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Rural Financial Markets in Developing Countries

Their Use and Abuse

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9. *Measuring the Farm Level Impact of Agricultural Loans*

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[A variety of quantitative analytical techniques commonly used in studies of the impact of agricultural credit programs have serious methodological shortcomings. Credit impact appears very hard to isolate with the use of common social science research tools; studies ignoring certain factors easily overestimate the value of credit as a tool for agricultural development. Research methods should be sensitive to the problems of fungibility, attribution, and the interdependence of farm and household decision making.]

Expansion of formal agricultural credit has become a major policy in many low-income countries. The current amount in all low-income countries could range from $30 thousand million to $40 thousand million a year, and concessionary interest rates, high administrative costs, and low repayment rates require substantial subsidies. There is growing concern that this credit has not produced the desired improvements in farm income, output, and income distribution.

Role of Credit in Resource Allocation

The lack of a sound theoretical framework has led to errors in the specification of credit research models and misinterpretation of results. Two issues are particularly troublesome. First, farm households are complex units simultaneously making production and consumption decisions. Second, given fungibility (that is, the ability to shift money from one use to another) in the cash flow management of farm households, it is difficult to identify a loan's effect on the farm as opposed to its effect on the household. Since government credit is usually intended to increase production, not consumption, many researchers assume that loans extended for productive purposes are actually used for production.

The empirical measurement of the total benefits of borrowing by a

Extracted from *Borrowers & Lenders*, edited by John Howell (London: Overseas Development Institute, 1980), pp. 201–34.

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farm household is much more complex than is implied by simplified farm models that ignore possible changes in consumption and nonfarm activities. The effect of borrowing with which we are most concerned is the increase in farm inputs and output, but because of fungibility, loans may simply substitute for a household's savings or other sources of liquidity (cash or loan). Accounting for substitution may improve the measurement of the impact of loans on the farm, but documenting the impact on other farm household activities remains difficult. Complete evaluation requires information on all the household's sources and uses of additional liquidity, not merely on the impact of the direct expenditure of loan funds. But such information is extremely difficult to collect through typical cross-sectional farm surveys.

Even with more comprehensive data, the attribution problem remains. It consists of trying to isolate the effect of loans by observing differences between borrowers and nonborrowers, or by observing borrowers before and after the loans. At least four factors other than credit can explain differences between borrowing and nonborrowing farm households:

- Differences in technology, technical information, irrigation, weather, and other variables not easily quantified in production models
- Differences in yield, price uncertainty, and management ability
- Differences in product and input prices
- Differences in household financial constraints or savings.

Multipurpose agricultural credit programs also contribute to the attribution problem, since they frequently provide intensive extension services and input subsidies in addition to credit. Many researchers assume that extension explains little of the differences between borrowers and nonborrowers, but this is not well documented. The effect of input subsidies on input use and production may be significant and needs to be separated from the impact of credit.

Concessionary low interest rates further complicate research. They create excess demand for loans, which forces lenders into nonprice rationing (that is, lender selection of borrowers). This typically favors loans to farmers with large factor endowments, access to the best technical information, and better managers. Therefore, borrowers may be systematically different from nonborrowers, with borrowing the result rather than the cause of differences in performance.

Review of Empirical Literature

Surprisingly little research has measured the impact of the vast sums spent on agricultural credit programs. For example, the 1973 *Spring*

Table 9-1. *Percentage Differences in Selected Measures between Borrowers and Nonborrowers, Selected Areas*

Area	Year	Number of observations	Farm size	Percentage differences per hectare			
				Operating expenses	Investment	Production	Net farm income
Brazil	1965	132	78	112	n.a.	30[a]	2
Southern Brazil	1965	954	94	127	80	62[a]	n.a.
	1969	732	68	281	338	133[a]	n.a.
Colombia	1968	52	74	104	n.a.	6	n.a.
	1968–65[b]	25	30	56	n.a.	35	n.a.
Guatemala	1975	1,600	5	39	n.a.	−3	0[c]
Korea, Rep. of	1970	438	3	5	5	n.a.	−1
Philippines	1975–77[d]	577	16	15	n.a.	n.a.	4
	1975–77[e]	497	2	−15	n.a.	n.a.	0
Taiwan	1965, 1970, 1975	1,373	16	21	n.a.	8	−2

n.a. Not available.

a. Gross farm income per hectare.

b. Comparison of borrowers before (1965) and after (1968) the credit program.

c. Based on lower 76 percent of farms by size.

d. Nonborrowers include those who borrowed from nonformal institutions.

e. Comparison of borrowers from nonformal sources and nonborrowers.

Sources: *Brazil*: P. F. de Araujo, "An Economic Study of Factors Affecting the Demand for Agricultural Credit at the Farm Level," M.A. thesis, Ohio State University, 1967. *Southern Brazil*: G. Singh, "Farm Level Determinants of Credit Allocation and Use in Southern Brazil, 1965–69," Ph.D. thesis, Ohio State University, 1974. *Colombia*: D. Colver and G. Jimenez, "Supervised Credit as a Tool in Agricultural Development," *American Journal of Agricultural Economics*, vol. 53, no. 4 (November 1971), pp. 639–42. *Guatemala*: S. R. Daines, "Guatemalan Farm Policy Analysis: The Impact of Small Farm Credit on Income, Employment and Food Production," Analytical Working Document no. 10 (Washington, D.C.: U.S. Agency for International Development, Bureau for Latin America, 1975), pp. 1–106. *Korea, Rep. of*: O. Nyanin, "Credit and Farmers in South Korea," M.S. thesis, Ohio State University, 1978. *Philippines*: V. Cordova, P. Masicat, and R. W. Herdt, "Use of Institutional Credit in Three Locations in the Philippines, 1975–77" (Laguna: International Rice Research Institute, 1978), pp. 1–8. *Taiwan*: Farm household record-keeping data available to the Department of Agricultural Economics and Rural Sociology, Ohio State University.

Review of the U.S. Agency for International Development contained about sixty papers describing various credit programs, but none systematically assessed the farm level impact of loans. Some studies reported trends in aggregate output, use of inputs, or adoption of new varieties, while lamenting the scarcity of data for more detailed analysis. We review briefly the following types of study on the farm-level impact of borrowing: descriptive studies, econometric studies—of the production function, the input demand function, and the efficiency gap function—and programming studies.

Descriptive Studies

The most common analysis of credit programs is the comparison of farm inputs, production, and productivity before and after borrowing, or between borrowers and nonborrowers. Most descriptive studies are unpublished reports or graduate theses. Table 9-1 summarizes the results of studies from six countries to illustrate the variables examined and the impact usually attributed to borrowing. Except in the case of Colombia, these studies were cross-sectional analyses of borrowers and nonborrowers. Before-and-after comparisons are few because evaluation is generally initiated after the program begins. Quantification of the "before" situation is based on questionable farmer recall.

The Latin American studies cover relatively large farms producing multiple crops, and programs including both short- and medium-term loans. Asian studies refer to small monoculture rice farms receiving only short-term credit. Despite these differences, several common patterns emerge. Borrowers had considerably larger farms than nonborrowers in Brazil and Colombia, whereas farm size differences in Asian countries were only 2 to 16 percent; Guatemalan farms were of similar size because of the sampling procedure. Operating expenses and investment were higher for borrowers, but production differences per hectare were less marked. Moreover, reported differences in net farm income per hectare were clearly small.

Inferences about loan impact must be treated with caution because of attribution problems. Small differences in production and net farm income do not necessarily imply that borrowing leads to misallocation or that loans have been diverted. In the Guatemala study, Daines used a sampling procedure designed to control for potential effects of farm size and region-related factors. Differences in value of production between borrowers and nonborrowers were decomposed to reveal the effect of price, yield, crop mix, and crop area. Daines concluded that expansion in cropped area, which explains most of the production differences, was largely due to credit.

A decomposition technique was also used in a 1976 World Bank evaluation of projects providing medium- and long-term credit to crop

farms in the Philippines, Pakistan, and Morocco and to livestock farms in Uruguay and Mexico. Crop production changes were accounted for by changes in cultivated area, cropping intensity, and yields, and changes in livestock production by changes in breeding cattle, feeders, reproduction rates, and beef yields. Judgments were made about the probable effects of the project on each source of growth; adjustments were also made for the possible effect of other loan sources. The study concluded that the projects raised crop production by 67 percent, compared with the observed unadjusted 82 percent.

This World Bank study also dealt with substitution. First, borrowers were asked to estimate the investment they would have made without the program, and the probable source of finance. Second, investments of borrowers and nonborrowers were compared. Third, assets financed by the project were related to the borrowers' total assets. On the basis of these data, a crude substitution factor of 40 percent was assumed; after making this second adjustment, the credit projects explained approximately 28 percent of the net production increase rather than 67 percent.

Econometric Studies

Several recent studies have used econometric techniques to analyze the impact of borrowing. Three different models have been used: a production function, an input demand function, and an efficiency gap function.

PRODUCTION FUNCTION. Colombian, Brazilian, and Ghanaian studies hypothesized that loans influence the farm production relationship, with the credit variable specified in several ways (table 9-2). The Colombian studies treated credit as a separate unit; one study further hypothesized that borrowers have a different production technology, so separate production functions were estimated for borrowers, nonborrowers, and borrowers prior to the supervised credit program. In the Brazilian model credit was assumed to shift production coefficients for operating expenses, modern inputs, and machinery but not for land, labor, or animal power. The Ghanaian study assumed all production parameters were affected by credit. It used time series aggregate data, while the other studies used cross-section farm level data.

Production function studies have some major weaknesses. First, specifying credit as a separate production input presents a conceptual problem, because loans are claims on resources and do not directly generate output; double counting of inputs occurs when credit is treated as a separate variable. Second, attributing to borrowing the differences in production functions between borrowers and nonborrowers implicitly assumes a relationship between the source of liquidity

and the production function. The unclear picture of loan impact in these results is not surprising. Short-term credit programs attempt to encourage adoption of new seed-fertilizer technology, but there is little reason to expect a shift in a production function to be conditional on such borrowing. Modern varieties of seed frequently imply greater operating expenses for the optimal use of fertilizer and chemicals than do traditional seeds. But seed costs are similar, modern varieties are usually more responsive to all levels of fertilization, and fertilizer is highly divisible. Therefore, farmers with varying financial constraints should simply be located at different points on the same modern production function. Medium- and long-term credit, however, may be more likely to change the production relationship because these loans could finance "lumpy," or large, indivisible inputs more difficult to fund internally.

Apparent differences in production coefficients between borrowers and nonborrowers may be due to the omission of other inputs, such as technical information or irrigation, associated with loans. Short-term loans would not be expected to have a major impact on these variables, but progressive farmers with irrigation and better technical information would probably borrow more. Thus, causality is as likely to run from higher inputs, outputs, and income to loans, as it is from loans to these changes.

INPUT DEMAND FUNCTION. Input demand studies do not directly test loan impact on production and thus avoid the problem of relating loans to the production function. In a comprehensive analysis of the impact of uncertainty on resource allocation, for example, Schluter estimated input demand functions for labor, modern varieties, fertilizer, crop area, and animal and machine power (see table 9-3). The explanatory variables included financial constraints represented by credit availability and income, nonfarm assets and farm size, technology and knowledge.

Table 9-3 presents Schluter's results for modern seed varieties and fertilizer, the main targets of supervised credit programs. Access to loans, dairying income, area cropped, and assets were significant explanatory variables for fertilizer use. Schluter regarded assets and farm size as indices of farmers' ability to bear risk: farmers more able to cope with uncertainty and with better access to institutional loans were significantly more likely to adopt modern rice varieties. Interestingly, these variables did not explain adoption of new wheat varieties. Access to loans and land planted with modern rice varieties were the most significant factors explaining fertilizer use. Access to loans appeared to be less important, however, in explaining demand for inputs (not reported in table 9-3) other than rice and fertilizer.

Table 9-2. *Estimates of Effect of Borrowing on the Cobb-Douglas Production Function, Selected Countries*

Item	Brazil (1971–72)	Colombia (1960)	Colombia			Ghana 1962–74
			Borrower[a]		Nonborrower (1968)	
			1965	1968		
Log *a*	1.514		1.174	2.899	0.740	0.006
Land	0.293*	0.303*	0.379*	0.777*	0.418*	−2.127
	(4.42)	(1.620)[b]	(1.560)	(3.964)	(1.742)	(1.217)
Labor	0.009	n.a.	0.396*	0.049	0.456*	4.248*
	(0.88)		(1.472)	(0.383)	(2.505)	(1.977)
Farm equipment	0.045*	−0.103*	0.144	0.048	0.034	n.a.
	(1.34)	(−1.873)	(1.043)	(0.533)	(0.354)	
Livestock	0.009*	n.a.	n.a.	n.a.	n.a.	n.a.
	(1.83)					
Operating expense	0.246*	0.115[c]*	0.314*	0.279*	0.405*	0.336
	(4.30)	(1.885)	(1.377)	(1.898)	(3.092)	(0.269)
Modern varieties	0.356*	n.a.	n.a.	n.a.	n.a.	n.a.
	(5.02)					
Credit	n.a.	0.641*	0.064	−0.084	0.104*	n.a.
		(3.705)	(0.877)	(−1.000)	(1.825)	

Credit × land	n.a.	n.a.	n.a.	n.a.	n.a.	1.559
						(1.505)
Credit × labor	n.a.	n.a.	n.a.	n.a.	n.a.	−1.941
						(−1.691)
Credit × operating expense	0.0001*	n.a.	n.a.	n.a.	n.a.	−0.395
	(1.97)					(−0.297)
Credit × modern inputs	−0.00003	n.a.	n.a.	n.a.	n.a.	n.a.
	(−0.37)					
R^2	0.96	0.89	0.57	0.90	0.80	0.85
Number of observations	129	17	27	27	25	13

n.a. Not available.

a. Borrowers are participants in supervised credit programs. Nonborrowers are nonparticipants, including farmers borrowing from nonformal sources.

b. Figures in parentheses are *t*-values. Asterisk indicates statistical significance at 10 percent or better confidence interval.

c. Includes fertilizer only.

Sources: *Brazil*: P. B. Rao, *The Economics of Agricultural Credit Use in Southern Brazil* (Waltair, Andhra Pradesh, India: Andhra University Press, 1973). *Colombia*: D. Colyer and G. Jimenez, "Supervised Credit as a Tool in Agricultural Development," *American Journal of Agricultural Economics*, vol. 53, no. 4 (November 1971), pp. 639–42; and W. S. Becker, "Agricultural Credit and Colombia's Economic Development," Ph.D. thesis, Louisiana State University, 1970. *Ghana*: A. B. Gyeke, E. T. Acqah, and C. D. Whyte, "An Evaluation of Institutional Credit in Ghana" (Petersburg, Va.: Virginia State College, Bureau of Economic Research, 1977).

Table 9-3. *Linear Regression of Factors Affecting Use of Modern Rice and Wheat Varieties and Fertilizer in Surat District, India, 1971–72*

Variable[a]	*Modern varieties*		
	Rice	*Wheat*	*Fertilizer*
Credit[b]	0.182*	−0.114	82.676*
	(2.02)[c]	(−1.57)	(4.28)
Assets	0.020*	−0.005	−0.585
	(2.52)	(−0.89)	(−0.3)
Nonagricultural income	0.089	−0.016	8.575
	(1.38)	(−1.28)	(1.18)
Dairying income	0.100	0.073	25.656*
	(1.54)	(1.53)	(2.49)
Area under crop[c]	0.661*	0.541*	66.998*
	(6.59)	(3.84)	(4.78)
Gross cropped area	−0.056*	0.006	—
	(−2.17)	(0.29)	
Area under improved rice	—	—	54.359
			(2.48)*
Area under traditional rice	—	—	18.513*
			(2.50)
Area under unirrigated crops	—	—	−8.991
			(−0.89)
Education	−0.035	0.076*	−5.129
	(−0.12)	(3.23)	(0.97)
R^2	0.76	0.74	0.63
Number of observations	59	56	25

— Not applicable.

Note: Figures in parentheses are *t*-values. Asterisk indicates significance at 1 percent level.

a. Two other variables, number of family workers and home consumption requirements, were included in these equations but were not statistically significant.

b. Refers to maximum amount the cooperative would be willing to lend the farmer for various inputs based on area, cropping pattern, assets, and character of the farmer.

c. For fertilizer, this represents area under high-yielding rice varieties.

Source: M. G. Schluter, "The Interaction of Credit and Uncertainty in Determining Resource Allocation and Incomes on Small Farms, Surat District, India," Occasional Paper no. 68 (Ithaca, N.Y.: Cornell University, Department of Agricultural Economics, February 1974).

EFFICIENCY GAP FUNCTION. The third econometric approach relates credit not directly to input or output levels but to the farmer's ability to allocate resources efficiently. These studies attempt to determine whether loans explain differences in ability to use optimal levels of inputs. Some studies simply compare whether borrowers and nonborrowers equate marginal value products to prices of inputs frequently financed by loans. Separate production functions are estimated for

borrowers and nonborrowers, but the differences in initial level of savings, managerial ability, and perception of risk are usually not considered. An exception is a Malaysian study which classified farmers by capital availability rather than as borrower and nonborrower.

A study of Philippine rice farms by A. M. Mandac and R. W. Herdt ["Economic Inefficiency as a Constraint to High Rice Yields in Nueva Ecija, Philippines," paper presented at International Rice Research Institute, Laguna, Philippines, 1978] supplies an alternative way of measuring loan impact. They compared data on normal farming operations with data from experimental trials conducted on the farmers' same fields to determine efficiency. Measures of technical as opposed to allocative inefficiencies were identified for each farm: it was expected that levels of technical knowledge and environmental factors such as irrigation and soil fertility would influence technical efficiency, while managerial ability, perception of risk, financial constraints, and credit availability would affect allocative efficiency.

Efficiency gap models are conceptually appealing, and future analysis might be extended to estimate loan impact on farm production or income. However, the use of experimental data to establish a frontier production function and thus to distinguish physical from price efficiency is rarely possible. In many cases farm practices of the "best" farmers may have to be used, as in other empirical studies of technical efficiency.

Programing Studies

Several studies of loan impact and demand have used mathematical programing. These studies provide estimates of normative behavior and simulate the impacts of alternative policy changes. Single period linear models are commonly used. Typically, a representative model is developed for reasonably homogeneous farms with respect to size, technology, resource endowment, and other characteristics. Profit maximization is normally assumed, subject to maximum and minimum farm or household constraints. The activities included can represent what exists or explore what is expected under alternative scenarios.

Multiperiod models, with and without discounted future cash flows, provide important advantages for the study of the impact of loans on investment, growth of enterprises, and liquidity management. Various issues have been studied with multiperiod models. For example, Michael D. Boehlje and T. Kelly White ["A Production-Investment Decision Model of Farm-Firm Growth," *American Journal of Agricultural Economics*, vol. 51, no. 1, February 1969, pp. 546–63] compared results of maximization of income versus net worth. Baker and Bhargava (chapter 12) and S. S. Hadiwigeno ["Potential Effects of Modification in the Credit Program for Small Farms in East Java, Indonesia," Ph.D.

dissertation, University of Illinois, 1974] tested how the value of unused cash and credit could influence liquidity management.

Recursive models of both representative farms and agricultural regions have been used. Unlike other multiperiod models, the objective function is solved each year with the result for one period linked to previous periods by feedback constraints. These constraints are specified to reflect farmer behavior—for example, accounting for risk aversion by safety-first objectives. Another feature of regional models is decomposition by farm size to test competition for resources—as in the case of a fixed regional credit constraint—among different size farms.

Several similar results emerge from these programing studies. Technological change, adoption of new varieties and cropping systems, mechanization, and farm income are frequently found to be constrained by the lack of formal loans. It has also been shown that certain productive alternatives would allow farmers to pay substantially higher interest rates with only a limited reduction in their borrowing. Small farmers appear particularly insensitive to interest rate levels.

Results and Methodological Problems

Virtually all these econometric studies—whether of production function, input demand function, or efficiency gap function—or programing exercises show positive contributions of credit to farm production, many of them statistically significant. The interpretation of several methodological issues, however, requires caution. The actual or expected impact of borrowing or demand for loans may be substantially under- or overestimated in a particular study for at least six reasons.

- Few studies capture the complexity of farm household behavior. Model activities are largely limited to the farm, with few efforts to include household resources allocated to off-farm activities. Since loan funds are fungible, the true impact of loans is hard to determine without an integrated household model and extensive data on the household's sources and uses of liquidity.
- Many studies focus on working capital. But in many countries where long-term credit is scarce, there is an excessive use of short-term loans to help finance investment. The impact of short-term loans must be considered in relation to investment, not to production alone.
- True costs and benefits of borrowing may not be adequately captured by interest rates and borrowing limits. Borrowing costs, especially for small farmers, may far exceed interest charges. Also, the reliability of the credit source, expectations about the need to repay, and noncredit services influence the extent to which a borrower will

switch from an informal to a formal source, or borrow rather than use savings.

- In spite of various elaborate methods, it is not clear that research has adequately dealt with risk and uncertainty. If credit were priced at equilibrium rates, with repayment expectations and farmer attitudes toward risk adequately captured, optimal borrowing might be significantly less than many studies have estimated.
- Compared with some other methodologies, mathematical programming models offer fewer possibilities for statistical tests of goodness of fit. It is not clear whether farmer behavior has really been captured by the models, and if not, their projections are dubious.
- The applicability of these models to many low-income countries is questionable. Many sophisticated models have been developed, but few low-income countries have sufficient data to justify their use.

Research on rural finance will improve as researchers develop greater appreciation for the major issues raised here: interdependence of farm and household decision making, fungibility, and attribution. The immediate priority is to develop a data base sufficient for more detailed analysis of agricultural finance. Fungibility and farm household decision making indicate the need for collecting comprehensive data on sources and uses of farm household liquidity. All sources of liquidity need to be quantified and related to the various farm and household uses. Careful monitoring of production expenses, investment, consumption, and nonfarm activities is necessary to describe accurately when and where additional liquidity is allocated. Once this is described, more rigorous analysis can identify factors explaining the allocation and impact of loans. The massive cross-section surveys currently undertaken in many countries are not suitable for this purpose. Much more careful collection of data over time from the same households is required, even if it means a smaller sample size.

Finally, the ultimate objective of agricultural credit policies and programs should be to improve rural welfare. Although the benefits and shortcomings of credit are frequently enumerated, they have not been systematically compared with the benefits and costs of other policy instruments, such as input or product price policy, that could be used to meet the same objectives. We suspect such an analysis would reveal that agricultural credit programs are less cost-effective, but are preferred because they are easy to administer and because rich, politically powerful farmers can manipulate them to their advantage.

Recommendations for Further Reading

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Issues for Discussion

1. How can rural financial markets affect the distribution of income and of asset ownership? What policies could cause rural financial markets to have a *neutral* effect on income and wealth distribution?
2. How does financial intermediation assist in overcoming the disadvantages of barter?
3. How does financial intermediation affect the efficiency of resource allocation?
4. What types of change in financial markets can be expected as an economy develops?
5. What are the differences between a supply-leading and a demand-following strategy of finance in development?
6. How important are formal agricultural loans in early stages of development? Does their importance decrease or increase as development progresses?
7. What are the effects of trying to control fungibility by tightening up the administration of agricultural credit programs?
8. What measures could a donor use to document the extent to which additionality was achieved in a small-farmer credit project?
9. If a group of borrowers have crop yields substantially higher than a group of nonborrowers, can one conclude that all the difference in yields was due to credit use?
10. Is it desirable for rural financial markets to mobilize funds through savings deposits in rural areas and recycle them as loans to nonagricultural activities?
11. How do prices and yields in agriculture affect the ability of financial markets to serve rural areas?