypothesis testing, (11b) and (11c) can be combined into a single unconditional regression equation for the full sample:

$$(12) \quad E(G_i) = E(G_{i1}|D_i=1)\text{Prob}(D_i=1) + E(G_{i0}|D_i=0)\text{Prob}(D_i=0)$$

Note that $\text{Prob}(D_i=1) = \Phi(C_i)$ and $\text{Prob}(D_i=0) = (1-\Phi(C_i))$. Substituting from (10) above, the estimating form for a full endogenous switching regression model becomes:

$$(12') \quad E(G_i) = \beta_0'Z_i + \delta'[\Phi(C_i)Z_i] + \alpha'[\Phi(C_i)\bar{L}_i] + (\rho_1 - \rho_0)\phi(C_i)$$

Under a two step procedure, $\Phi(\cdot)$ and $\phi(\cdot)$ can be constructed from first stage probit estimates of (11a) and then used as regressors in (12'). OLS estimate of (12') yields consistent estimates of β , α , δ , and $(\rho^c - \rho^n)$ (Madalla).

Using the parameterization given in (12'), the expected value of the Counterfactual Credit Effect for Loanees (expression (2b) above) can be written as:

$$(13) \quad E[\Delta G^l(L)] = \delta Z_i + \alpha \bar{L}_i + E[\bar{V}_{i1} - \bar{V}_{i0}|D=1] = \delta Z_i + \alpha \bar{L}_i + (\rho_1 - \rho_0)\lambda_i^l,$$

with a similar expression for the counterfactual credit effect for non-loanees. Note that if $\rho_1 = \rho_0$, the expected counterfactual credit effect reduces to the random credit effect, as it would in the case where $\tau_0 = \tau_1$ and loanees obtain no *additional* returns to their latent skills when they produce with credit (see expression 2b above).

With the parameterization in (12'), it is not possible to recover separate estimates of ρ_0 and ρ_1 . Therefore the Adams Gap ($\tau_0(V^l - V^n)$) which could be estimated by $\rho_0(\lambda_i^l - \lambda_i^n)$ cannot be directly estimated. However, by utilizing naive OLS estimates (which ignore non-random sorting) to residually calculate the gross gap between selected loanees and non-loanees, the Adams Gap can be estimated using expression (4).

3. **ECONOMETRIC ESTIMATES OF PRODUCER HETEROGENEITY AND THE IMPACT OF CREDIT**

The descriptive statistics in Table 1 above show higher average input use, production and income on loanee versus non-loanee farms, supporting the notion that credit was an important constraint on small farm production. However, there could be many other factors related to the farm and farmers attributes of the two groups which might be responsible for the above statistical association. To untangle these multiple influences, we turn to the estimation of the model and measures developed in Section 2.

Three separate relationships (total supply, net farm income and default income functions) were employed to study the effect credit has on small farms. As in Table 1, total supply refers to the total value of output of wheat and cotton during the year 1987-88. Net farm income is defined as the total output minus the cost of variable inputs. Finally, default income is defined as net farm income plus the loan amount. For each of these dependent variables, three types of estimates are obtained: (1) A single equation, or "naive" OLS estimate; (2) A full endogenous switching regression estimates; and, (3) A restricted version of endogenous switching model. The endogenous switching models accounts for the potential heterogeneity of borrower versus non-borrowers.

As a first step toward estimation of the endogenous switching regression model, univariate probit was used to estimate equation (7), the loanee status relationship. For the estimation, loanee status was specified as a function of family labor stock, land stock, non-fixed assets, education, age, a co-operative membership dummy variable and a land tenure dummy variable.¹¹ Family labor stock is posited to affect the probability of credit use negatively. This is based on the assertion that families with large number of family workers might substitute labor for cash inputs like weedicide, etc., and, or sell additional family labor on the market, and in turn use off-farm income to purchase cash inputs. Land stock and non-fixed assets are posited to positively affect the farmer's credit worthiness and are expected to increase the probability of using credit. Higher levels of education imply better technical know-how and farming skills, more information on market and facilities provided by the government and familiarity with bureaucratic procedures. Therefore, it is expected that educated farmers will make use of credit more productively than uneducated ones. Age is posited to negatively affect the probability of credit use in so far as older farmers may not be as active as

may not be as active as younger ones in their farm activities. The credit co-op dummy is equal to one if the farmer is a member of credit co-operative and zero otherwise. Membership is expected to be positively related with the probability of getting credit. The tenorial status dummy is equal to one if the farmer is an owner-proprietor and zero if tenant. Ownership (as opposed to rental) of land increases long run investment incentives, and should translate into a larger demand for credit (Feder, 1987). Thus owner-proprietors are expected to have a high probability of obtaining credit. Also, since the owned land is the most preferred collateral by the lenders, it thus, is expected to increase the amount of credit offered as compared to other forms of collateral.

Table 2 reports the probit estimates for the loanee status equation. Except for age, all the variables have the relationships theorized above. The only variables significant at the 5% level are education and family labor stock. The joint hypothesis that all coefficients in the loanee status equation are zero is rejected, as two times the log likelihood ration was 107 while the 1 percent critical value (χ^2 , 7 degrees of freedom) is 18.475. Using these coefficient estimates, the cumulative probability functions, $\Phi(\cdot)$ and probability density function $\phi(\cdot)$ were constructed to use as regressors to endogenize the credit status in the estimation of supply functions.

Table 3, 4, and 5 report endogenous switching as well as naive OLS estimates of the output supply, net farm income and default farm income functions. All equations specified the dependent variables in log form. Independent variables are the log of output price, a fertilizer price, wage rate, family labor, number of dependents, cultivated area, capital, and farming experience plus education, loan amount and loan amount square. As can be seen in Tables 3-5, none of the parameters which give the differential returns enjoyed by loanees (the $\underline{\delta}$ in the notation of section 2) are significantly different from zero at the 5 percent level. It is impossible to reject the hypothesis that aside from loan itself, credit recipients experience no additional returns on other observable and unobservable factors. Given the relatively small sample size, it is unfortunate, but not surprising, that the data cannot precisely decompose the impact of credit into direct and indirect effects. Under the assumptions of the restricted model (with $\underline{\delta}$ and $(\rho_1 - \rho_0)$ restricted to zero in the notation of equation 12'), the random and counterfactual credit effects are all identical. This restricted

endogenous switching model (which mechanically modifies the OLS specification only by multiplying the loan variables by $\Phi(C_i)$) continues to control for the correlation between loanee status and latent farmer characteristics. The discussion which follows only discusses the credit impact measures based on the OLS estimates and the restricted endogenous switching models.

Table 6 summarizes the regression estimates in Tables 3-5 by calculating the various credit effect measures defined in Section 2 for output supply, net farm income and default net income. Using the OLS estimates, the marginal output effect of additional rupee of loan is Rs. 1.18 evaluated at the mean loan size and the average characteristics of the loanee sub-sample. As shown in section 2, the naive OLS estimates do not account for the endogeneity of credit status and do not in general identify the effect of credit from the effect of latent characteristics correlated with credit use. If Adams is correct in his suspicion that credit recipients are intrinsically better performers, then this OLS estimate should be an overstatement of the credit effect.

Using the restricted endogenous switching regression results to control for loanee versus non-loanee heterogeneity (and for the Adams gap), the marginal output effect of one more rupee of credit is estimated to be Rs. 1.11 at the mean loan size of Rs. 7,584, and is statistically different from zero at the 5% level. This estimated marginal effect indicates that the average loan amount is above-optimal size since estimated marginal net return (11%) is less than the 13.25% interest rate charged.¹² Figure 3 graphs this estimated regression function (evaluated at the average characteristics of the loanee subsample). As can be seen, at the mean loan size the slope of the supply function is flatter than the slope of the line $(1+r)L$, indicating marginal returns below the interest rate.

As discussed in Section 2, while OLS does not consistently estimate the structural parameters of interest, it does consistently estimate the gross output gap between endogenously sorted loanees and non-loanees. Using the OLS results, the gross supply output gap between loanee and non-loanee (controlling for observable characteristics) is 27 percent. As expression (4) above shows, this gross output supply gap is the sum of "Adams gap," the random credit effect, and any added returns to loanees' latent attributes. Under the restricted endogenous switching regression model specification, the estimated random credit effect is an

output increase of 26 percent (or approximately 10,000 rupees for the average loanee producer, as shown in Figure 3), and is significantly different from zero at 1 percent level. The slight 1 percent arithmetic difference between the gross output gap and the random credit effect is the so called "Adams gap". Figure 3 uses the estimates in Table 3 to decompose the estimated gross output gap (distance "E") into the "Adams Gap" (distance "C") and the random credit effect (distance "A"). Recall that the *restricted* switching regressions model imposes the condition that credit does not enhance returns to loanee attributes (i.e., it restrict to zero the distance "B" in Figure 2).

To evaluate the capital market inefficiency hypothesis, Table 6 presents the estimated marginal effect of credit at *zero* loan size. As discussed in section 2.1, capital market inefficiency implies that without targeted credit, the marginal impact of a program loan would exceed the social opportunity cost of capital. Evaluated at loan size of zero, the estimated output effect of a one rupee loan increment is 1.74 rupees, indicating that the shadow price of capital would be 74% for a randomly selected individual who had no targeted credit. Reflecting this high marginal return to targeted credit is the steep slope of the estimated output supply function at the point of its intersection with the vertical axis in Figure 3.

Credit effect measures similar to those for output supply are also given for net farm income and default income in Table 6. The estimated marginal effect of an additional rupee of loan on net farm (assuming full loan repayment is made) is Rs. 1.05 and Rs. 0.46 evaluated at loan sizes of zero and Rs. 7584 respectively. At the average loan size, the estimated indicate that a randomly selected individual would experience a 30% increment in net income compared to a zero credit state. (The estimated gross net income gap and Adams' gap are 28% and -2%, respectively.) However, while these point estimates present an even more buoyant picture of credit's effect than did the output supply estimates, their imprecision is sufficiently high that the hypothesis that there is no credit effect cannot be rejected at the 5% level. The default net income estimates in Table 6 (which assume that neither loan principal nor interest are repaid) show even higher income effects of credit than do the full repayment, net farm income estimates.

4. SUMMARY AND CONCLUSION

Formal agriculture credit in Pakistan increased substantially over the 1971-72 to 1986-87 period. Complementary policies simultaneously adopted by the government also improved small farmers access to institutional credit. Descriptive statistical comparison of samples of credit users and non-users reveals a positive association between credit and small farm productivity. The simple mean difference in output and income between loanees versus non-loaneees in the samples is Rs. 14,700 versus Rs. 9,700, or Rs. 1000 versus Rs. 440 on a per-acre basis. How much of this difference reflects the effect of credit *per se*?

Endogenous switching regression estimates indicate that an individual selected at random from the population at large would produce 26% more output were he or she given an average sized loan. While there are differences in the observable resource endowments of loanees versus non-loaneees (differences which explain a portion of the large descriptive statistical output and income gaps), the econometric estimates do *not* support the hypothesis that loanee-type producers receive gains to credit beyond those which any other type of individual with the same observable physical endowments would receive. The estimates also show to be unimportant the "Adams Gap" (meaning the econometrically troublesome output or income gap which might be presumed to distinguish loanees from non-loanee performance, even if the former lacked credit).

While the estimated average return to the credit program are positive, estimated *marginal* returns indicate that at the observed average loan size, marginal returns (net of principal repayment) are only 11% and fall short of the average program interest rate of 13.25%. Loan sizes appear to be too large on average from the perspective of private income maximization.¹³ However, the optimal loan size is estimated to be well above zero as evaluation of the capital market inefficiency hypothesis suggest that credit is a binding constraint on small farm output supply. A randomly selected individual with zero formal credit is estimated to be sufficiently capital-constrained that he or she would generate an additional Rs. 1.74 worth of output with a one rupee loan.

In summary, this paper confirms the hypothesis which motivates Pakistan's, and other country's, small farm credit programs, namely that informal capital market mechanisms leave small farms tightly credit

constrained. While findings here indicate that small farm loans are larger than needed to maximize net farm income (assuming full loan repayment), the evidence of capital market inefficiency is *prima facie* evidence that agricultural credit programs are needed. But, are programs which extend formal credit to the small farm sector good economic policy? The results obtained here are a necessary, but not sufficient, condition for a positive answer to that question. In addition, it must be determined if small farm credit programs are financially viable. Do their social returns outweigh their full opportunity and administration cost? A forthcoming paper will address these questions.

Figure 1
Hypothetical Impact of Credit on Farm Output and Income

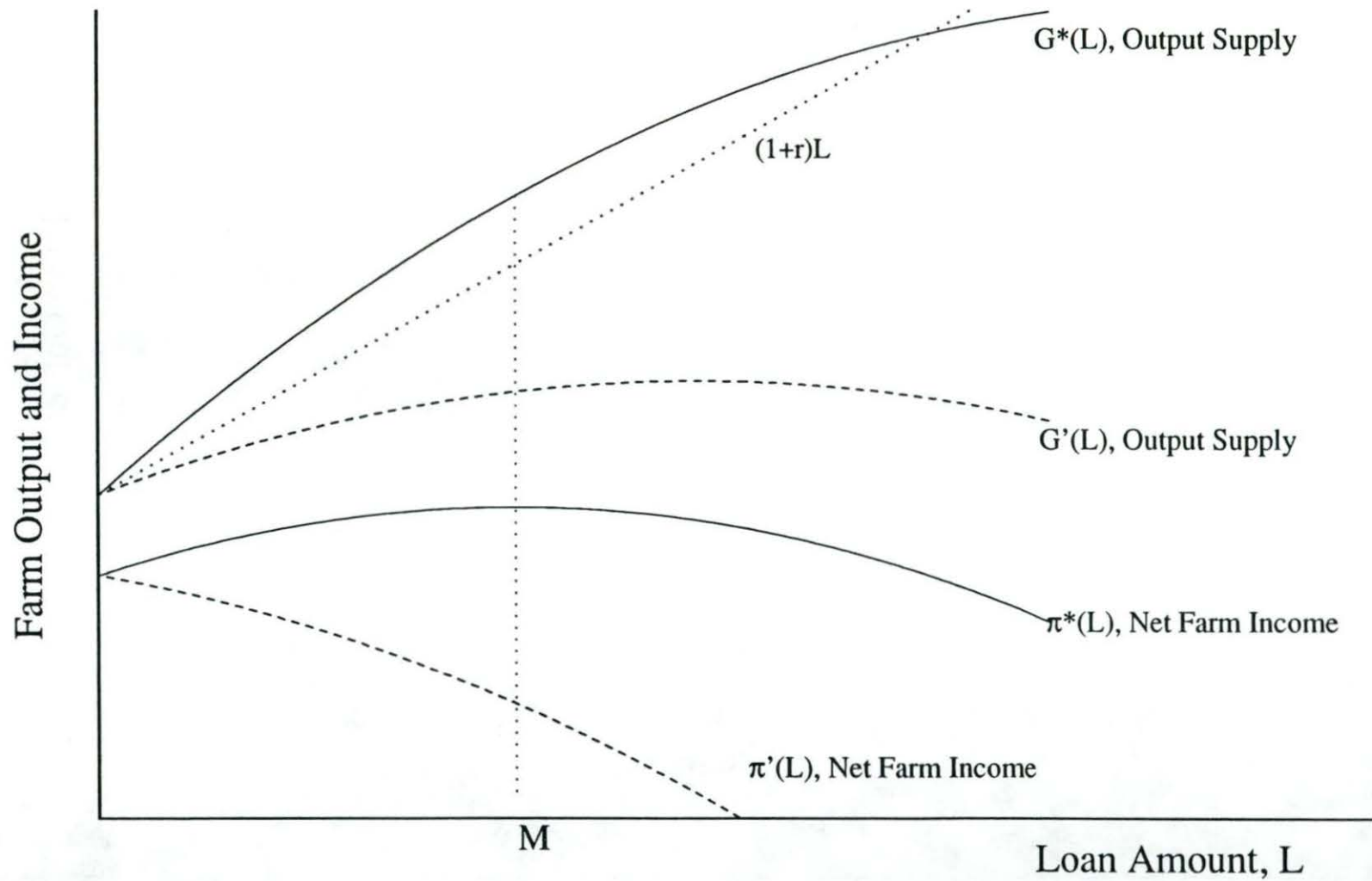


Figure 2
Decomposing the Relation between Credit and Output

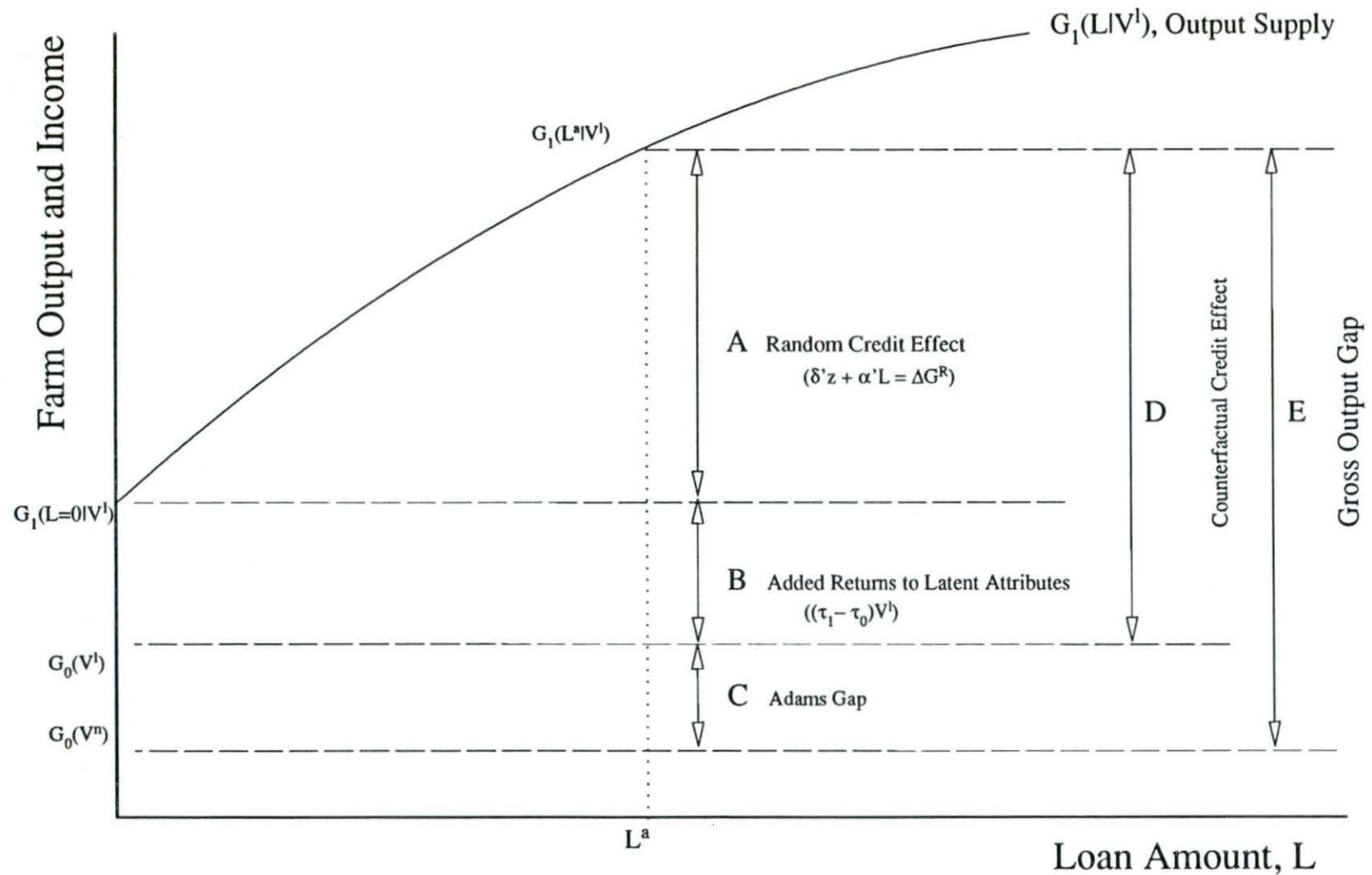


Figure 3
Estimated Output Supply Effect of Credit

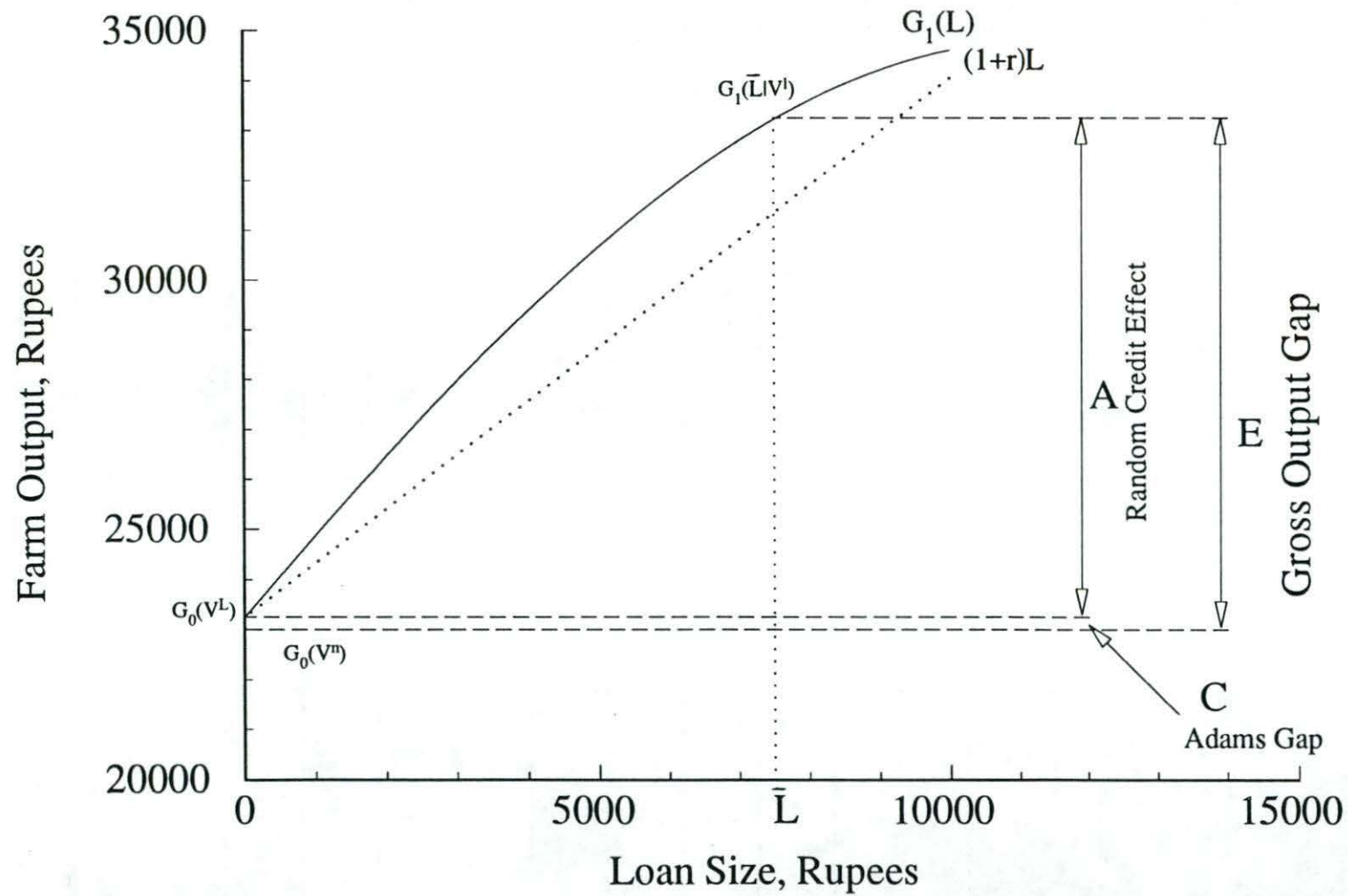


Table 1: Mean Sample Characteristics for 1987-88 for Credit Status¹

Variable	Loanee n=38	Non-Loanee n=87	t-value
Output/acre ² (Rs.)	3791.60 (778.76)	2751.75 (799.42)	6.74*
Intermediate Input/acre ³ (Rs.)	1308.52 (334.20)	951.57 (247.83)	6.63*
Family Labor/acre (days)	5.38 (3.83)	8.68 (3.49)	4.70*
Hired Labor/acre (days)	10.82 (4.33)	6.20 (3.55)	6.24*
Hired Labor Cost/acre (Rs.)	403.03 (120.37)	213.06 (121.64)	8.06*
Traction Input/acre ⁴ (Rs.)	401.10 (91.87)	348.83 (71.29)	3.44*
Net Farm Income/acre ⁵ (Rs.)	1678.93 (750.85)	1238.28 (738.72)	3.05*
Education (Years)	7.13 (2.82)	1.93 (3.35)	8.38*
Farm Size (Acres)	9.28 (2.87)	7.28 (3.40)	3.16*
Loan Amount/acre (Rs.)			
Average	816.47	-----	-----
Maximum	1929.00	-----	-----
Minimum	89.83	-----	-----
"Default Income"/acre (Rs.)			
Average	2495.00	-----	-----
Maximum	4379.00	-----	-----
Minimum	975.00	-----	-----

¹ Figures in parentheses are standard deviations.

² Value of output per acre was calculated by aggregating yield per acre of cotton and wheat multiplied by respective reported harvest prices and area, and then divided by total area under wheat plus cotton.

³ Value of intermediate input per acre is the summation of fertilizer cost, weedicide and insecticide, and actual and imputed cost of seed weighted by area under respective crop and then divided by total area under both crops.

⁴ Traction cost is the actual and imputed cost of animals and mechanized traction per acre, calculated in a similar way as the cost of intermediate inputs.

⁵ Net revenue per acre is the value of output per acre less cost of intermediate inputs, hired labor and traction per acre.

* Significant at the 1 percent level.

Table 2: Probit Estimates of Loanee Status¹
(n = 125)

Variable	Coefficient
Constant	-3.920 (1.222)
Family Labor Stock (Adult Members)	-0.312 (0.149)
Land Stock (acres)	0.099 (0.073)
Capital ('000's Rs.)	0.002 (0.006)
Education (years of schooling)	0.252 (0.065)
Age (years)	0.034 (0.020)
Credit Co-op Membership (dummy)	5.443 (34.63)
Tenurial Status (dummy)	0.837 (0.534)
-2Log - Likelihood Ratio	107.490
Percent correctly predicted	92.000
Inverse of Mills Ratio (mean for Loanees)	0.336
Inverse of Mills Ratio (mean for Non-Loanees)	-0.147

¹ Figures in parentheses are standard errors.

Table 3: Total Output Supply Estimated Regression Coefficients^a

Variables	OLS	Endogenous Switching Regression		
		Full Switching Model		Restricted Model
		All Producers	Loanee Differential	
Constant	3.099	1.097	3.102	4.112
Output Price	1.554 (0.199)	1.644 (0.250)	0.161 (0.694)	1.601 (0.202)
Fertilizer Price	-0.558 (2.131)	-0.302 (2.738)	-0.024 (0.046)	-0.816 (2.171)
Wage Rate	0.055 (0.065)	0.095 (0.080)	-0.017 (0.248)	0.073 (0.066)
Family Labor	-0.035 (0.067)	0.019 (0.095)	-0.426 (0.242)	-0.049 (0.068)
Number of Dependents	0.069 (0.044)	0.074 (0.059)	0.045 (0.117)	0.071 (0.045)
Cultivated Area	0.936 (0.071)	0.946 (0.095)	-0.053 (0.234)	0.944 (0.072)
Capital	0.007 (0.016)	0.019 (0.023)	-0.049 (0.050)	0.003 (0.017)
Education	0.011 (0.009)	0.029 (0.021)	-0.168 (0.034)	0.014 (0.009)
Farming Experience	-0.061 (0.033)	-0.073 (0.043)	0.104 (0.118)	-0.062 (0.034)
Loan Amount ('000' Rs.)	0.072 (0.019)	-----	0.084 (0.037)	0.071 (0.023)
Loan Amount (squared)	-0.003 (0.001)	-----	-0.004 (0.002)	-0.003 (0.001)
Pdf	-----	----	-0.180 (0.398)	-----
R ² (adjusted)	0.801		0.786	0.793

^a Figures in parenthesis are standard errors. These have not been corrected for heteroscedasticity.

Table 4: Net Farm Income Estimated Regression Coefficients^a

Variables	OLS	Endogenous Credit Status		
		Full Switching Model		Restricted Model
		All Producers	Loanees Differential	
Constant	-4.898	-27.728	20.821	-3.766
Output Price	3.725 (0.869)	4.262 (1.096)	-2.532 (3.042)	3.770 (0.865)
Fertilizer Price	-1.514 (9.324)	2.481 (11.999)	-0.038 (0.201)	-1.793 (9.315)
Wage Rate	0.176 (0.286)	0.208 (0.352)	-0.260 (1.088)	0.196 (0.285)
Family Labor	0.092 (0.293)	0.411 (0.415)	-0.805 (1.058)	0.084 (0.293)
Number of Dependents	0.188 (0.193)	0.268 (0.259)	-0.148 (0.515)	0.190 (0.194)
Cultivated Area	0.994 (0.309)	0.866 (0.418)	0.251 (1.023)	0.995 (0.309)
Capital	-0.027 (0.072)	-0.015 (0.103)	-0.032 (0.218)	-0.033 (0.074)
Education	0.041 (0.041)	0.033 (0.092)	-0.080 (0.150)	0.042 (0.049)
Farming Experience	0.013 (0.146)	0.017 (0.187)	-0.172 (0.519)	0.011 (0.147)
Loan Amount ('000' Rs.)	0.084 (0.085)	-----	0.058 (0.162)	0.093 (0.099)
Loan Amount (Squared)	-0.004 (0.004)	-----	-0.003 (0.007)	-0.005 (0.005)
Pdf	-----	-----	0.876 (1.746)	-----
R ² (adjusted)	0.253	-----	0.192	0.252

^a Figures in parenthesis are standard errors. These have not been corrected for heteroscedasticity.

Table 5: "Default Income" Estimated Regression Coefficients^a

Variables	OLS	Endogenous Credit Status		
		Full Switching Model		Restricted Model
		All Producers	Loanees Differential	
Constant	-5.209	-24.549	20.547	-2.884
Output Price	3.667 (0.865)	4.324 (1.092)	-3.254 (3.033)	3.755 (0.863)
Fertilizer Price	-1.399 (9.285)	1.761 (11.964)	-0.005 (0.200)	-1.965 (9.299)
Wage Rate	0.182 (0.284)	0.241 (0.351)	-0.435 (1.084)	0.220 (0.285)
Family Labor	0.118 (0.292)	0.408 (0.413)	-0.606 (1.055)	0.100 (0.293)
Number of Dependents	0.193 (0.192)	0.272 (0.258)	-0.139 (0.513)	0.202 (0.194)
Cultivated Area	0.962 (0.307)	0.859 (0.417)	0.161 (1.020)	0.969 (0.308)
Capital	-0.025 (0.072)	-0.023 (0.103)	-0.025 (0.217)	-0.037 (0.074)
Education	0.041 (0.041)	0.032 (0.092)	-0.081 (0.149)	0.047 (0.048)
Farming Experience	0.018 (0.146)	0.012 (0.187)	-0.186 (0.517)	0.013 (0.147)
Loan Amount ('000' Rs.)	0.240 (0.084)	-----	0.135 (0.162)	0.152 (0.099)
Loan Amount (Squared)	-0.005 (0.004)	-----	-0.005 (0.007)	-0.006 (0.005)
pdf	-----	-----	1.120 (1.741)	-----
R ² (adjusted)	0.299		0.240	0.295

^a Figures in parenthesis are standard errors. These have not been corrected for heteroscedasticity.

Table 6: Estimates of Credit Effects On Output Supply, Net, and "Default Income"

Credit Effect Measures	Output Supply	Net Income	Default Income
<u>OLS Estimates:</u>			
-Marginal Credit Effect (per rupee) at Mean Loan Size	1.177 (0.407)		
-Gross Gap: Loanee, Non-loanee (%)	0.270 (0.076)	0.275 (0.334)	0.613 (0.337)
<u>Restricted Endogenous Switching Regression Estimates:</u>			
-Marginal Credit Effect (per rupee) at Mean Loan Size	1.109 (0.474)	0.508 (0.905)	1.905 (1.224)
-Marginal Credit Effect (per rupee) at Zero Loan Size	1.735 (0.570)	1.048 (1.126)	1.710 (1.124)
-Random Credit Effect* (%) at Mean Loan Size	0.260 (0.092)	0.303 (0.396)	0.656 (0.395)
-Adams Gap (%)	0.010	-0.028	-0.043

* Under restricted model specifications, counterfactual and random credit effect estimates are the same.

Appendix: Data:

The population from which data for this study were collected is the set of small farmers (i.e those having farm area up to 12.5 acre) in Vehari, a district in the southern plains of the Punjab province. Wheat is the dominant crop of the rabbi (winter) season while cotton is the major crop during the "Kharif" (summer) season in the study area. Among the three sub-divisions or "tehsils" namely Burewala, Vehari and Mailsi of district Vehari, Burewala was selected for the purpose of sample selection. The selection of Burewala was based on relatively higher number of small farms in this subdivision. The formal credit institutions serving small farm credit needs in the study area are the Agricultural Development Bank of Pakistan (ADBP), nationalized commercial banks and co-operative societies.

A two stage cluster sampling was employed to obtain a random sample of small farmers in Burewala tehsil. In the first stage a random sample of villages was selected as primary units and at the secondary stage a sample of small farmers was chosen from the selected villages. A list of the villages was obtained from the local revenue office and the lists of farmers in selected villages were prepared from the books of the respective village lumberdars (village headmen) and revenue agents. An optimum sample equal to 120 small farmers in six villages was determined in order to collect the required information. (An adequate sample size for villages and small farmers was determined by employing an optimum allocation criteria for each stage -- see Som, 1973; Cochran, 1977). The total sample of small farmers was then proportionately distributed among selected villages according to ratio of small farmers in each village.

A pretested questionnaire was employed to collect the data on Socio-economic characteristics, the use of credit, crop production, input use and prices on the sample farms pertaining to the year 1987-88. Although the sample size of farmers was 120, in practice it was raised to 132 to accommodate any inconsistencies or reporting errors. After discarding the inconsistent cases, we had total sample of 125 farmers out of which 38 were formal credit users, and the rest were non-users.

ENDNOTES

1. Nominal annual credit growth was deflated by average inflation rate of 10.36% between 1971 to 1987.
2. "Taccavi" loans are administered by the Land Revenue Department and are meant for land improvement and for the relief of agriculturists in distress as well as for the purchase of farm inputs. They constitute a very minor part of the total institutional credit.
3. \$1 was equal to Rs.4.76 in 1971 (FAO Trade Yearbook 1976, Vol.30).
4. \$1 was equal to Rs.16.13 in 1986 (FAO Trade Yearbook 1986, Vol.40).
5. Such aggregation is useful to assess the mean differences between the two categories of farms based on their crop production activities for the whole agricultural year, since in general, farmers would make decisions regarding how to allocate resources among various crop enterprises at the beginning of the year. This type of comparison may also be warranted if the use of credit to apply purchased inputs in the first crop affect the productivity of the second crop as well.
6. The term "anticipated" is used throughout this paper to denote expectations conditional on full information, including that on farm and farmer characteristics which are unobservable to the outsider. Anticipations thus describe the individual producer's perceptions about him or herself. The term expectations will be reserved in the text to denote the outside econometrician's limited information perceptions.
7. Note that the heterogeneity problem could work in the opposite direction as well with a negative "Adams Gap," indicating that non-loanees would outperform loanees in the absence of the credit program. This circumstance could occur if small farmers are not in general capital-constrained, and only those individuals who are capital-constrained obtain targeted credit. Without targeted credit, these loanees would produce less than non-loanees. With targeted credit, they might produce at levels similar to non-loanees. However, the descriptive statistical evidence presented in Section 1 is preliminary evidence of a positive Adams Gap.
8. In the special case where $\sigma^c = \sigma^n$, all three measures equal and identical to Random Credit Effect, whereas the latter reduces to $\alpha(l_i)$ when $\beta^c > \beta^n$. Both sets of parameter restrictions correspond to cases in which credit has a neutral effect and does not enhance returns to either the latent or the observable factors which explain output supply.
9. Determination of loatee status could also be modelled as a Tobit problem, as opposed to the binary variable approach specified here. Lee *et al.* (1980) discuss these alternative treatments.
10. Given the structure of the model and the nature of the observed data, $V(\eta_i)$ cannot be observed. It is, therefore, normalized to one.
11. Although the soil quality differences among farms could also affect the determination of credit status and hence the farm productivity. Yet no measure of soil quality was incorporated either in the probit equation or the output functions since the study area comprised of same agro-ecology and soil quality. A cluster sampling was used to draw the sample.

12. This sample average interest rate of 13.25% includes the nominal rate of interest plus transaction cost per rupee of institutional loans.
13. Efforts to directly estimate the impact of credit on net farm income showed quantitatively larger, but statistically imprecise and insignificant effects.

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