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RURAL CAPITAL FORMATION AND TECHNOLOGY: CONCEPTS AND RESEARCH ISSUES

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Introduction

Agricultural growth is both the cause and consequence of a number of forces. Some of these are qualitative, such as changes in institutional arrangements, improved enterprise, technical progress, and upgrading the attributes of production factors. Quantitative changes in education, land, labor, capital, and other inputs are also important. Many of these forces have been extensively studied by agricultural developers, but relatively little attention has been directed at the process of rural capital formation. Very little is known about the extent of rural capital buildup, what factors determine its growth, what forms capital takes, how technical change affects this accumulation, and how rural capital relates to firm, sector, and overall growth.

The following discussion attempts to shed light on these questions as well as identify major research issues related to rural capital formation. The first section briefly reviews prior studies of capital. A typology for classifying various levels of capital analysis is next put forward, followed by a definition outline for rural capital. Since technological change has been intimately related to capital growth, an attempt is also made to clarify the relationship between technology and rural capital. The discussion continues with an outline of some major policy questions related to rural capital and technology, including a list of research issues. In the last section of the paper, an attempt is made to lay out a research schedule by placing some priorities on these issues.

Economic Studies of Capital

Economists have paid a good deal of attention to the analysis of capital, but because of unstandardized terminology and ideological issues, the topic has often been troublesome. Historically, capital studies have gone through three phases. Prior to about 1900, economists were mainly interested in capital as it related to national wealth [11, 27].* During the first half of the 20th Century, however, capital was placed in the shadows as attention shifted to questions of national income. It was not until after the Second World War that economists turned their attention again directly on capital and on its role in economic growth.

Schumpeter suggests that the term 'capital' was appropriated by economists from the legal and business world where it was used to mean loan principal [68, p. 322]. Over the years, economists extended the original meaning of the term and equated it with the stock of wealth and riches. Popular usage partially followed the economists, but the monetary and accounting aspects were heavily emphasized in the lay use of the term.

A. R. J. Turgot was one of the first economists to suggest that capital be considered as a factor of production, a point later driven home by Marshall. Authors such as Smith, Senior, Böhm-Bawerk, and Marx suggested different classification schemes for capital which were useful in determining its function: fixed vs. circulating capital, human capital vs. physical capital, wage capital and technological capital. Walras also shed light on the subject by terming capital as all goods that serve more than once in the production process.

In many respects the analysis of capital was sidetracked in the mid-1800's by the Ricardo-Marx labor-theory-of-value. Attention turned

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*Citations refer to listings in the Bibliography.

from how capital enters the production process to normative questions of how its product should be divided [62]. Because of the confusion injected by the labor-theory-of-value and the emergence of the marginal school, led by Marshall [47], general interest in the topic flagged during the late 1800's.

After the turn of the century, a number of economists became interested in national income and some of them worked on issues connected with capital. Contributions by Fisher, Knight, Hicks, Hayek, and Keynes were in the general area of interest rates, risk, equilibrium in capital markets, and marginal returns from investment [15, 23]. Relatively little attention was directed at capital growth itself, however.

A classification of recent capital studies

Since about 1950 a number of economists have focused on various aspects of capital buildup. The Harrod-Domar growth models were especially important in directing attention to the process of saving, investment, and capital formation in less developed countries [17, 29]. Schultz and others' studies of investments in human beings also opened up a new field for capital analysis [67]. Using level of analysis as a criteria, and emphasizing agriculture, there have been seven types of capital studies carried out since interest switched to growth.

(1) A number of studies have treated the international capital transfer process. This has included private transfers and investments, government-to-government arrangements, multilateral agency transfers, terms-of-trade arguments, and special pricing arrangements on specific commodities [12]. Some economists have also looked at the foreign capital requirements needed to maintain some level of growth in a given country [9].

(2) A few aggregate national capital growth studies have also been done. Simon Kuznets' work in this area has been especially prominent [1, 21, 41, 42]. The work on human capital has also contributed to this area. In general these studies emphasized accounting problems related to measurement of capital, savings ratios, capital-output ratios, and changes over time in these ratios [7, pp. 35-130]. As Hooley has pointed out, however, these studies in less developed countries generally have very limited measures of capital formation in primary industries such as agriculture [32, p. 202].

(3) In the past few years a number of studies have stressed inter-sectoral capital transfer. Much of this evolved from the work by Nurkse, Lewis, and Ranis and Fei [53, 45, 56]. They concentrated on using underemployed rural labor in capital building projects. Johnston and Mellor, Kuznets, and Perkins and Witt, plus others later expanded the analysis of inter-sectoral capital transfers, especially out of agriculture [36, 40, 54]. In addition to "surplus" labor, agriculture has been shown to contribute to capital formation by providing taxes and inexpensive products for consumption, processing, and export.

A few studies have attempted to measure the capital transfers to and from agriculture, and from this to identify who is carrying the largest burden in overall capital development [20, 24, 38, 44, 66]. Taxing and pricing policy, plus public investments have received major attention in these studies.

(4) In the last 15 years there have been some attempts to measure an agricultural sector's capital base and growth [2, 70, 71, 74, 75]. Most of these studies have been done in developed countries where secondary data are available. These studies have tended to emphasize capital composition, capital's role in development, and the relation

of capital growth to various policy instruments.

(5) Some attention has also been paid by researchers to sub-sector capital formation. This has included, for example, studies of capital growth (a) within geographic regions, (b) among an economic class of farmers, (c) among producers of a specific commodity, or (d) within farm units affected by a specific policy instrument. Regional firm growth studies in the U. S. are partial examples of this level of analysis. Few of these studies have addressed differential capital growth issues or intra-sectorial capital transfers.

(6) Only a handful of studies have looked at the buildup of non-farm rural capital. That is, the public and private capital infrastructure which supports rural development. It also includes jointly owned capital created within machinery pools and marketing and credit cooperatives. Wharton, Mosher, and Martin have, however, laid out a number of issues to be considered [76, 51, 48]. Only a few empirical studies, unfortunately, have been carried out [19, 22].

(7) Finally, some research has been done in developed countries on farm-level capital formation or firm growth [5, 28, 34]. Very little attention, nevertheless, has been paid to this process in less developed countries.

Capital Defined

As suggested earlier, a good deal of confusion surrounds the use of the term "capital"; there are almost as many definitions as there are authors on the subject [33, 55].[1/] An outline of a definition is here

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1/ After reviewing a number of works on capital, Schumpeter concluded that too much time had been spent on trying to solve problems by hunting for the meaning of words [68, p. 898].

presented ir an attempt to clarify the meaning of the term for the discussion which follows. Pragmatic criteria are used in constructing the definition: (1) it must be useful in making policy decisions, and (2) it must be operational for research purposes.

Assets and capital: With these criteria in mind it might be useful first to specify the difference between assets (or wealth) and capital. From a growth perspective we are interested in those assets which enter the production process. At the farm level this might include value of farm land, fences, irrigation systems, machinery, livestock inventories, storage facilities, drainage systems, and operating funds. This type of productive assets make up part of what we want to call "capital."

Productive capacity and capital: Our use of the term "capital" is closely associated with the notion of productive capacity. At the firm level, owned productive assets as well as borrowed inputs make up this capacity. Rented farm land would be part of a farm's productive capacity, as would rented machinery or borrowed funds. We are interested in access and not strictly ownership.

Investment and capital: We are particularly interested in that part of productive capacity which can be created by man in relatively short time periods; that portion of productive capacity which requires postponed consumption, savings, and investment by individuals and/or society. We are especially interested in changes resulting in net increases in society's agricultural productive capacity. Since the natural endowments of land and, to a large extent, the labor force are outside policy consideration, they will enter only lightly into our concern with capital formation.

Private versus public viewpoint: As in any aggregation exercise, care must be taken in adding capital across individual firms to arrive at some notion of total social capital. From a policy standpoint, we are very much interested in changes in the entire agricultural sector's productive capacity. The purchase of a unit of land, for example, may add to a firm's production base, but if the funds paid for the land are used outside the agricultural production process, the net effect of the transaction may be a decrease in agriculture's overall productive capacity. Likewise, the borrowing of inputs increases an individual's capital base, but this often has little or no impact on agriculture's total productive capacity. Care must also be taken not to double count. A public investment in a road into a new area will likely raise land prices. The value of both should not be included in a social summation.

The analysis of non-farm rural capital would include both social and private investments. Things like transportation systems, marketing facilities, service facilities for agriculture, and jointly owned forms of capital would be included.

Types of capital: Capital can take at least three forms. The first might be termed physical capital (K_1) which is tangible and takes the form of a stock. Services from this input flow into the production process over a number of production periods: e.g., tractors, irrigation systems, and work animals. Land improvements (or depletion) are also examples of changes in K_1. The second type has been termed human capital, K_2. Investments in health and formal or informal education help generate this type of capital. The third type might be termed liquid or operatinal capital, K_3. This would include owned or borrowed monies which give the holder call upon the use of

additional inputs and their services. K_3 may be converted into K_1 or K_2, consumed, hoarded, or it may be used to purchase variable inputs expended in a single production period.

Technology and Capital

A number of productivity studies in the past have attempted to measure the impact of technology on production [30, 63, 64, 72]. When these types of studies are applied to the agricultural sector the capital variable is often poorly specified. A number of capital investments tied to land are subsumed in the land variable, human capital formation is submerged under the labor variable, and the measurement of other capital is only partial because certain types of farm investments have not passed identifiably through the marketing system or public accounts. It may be that a significant portion of the residual production which has been assigned to technological change in agriculture is more closely related to the contribution made by this unmeasured capital buildup.

Why is it necessary to try and separate the impact of previously unmeasured capital formation on production from the impact of technology [16]? The answer stems from the policy considerations involved. The actions necessary to create a new technology are quite different from those needed to stimulate farm-level capital formation. New technology for agriculture is largely developed outside of the farm unit itself by government agencies, foundations, or large private corporations. On the other hand, capital formation at the farm level is basically a farm unit decision. Each individual farmer, in responding to various price relationships, his income utility map, consumption desires, availability of

internal savings and external credit plus technical possibilities, decides on how to change his capital stock. Policy instruments for stimulating capital formation, in contrast to technological change, must be aimed at different decision-making units.

On a use level it is difficult to conceptually separate the economics of capital formation and adoption of technological change. In a sense there seems little need to do so. Abstracting from some time considerations, the economic decisions regarding the addition of another unit of capital, a new unit of capital including a new technology, or a new technology which included little capital are identical.

There are a number of ways in which new technology and capital are interrelated:

(1) In some cases new technology is embodied in physical capital. A farmer who changes from oxen to plow his land, to a tractor is a case in point.

(2) Still other new technologies may involve little capital directly but required an increase in complementary capital in order to produce successfully. Biological technologies often fall in this group [31]. The new high-yielding varieties of rice and wheat which responded well only under irrigation are examples. The need to sharply expand owned or borrowed operating funds to purchase fertilizer for these new varieties is a further example. What the new technologies have done in this case is shift the production function so that it is now profitable to use more units of capital.

(3) A technological change may also require a major adjustment in the structure of a firm's capital base without requiring any significant

increase in overall capital [13, 26]. A switch from extensive cattle to intensive crop production may result in little change in the firm's overall amount of capital. It may mean that a much larger portion of the capital base is used for operating capital, however, and much less held in physical capital. [58].

(4) New technology may also have a direct impact on the efficiency of old and/or new capital [15]. That is, there is technological development in capital production. Examples might be a metal plow which, although costing little more than an older wooden model is much more efficient in stirring dirt [57].

(5) Finally, new technology may help an operating unit to generate more net income, expand savings capacity, make more funds available for investment, increase the marginal returns to investments, and, thus, result in more within-unit capital formation. This is, of course, true for all cost-reducing technologies at the firm level.

Major Policy Questions and Research Issues

Rural capital formation is associated with at least six major policy questions. These questions along with a brief discussion of related research issues follow.

Extent of rural capital formation

As already suggested, we do not have a clear idea of the extent to which capital formation is taking place in rural areas. Is rural capital formation substantial in various stages of development? This question might be translated into the following research issues:

1. What things should be called capital?

2. What are the amounts of capital formation which are occurring among different economic classes of farms? On the basis of cross-sectional data, what is the composition of this capital.

3. What are the amounts of capital formation taking place through time on various types of farms? Does a time series analysis show any different patterns in accumulation, composition, or secuence than the cross-sectional analysis?

4. What other methods would be useful in capital analysis?

5. How do we value capital for research accounting purposes [35, pp. 153-163]?

6. Does the social versus the private view affect the valuations which should be placed on capital?

7. What are the important forms of on-farm capital: owned vs. borrowed, fixed vs. liquid assets [8, 50, 58]?

8. What part of the rural capital base is located off-farm?

Sources of farm-level capital formation

An understanding of the rural capital formation process requires detailed knowledge about sources of capital formation at the farm level. Various policies have differential impacts on the formation of capital from alternative sources. Some important related research issues are:

1. What are the main sources of farm-level capital formation: internal savings, external borrowings, or labor inputs [54]?

2. How do these sources vary in importance among alternative types of farming units?

3. Over time, do the sources of capital formation change as a farm evolves through different economic classes?

4. What impact do various policy variables have on the different sources of capital formation?

Interaction of technology and capital

A third policy question revolves around the interaction of new technology and capital. Specific research issues are as follows:

1. What impact do various forms of new technology in agriculture have on the rural capital base [14]?

2. Which new technologies are embodied in capital such that a change in technology is also a direct change in capital? Which new technologies require substantial changes in complementary capital inputs? Which technologies require little or no change in rural capital?

3. How much change in the efficiency of capital is due to changes in the technology of producing capital [18]?

4. What is happening to the capital-output ratio in agriculture? What causes it to remain relatively constant or to change?

5. What are the impacts of specific technologies like fertilizer and mechanization on farm incomes?

6. How important is credit in helping farmers to reorganize their operations in the face of technological change [13]?

Policy variables and capital

Capital does not grow in a policy vacuum. If rural capital is a vital part of agricultural development, it is important to know which policy variables accelerate, retard, or modify its growth. A number of research issues are closely related to this question:

1. How important are product pricing policies in explaining capital growth. [49]?

2. How important are input pricing policies and input promotion programs in explaining capital use and growth?

3. How important is formal credit policy in determining capital buildup [4]? How important are institutional credit rationing policies, and credit pricing policy in explaining capital buildup among different economic classes of farmers [3, 10]?

4. How do various taxing programs affect capital buildup?

5. What role do public investments play in rural capital growth?

6. How critical are educational inputs in explaining capital increases?

7. How important is generation of new technologies to capital growth?

8. How important are land tenure arrangements in explaining capital accumulation [59, 60]?

9. What impact does chronic inflation have on farm-level capital formation?

10. How effective are "package-programs" in stimulating capital buildup at the farm level?

Rural savings

The growth in a farm family's saving capacity is an important factor in determining farm investments. This savings capacity also has broader implications for taxation policy, pricing policy, and institutional savings.

A capital surplus often must be withdrawn from agriculture to help finance development outside the agricultural sector. Also, a mobilized surplus of rural resources is very helpful in financing investment activities within the agricultural sector itself. Research issues related to these questions are:

1. How closely are increases in credit use associated with increases in farm family consumption?

2. What is the marginal propensity to consume among various economic groups of farmers in areas where incomes are increasing?

3. At what level of income are farmers able to create a savings capacity?

4. What growth has occurred in rural savings capacity under conditions of rapid development?

5. What factors are most closely associated with the growth in farm-level savings capacity?

6. What access do farmers have to institutional savings forms?

7. How responsive are farmers' time deposits in savings institutions to changes in economic incentives?

8. Could higher interest rates paid on saving help institutionalize substantial rural savings? Could these savings, in turn, provide a significant portion of growing rural credit needs.

9. Are the on-farm investment possibilities and the on-farm savings capacity so unequally distributed that a savings institution might help in combining saved resources with investment possibilities?

10. What are the most efficient means of extracting some savings capacity from the rural area: with taxes, through input prices, through output prices, capital invested in rural-to-urban migrants, or voluntary savings?

11. How much on-farm-capital formation is it desirable to encourage while at the same time extracting capital for use outside the farm unit?

Rural capital and agricultural development

A further policy question is an analytic extension of a number of the issues laid out above. Namely, what part does rural capital formation play in agricultural development? Stated another way, what proportion of rural growth is due to capital accumulation? The following research issues relate to this question:

1. What is the relationships between capital growth, technological change, increases in other conventional inputs, and output responses to changes in terms-of-trade between sectors [25, 37, 43, 46, 52]?

2. Why is capital generally productive? Why does it usually return the user more than its costs? How does capital contribute to productivity[15]?

3. What types of capital have the largest impact on production?

4. What is the relationship between various forms of rural capital and employment?

5. What are the income distribution implications of rural capital formation [31]?

6. How important is off-farm rural capital buildup in explaining on-farm capital growth? How important is off-farm rural capital formation to overall rural capital growth? What roles do public and private investments play in its growth?

Research Hypotheses and Priorities

Some of the most important research issues suggested above might be arranged into three time-priority groups. The first group (indicated by ***) include those hypotheses which ought to be at least partially resolved before moving on to group two (indicated by **). Group two questions should, in turn, be at least partially answered before moving into group three (indicated by *).

The following list of hypotheses, arranged by major policy questions, indicate the priorities which might be placed on these various research issues:

Extent of rural capital formation

*** 1. Substantial capital formation is occurring among all economic classes of farms, there is little difference in their capital structure, and various economic classes of farms follow essentially the same capital expansion path.

** 2. On-farm capital growth is a major part of total rural capital formation.

Source of farm-level capital formation

*** 1. The proportion of output marketed and proportion of inputs purchased largely explain what sources provide the impetus for farm-level capital formation. Poorly market-articulated farms rely on family labor investments, farms partially related to the market rely on internal savings, and highly commercial farms rely mainly on borrowed capital.

Interaction of technology and capital

*** 1. Various technological changes such as fertilizer and mechanization have differential impacts on a farm's capital structure.

*** 2. New technologies are resulting in major increases in farm income, larger farm units, changes in farm types, expanded capacity to save, improved incentive to invest, and accelerated farm-level capital formation.

** 3. Large bundles of technological change require substantial increases in managerial skills or human capital.

Policy variables and capital

*** 1. At the farm level expanded credit use is associated with increased expenditures for family consumption among various economic classes.

** 2. At current interest rate levels, farmers are very responsive to changes in real rates of interest charged on institutional credit.

** 3. Current price, marketing, fiscal, credit, and technology policies result in highly uneven capital formation among different economic classes of farmers.

** 4. The use of additional farm mechanization is complementary to labor use.

Rural savings

** 1. Under conditions of increasing incomes, the marginal propensity to save among various economic classes of farmers is similar. Further, the marginal propensity to save among farmers is significantly different from that of other people in the economy.

** 2. Given access to savings organizations and additional income, farmers are highly responsive to changes in the real rates of interest paid on institutions savings.

* 3. Voluntary savings are a relatively inexpensive way of mobilizing rural capital.

Rural capital and agricultural development

** 1. Accurate measurement of rural capital formation can help explain a significant portion of the previously unexplained increases in agricultural output.

* 2. Private investments make up a substantial portion of the off-farm rural capital buildup.

* 3. With an adequate model it is possible to specify the impact which various changes in price, credit, fiscal, and technology policies will have on rural capital formation.

In addition to the specific hypotheses listed above, priorities must also be assigned to some procedural questions: (1) Methodological issues associated with the measurement of rural capital ought to receive first order priority. (2) Retesting of some important policy-hypotheses in different geographic settings should receive second order priority. (3) Some consideration also should be given to marshalling sufficient data on rural capital formation so that an entire sector and intersector analysis could be constructed in the future.

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