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9. ABSTRACT

Despite the difficulty of assembling appropriate data, detailed knowledge regarding the capital formation processes at the rural firm-household level is necessary if the development process is to be understood. No satisfactory explanation of rural growth can be formulated until we understand how the primary capital producing unit, the firm-household, makes decisions. The major focus of this research project, therefore, is on how the firm-household decision making process is related to capital formation.

The following discussion is divided into three parts: (1) an outline of a firm-household decision making model which is being used to study the capital formation process, (2) a brief discussion of the major research issues on which the project is focusing in Brazil and Taiwan, and (3) an outline of how firm-household analysis can be aggregated into sub-regional or regional models for more comprehensive policy use.

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Capital Formation and the Firm—Household
Decision Making Process

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Capital Formation and the Firm-Household
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I. Introduction

A good deal of attention in economics has been given to capital
issues.1/ Much of this effort has focused on three types of questions:
(1) the definition of capital, (2) capital's role in economic growth
and (3) ways to transfer capital among different sectors or geographic
areas. Capital growth in urban-industrial settings has received much
of the research attention. Discussion of capital formation linked with
the agricultural sector has emphasized the-transfer-out-of-agriculture
question. Authors such as Nurkse, Lewis, Ranis and Fei almost completely
ignored the internal capital formation process within agriculture. Their
concern concentrated on how to extract "free labor" from agriculture in
order to form capital outside that sector. Nicholls, Johnston-Mellor
and Kuznets broadened the analysis of agriculture's contribution to
growth beyond just labor. They, however, spent little time analyzing
the contribution which agriculture makes to itself. We would argue,

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1/ In this paper capital is defined as man-made productive
capacity. This productive capacity often provides services over several
time periods and is the result of firm-household investment decisions.

in fact, that agriculture's largest contribution to the growth process is through the build up in its own productive capacity (read capital formation) which allows it to make positive contributions to other sectors of the economy. Even more importantly, the expanded productive capacity allows the agricultural sector to improve the employment and income conditions of its own residents, which usually comprise the majority of the population in most less developed countries.

There are several reasons why little analysis has been done of capital formation in rural areas: (1) In most cases only a small portion of the increase in productive capacity in rural areas moves through national accounting systems. Changes in the amount of capital in the sector are therefore difficult to estimate. (2) Aside from the public investments made in rural areas, rural capital formation is an accretionary process imbedded in a large number of firm-households. Data collection is thus made even more difficult. (3) It has been a widely held assumption that little private savings-investment takes place in rural areas and that there is, therefore, little need to study the capital formation process on farms.

We reject this latter assumption. We also feel that despite the difficulty of assembling appropriate data, detailed knowledge regarding the capital formation processes at the rural firm-household level is necessary if the development process is to be understood. No satisfactory explanation of rural growth can be formulated until we understand how the primary capital producing unit, the firm-household, makes decisions. The major focus of this research project, therefore, is on how the firm-household decision making process is related to capital formation. We also emphasize how various important research issues are related to the

decision making process and capital formation. We feel this knowledge is one of the theory building blocks which will assist in explaining agricultural development.

The following discussion is divided into three parts: (1) an outline of a firm-household decision making model which is being used to study the capital formation process, (2) a brief discussion of the major research issues on which the project is focusing in Brazil and Taiwan, and (3) an outline of how firm-household analysis can be aggregated into sub-regional or regional models for more comprehensive policy use.

II. The Firm-Household Decision Making Process 2/

Much of the early work on firm-household economic behavior by Fisher, Ramsey and others was set aside by the Keynesian neo-classical analysis. Most economic analysis of this type carried out in the past three decades has assumed that entrepreneurial decisions and consumption decisions are made independently. This assumption is clearly more functional for urban-industrial analysis than for rural studies. In most rural situations, including less developed countries (LDC's), farm families make consumption, production, and investment decisions which are highly interdependent. Capital formation is largely the product of the interaction of these decisions. An explanation of how and why farm capital is formed, therefore, largely depends on understanding how these decisions are made.3/

2/ See the Appendix for a more rigorous treatment of the economic functions and variables included in this decision making process.

3/ There are few discussions of rural firm-household decision making models in the literature. One of the few contributions is Chihiro Nakajima, "Subsistence and Commercial Family Farms: Some Theoretical Models of Subjective Equilibrium," in Subsistence Agriculture and Economic Development edited by C.R. Wharton Jr. (Chicago: Aldine, 1969) pp. 165-185. Recent work by I.J. Singh and R.H. Day have provided additional insights into this decision making model.

The Consumption Decisions

The farm firm-household decision making process is complex and includes economic as well as non-economic dimensions. On the economic side current consumption decisions appear to play a central role. Keynesian macro consumption analysis initially focused on the relationship between current income and consumption. Later Dusenberry, Modigliani, Friedman, Ando, Brumberg, Watts, and others extended consumption analysis by suggesting that the relative income position, permanent income, previous consumption experience, relative and desired wealth levels were important determinants of consumption. The major purpose of macro consumption analysis was to forecast and control business cycles. It also assumed that decisions to consume and save-invest were independently made. Furthermore, traditional consumption analysis assumes a rather stable bundle of consumption goods and relatively modest rates of economic growth. That is consumption and production surfaces are assumed to change only gradually over time.

Several modifications must be made in traditional consumption function analysis to make it appropriate for a diagnosis of farm firm-household decisions in LDC's. The first major addition is including rates of return from on-farm investment alternatives in the consumption function. That is to say that high rates of return to investments in fixed farm capital and/or operating expenses will encourage the farm family to defer consumption. The reverse is, of course, also true. Family consumption also may be affected by the rates of return offered savers through various financial savings instruments and/or off-farm investment opportunities.

In developing rural areas much more attention must be paid to the impact of rapidly changing production investment incentives as well as

rapidly changing consumption bundles on the consumption decisions.
High yielding rice and wheat varieties may make on-farm investment very
attractive in one time period, while availability of television sets,
motor bikes, refrigerators, and sewing machines in rural areas may make
consumption very attractive in a later time period.

Other considerations which might be included in the consumption
function analysis are the age composition of the family, the age of
operator and the presence of heirs, and the composition and sources of
income.

Production Decisions

As already suggested, consumption functions lie at the heart of
the firm-household decision making process. Likewise, the production
function is the core of the capital formation process. Production
decisions are closely related to consumption and also provide the major
analytic focus for examination of the capital formation process. In
large measure, the production function provides the firm-household with
resource use possibilities, it provides the economic incentive which
stimulate the capital formation process, it also provides the signals
which indicate the forms of capital which are most economically desirable,
and it grinds out the additional product which can provide part of the
resources necessary to make further investments in farm capital.

The production function facilitates an analysis of the contribution
of various types of inputs to the production process. This includes
the impact of changes in forms of inputs as well as introduction of
new inputs (read technological change). The capacity to finance capital
inputs, the ability to absorb additional capital, and incentives to do
so, are all related to the production function.

The fourth set of investment activities relate to creation of human capital within the household. This includes investments made in furthering the formal education of the operator and his family. It also includes time and resources spent in improving the quality of child rearing in the home and investments made in improving family health.

To a large extent the farm family's decision to invest in one of the sets of activities described above will be determined by the rates of return expected from the investment discounted by associated risk and uncertainty. These rates of return will, in turn, directly affect consumption decisions.

III. Major Research Issues

There are at least five major research topics which must be treated in a comprehensive analysis of capital formation. These include two basically descriptive topics: (1) the nature and amounts of the capital formed, and (2) the nature and amounts of the consumption bundle. It also includes three policy avenues which might be used to affect firm-household capital formation decisions: (3) technological change, (4) price policies, and (5) rural capital markets. These last three research areas focus much more on explanation of capital formation and tracing through how various policy avenues might affect this process.

Description of Capital Formation

An explanation of capital formation involves making an inventory of the stock of capital within the farms under analysis. This includes a description of the nature and composition of the capital, how the capital base varies among farm types and regions, the time sequence of these capital inputs, and how the capital enters various production

processes.

Description of Consumption Bundles

As already suggested, changes in the bundle of consumption goods available for purchase by the firm-household may alter the desirability of consuming. Other things being equal, more attractive consumer goods may make saving-investment alternatives less desirable. A description of the time-changes in consumption bundles which are exogenous to the firm-household appear to be an important dimension of capital analysis.

Technological Change

The relationship between technological change and capital formation is an intimate one. In many cases new technology is imbedded in capital, in other cases new technology requires a substantial change in factor proportions which favors capital. In still other cases technological change requires a new capital input. New technology may substantially alter the average and marginal returns to capital inputs.

New farm technology directly affects the firm-household decision making process by altering the production process. Important research issues to be treated under technology include:

1. What are the total average and marginal returns of various farm inputs? Are farmers working with high or low altitude production functions?

2. What are the use levels and returns from various types of farm technologies? How important is profitability in explaining the diffusion of these technologies?

3. How do technological changes affect farmer needs and returns from operating expenses?

4. How does technological change affect the farmers' incentives to invest in various forms of fixed capital?

5. How does technological change affect the farmers' ability to

invest? That is, how does technology affect production, affect income, affect availability of discretionary resources, affect incentives to invest and finally affect stock of capital held?

6. Does technology have a differential impact on income distribution, production and employment? How could these differential impacts be modified?

Price Policies

Agricultural product and input pricing policies also have a direct impact on production functions in the firm-household decision making process. In many respects an analysis of pricing policies runs parallel to the analysis of technological change. Both involve an alteration in the nature of the value-production function, both entail factor and product substitution, and each policy avenue involves questions of differential impacts on production, employment and income distribution. In both cases we are interested in how the particular policy affects the incentive to invest, induces changes in mix of capital inputs, and alters the capacity of the firm-household to make investments from internally generated resources. All of the research questions already listed under technological change will be addressed for pricing policies. Some additional attention, however, will be placed on who receives the benefits of the price policies and who pays the cost of these policies.

Rural Capital Market Policies

Policies in rural capital markets impinge on the firm-household decision making process from two different angles. First, rural capital markets may provide additional discretionary resources to the farm operators, through credit, to respond to various investment opportunities emerging from his production process. In many cases the operator's own discretionary resources are not sufficient to allow him to move to appropriate levels of input use. Credit provides the lubrication necessary

to allow operator's to make such moves.

The second manner in which rural capital markets influence the firm-household decisions comes through the financial incentives provided for savers to deposit money in rural capital markets. This includes interest rates paid on deposits and security offered on the ability of institutions to repay deposits.

A number of questions related to rural capital market are being treated in our research:

1. What amounts of rural credit are needed to adequately lubricate the capital formation process?

2. What roles do the formal and informal credit systems play in providing these funds?

3. To what extent can additional internally generated farm funds supply the increased capital required by technological change?

4. How serious is external capital rationing for farms experiencing technological change and strong economic opportunities for capital formation? What types of farms generally become credit starved in this process?

5. Do the financial interest of credit-distributing agencies affect the way they ration credit?

6. Do credit repayment problems occur when the returns to credit use are low and cause the value of maintaining a good credit rating ab...

7. Do farmers need i... ...to induce them to make fixed capital ...

8. What affect ... various credit pricing policies have on:
   a) the way credit is rationed, b) size of loans granted, c) who gets loans, d) uses made of loans, e) ability of bank to maintain real value of credit portfolio, and f) way borrower allocates funds within his firm-household.

9. What affect do interest rate policies on financial savings have on: a) savings decision, b) consumption decision, c) decision to invest on farm, and d) ability of credit system to build up its own credit portfolio through funds mobilized from rural areas.

IV. Aggregation of Firm-Hou...
     Into Sub-regional Models

Information derived from firm-household analysis provides m...
of the information necessary to build sub-regional models. Re...
farm data can be estimated for various sizes of farms, types o...
etc., and used as building blocks for aggregate models. Farm le...
data, plus off-farm resource and regional resource constr...
the necessary ingredients for constructing policy models...
linear and recursive programming methods, as already applie...
Brazilian wheat region, is a technique of pulling this type o...
together for policy analysis. At a later stage it is possible to lin...
together various sub-regional models to form sector and inter-sector
models.

The application of sub-regional models to micro data helps
accomplish a number of tasks. Initially, results from the sub-regional
models can be used to check and evaluate results from the microeconomic
neo-classical analysis. The reverse check is also possible. More
importantly, sub-regional models provide an integrated framework in
which to analyze the consumption-production-investment decisions of
the firm-households. These models provide an analytic tool which allows
specification of alternative policies and tracing out expected con-
sequences. It also provides a dynamic framework within which both
short run and long run consequences of various sets of policy options
can be tested. The models also can be used to simulate actual past
performance of the sub-region. This allows a better understanding
of the histocial growth process, as well as providing a firm base for
projective work.

The use of micro studies as building blocks for sub-regional, and

la[...] [...]gregati[...] [...] [...]o[...] models, has several additional
advantages. In most [...]ing countries like Brazil there is a paucity
of farm level data. Policy decisions regarding the behavior of the rural
firm-household are often based on "conventional wisdom" rather than
empirical information. Building models from the bottom up provides a
systematic method of creating the data bases needed to make better policy
decisions. It also assists policy makers, research institutions, and
university people in a country like Brazil to get their feet wet in
building these data bases. Furthermore, it gives a U.S. university
like Ohio State the opportunity to work cooperatively over extended
periods of time with policy and educational agencies in LDC's on activities
which have substantial joint payoff.

In many cases sector model building involves a good deal of time
before new information is fed into policy making. The bottom-up, sub-
regional approach suggested here allows some policy insights to be fed
into decision making early in the research process. For example, a
micro study of the economics of fertilizer use in the State of Sao Paulo,
Brazil in 1970 quickly yielded information on the extent and level of
fertilizer use among the sample farms. Within a year it was clear
from analysis of the data that farmers were not using recommended levels
of fertilizer because of low economic payoffs. The information derived
from the micro studies allows decision makers to begin altering policies
in appropriate directions. An aggregation of this data into a sub-
regional model would allow a more comprehensive analysis of various
policy alternatives. The model analysis should help to more correctly
identify correct policy levels and mixes.

In sum, we see a focus on the firm-household decision making
process as being vital to explaining rural capital formation. We also

feel that this focus, in conjunction with emphasis on several important policy avenues can lead to important policy conclusions. Systematic policy analysis, however, requires some aggregation. The bottom-up, sub-regional model appears to offer the appropriate techniques for this aggregation.

Mathematical Appendix

This Appendix presents a preliminary mathematical formulation of the firm-household decision making process. Following the works of Fisher, Ramsey and Klein the following simple model can be written

(1) Max. $U_{it} = u(C_{it}, C_{it+1})$

where for the ith household in period t the choice is to derive maximum satisfaction out of current and future consumption bundles. Limiting the decision to one time period and simplifying by assuming a relationship between current investments and future consumption we can write

(2) $C_{it+1} = h(I_{it})$, therefore

(3) Max. $U_{it} = U'_{it}(C_{it}, h(I_{it}))$

where we assume that current disposable income is allocated between consumption expenditures and investment outlays (savings deposits being a form of investment) such as to maximize satisfaction.

Solving for (3) we get the following basic relationship:

(4) $\dfrac{\partial U_{it}}{\partial C_{it}} = \dfrac{\partial U_{it}}{\partial h(I_{it})}$

which describes the firm-household (f-h) decision in equilibrium. Our interest is in both how to lend empirical content to (4) as well as to analyse its dynamics in disequilibrium. If we assume that f-h units begin in some form of equilibrium (one such state being described by Schultz as traditional equilibrium, where the rates of return to new investments are so low that there are few incentives to invest), we

know that new consumption opportunities and new investment opportunities
have a tremendous impact on increasing both consumption and investment
utilities.

How do we analyse these decisions? Consider the following set
of decision functions:

Consumption Decisions

(5) $C_{it} = f_{it}(Y_{it}, C_{it-1}, W_{it}, F_{it}, r^j_{it-1}, P^c_t)$

where for the ith f-h unit in period t,

C_{it} = Family consumption outlays,

Y_{it} = Family disposable income,

W_{it} = Index of family wealth,

F_{it} = Index of family age composition,

r^j_{it-1} = Lagged rate of return from the jth investment opportunity

(eg. on-farm, off-farm, and human capital investments),

C_{it-1} = Lagged family consumption outlays,

P^c_t = Consumer price index.

Farm Production Decisions

(6) $Q_{it} = q_{it}(L_{it}, M_{it}, K^j_{it})$

Q_{it} = Value of farm output,

L_{it} = Quantity of land,

M_{it} = Quantity of labor,

K^j_{it} = Service flow from jth capital item (including quantity of

operating capital, human capital and fixed capital items).

Farm Investment Decisions

Relating investments in capital items to their lagged rates of return, their current market prices, the market rate of interest, the wage rate, and past levels of investments, we have

$$(7) \quad I_{it}^{j} = g_{it}^{j}(n_{t}^{j}, r_{it-1}^{j}, \cdots, r_{it-n}^{j}, P_{jt}^{k}, m_{t}, I_{it-1}^{j},$$
$$\cdots, I_{it-n}^{j}, I_{it-1}^{k}, \cdots, I_{it-n}^{k})$$

where

I_{it}^{j} = Current investment outlays on the jth capital items,

n_{t}^{j} = Current market rate of interest on which credit is available

for the jth capital item,

$r_{it-1}^{j}, \cdots, r_{it-n}^{j}$ = Lagged rates of return to the jth investment,

P_{jt}^{k} = Current price of jth capital good,

m_{t} = Current agricultural wage rate,

$I_{it-1}^{j}, \cdots, I_{it-n}^{j}$ = Lagged investment in jth capital item,

$I_{it-1}^{k}, \cdots, I_{it-n}^{k}$ = Lagged investment in kth capital item.

Stock-flow Relationships

Now relating current levels of capital use (service flows) which enter the production function to past levels of investment to determine the actual differential rates of depreciation as suggested by Yotopoulos[1] we have

$$(8) \quad K_{it}^{j} = k_{it}^{j}(I_{it-1}^{j}, \cdots I_{it-n}^{j})$$

where K_{it}^{j} and $I_{it-1}^{j}, \cdots I_{it-n}^{j}$ are previously defined.

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[1] Pan A. Yotopoulos, Allocative Efficiency In Economic Development (Athens, Greece: Center of Planning and Economic Research, 1967).

Income - Output Relationship

To close the system we define a direct relationship between current value of output and current disposable income

(9) $Y_{it} = 1_{it}(Q_{it})$

System Dynamics

Now we wish to trace the dynamics of the system. We start by re-stating the division of current disposable income into current consumption and investment outlays:

(10) $Y_{it} = C_{it} + I_{it}$

then

$$(11) \quad dY_{it} = dC_{it} \frac{\partial C_{it}}{\partial Y_{it}} + \sum_j dI_{it}^j \frac{\partial I_{it}^j}{\partial Y_{it}}$$

for each of the n f-h units in any specified sample grouped by size, farm type or other characteristics. Dropping the i subscript then for the grouped data by expanding (11) we have

$$(11.1) \quad dY_t = [dY_t \frac{\partial C_t}{\partial Y_t} + \cdots + dP_t^c \frac{\partial C_t}{\partial P_t^c}] \frac{\partial C_t}{\partial Y_t}$$

$$+ \sum_j \{[dn_t^j \frac{\partial I_t^j}{\partial n_t^j} + \cdots + dI_t^k \frac{\partial I_t^j}{\partial I_t^k}] \frac{\partial I_t^j}{\partial Y_t}\}$$

But $\frac{\partial I_t^j}{\partial Y_t} = \frac{\partial Q_t}{\partial Y_t} \cdot \frac{\partial I_t^j}{\partial Q} = \frac{\partial Q_t}{\partial Y_t} \cdot [\frac{\partial K_t^j}{\partial Q_t} \cdot \frac{\partial I_t^j}{\partial K_t^j}]$

for every jth capital item.

Now equations (5) through (9) estimated as a set of simultaneous equations allows us to lend empirical content to the following dynamic and recursive sequence:

(12) $E \rightarrow (7) \rightarrow \Delta I = \sum_j \Delta I^j \rightarrow (8) \rightarrow \sum_j \Delta K^j \rightarrow$

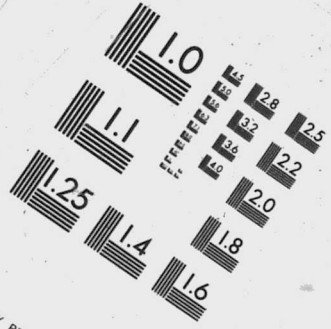$$\rightarrow (6) \rightarrow \Delta Q \rightarrow (9) \rightarrow \Delta Y \rightarrow (5) \xrightarrow[\rightarrow \Delta I + E \rightarrow (7) \rightarrow \Delta I]{\Delta C \rightarrow (5) \rightarrow \Delta C}$$

where E are exogenous variables, which entering the investment decision function (7) and determine levels of investments in various capital items. These are then transformed to flows using (8) which in turn are turned into output via (6). Output is related to disposable income via (9) and disposable income allocated to consumption and investment via (5). The allocations to investments leads to cummulative growth while increased consumption acts as a drain. Behind the consumption decision (5) lies the basic equilibrium condition in (4).
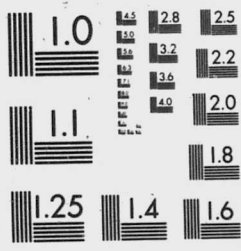
It is obvious that the allocation between consumption and investment outlays changes as both new consumption and investment opportunities appear, the direction and strength of the change depending upon the changes shown in (11.1).
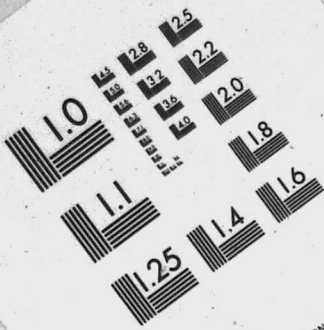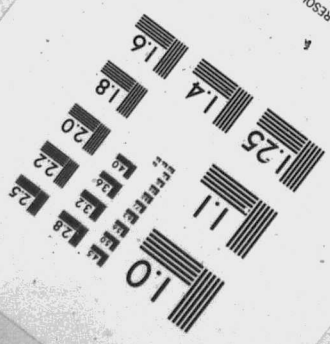
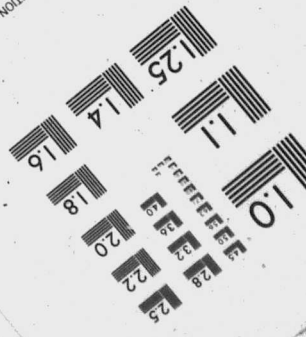MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A