RURAL DEVELOPMENT EXPERIENCE: ECONOMIC PERSPECTIVES

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by

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This conference is directed toward the broad issues of rural development. It is concerned with rural people and the impacts that government investments, regulations and market interventions have on their well-being.

Critics have generally noted:

1) That few, if any, projects have accomplished all of the goals and objectives set forth in the project design stage;

2) That the policy instruments implemented often have unintended consequences, i.e., they were inconsistent with project objectives; and

3) That the design and implementation of programs are often flawed and that programs that "work", when staffed by highly skilled and motivated staff, cannot be replicated under more general staffing conditions.

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Indeed, many critics of rural development projects are very harsh.[1/] Yet the rural development project continues to be the dominant institutional form for efforts to produce economic and social change in rural areas. Broadly defined, the magnitude of spending on rural development projects and programs in most contemporary developing economies generally far exceeds the magnitude of spending made by today's developed countries at comparable stages of their development. The mix of spending, however, tends to be different. Developing countries today invest less in activities designed to produce improved technology and more in activities designed to extend technology and facilitate its use through various subsidies (this can be seen in a later table, Table 6).

The general purpose of this paper is to discuss the relevance of the perspectives of the economics profession and of the analytic approach to rural development programming. The paper discusses five bodies of economic literature with a view of assessing their contribution to the improvement of the consistency between instruments and objectives in rural development activity and the design and institutional efficiency of these activities.

The five bodies of literature dealt with are:

1) The Economics of Farm Production

2) The Economics of the Family

3) Rural Markets and Institutions

4) Research Extension, Rural Development Projects and Productivity Change

5) Rural Development Projects, Technology, Population Growth and Income Distribution

1. The Economics of Farm Production

Farm accounting, farm management and production analysis are well established fields in agricultural economics. Empirical studies in these fields are generally highly regarded in terms of both the measurement of variables and the basic analysis. The extension of this work to more general supply response (to prices) analysis in the 1950s and 1960s had a profound effect on the way farmers in developing countries have been viewed by policymakers. The evidence that even the poorest farmers do respond to prices as they choose cropping patterns is now abundant. The old view that farmers' behavior is governed predominantly by traditions and cultural factors has pretty much disappeared and policymakers supporting low prices to farmers can no longer argue that such policies will not have supply effects.

In the past 15 years a new revolution in production and cost analysis in agriculture has taken place. This revolution in empirical work is based on the "duality" between production functions (or transformation functions in the case where more than one good is produced) and maximized profit functions or minimized cost functions. This duality exists when farmers actually maximize profits or minimize costs. They may, however, undertake this maximization subject to many restrictions such as technology availability, credit availability, and their own skills. Thus, in practice, duality can exist even where full profit maximization is not realized. The essential nature of this approach is outlined in Appendix 1.

Very recently, this author has completed a study for North India that illustrates the method and demonstrates some of its relevance for rural development concerns.[2/] The estimates were obtained using district level data from the states of Punjab, Haryana, Uttar Pradesh and Bihar. These districts can be grouped into two major groups: a primarily wheat-producing area (Punjab, Haryana, Uttar Pradesh and Bihar) and a primarily rice-producing area (Eastern Uttar Pradesh and Bihar). Table 1 provides a variable dictionary for the data set and reports means for the two areas. A brief definition of each variable is provided. The variables are classified as variable farm outputs, variable farm inputs, prices, and fixed environmental or structure variables. In this analysis, it is presumed that farmers maximize variable profits by choosing the appropriate mix of variable farm outputs and variable farm inputs. These variables are thus choice or 'endogenous' variables. It is likewise assumed in this model that the typical farm has no control over farm prices.

Table 2 reports elasticities computed at the means of the data for the eight equations. These are based on estimates of a system pooling all district data. By reading each column, one obtains the elasticity effects of each price and structure variable on the output supply or input demand variable in question. For example, in the first column, one can see the estimated effects on wheat supply of the wheat price, the rice price, etc., all the way down to the research variable. (All statistically significant variables are indicated by asterisks.) Note that the wheat supply elasticity with respect to its own price is .370. This means that a 10 percent increase in the wheat price, holding all other prices and structural variables constant, will cause a 3.7 percent increase in the supply of wheat. One can also see the consequences of a wheat price increase, holding everything else constant, not only on wheat supply but also on the supply of rice, coarse cereals and other crops, and on the demand for fertilizer, bullock labor, tractors and labor by reading across the wheat price row in the table. One thus finds that a 10 percent increase in the price of wheat causes a 3.7 percent increase in the quantity of wheat supplied, a 2.07 percent decrease in the quantity of rice supplied, a 2.24 percent increase in the quantity of coarse cereals supplied, etc.

The results indicate that rural electrification biases the output mix in favor of coarse cereals and other crops. It also biases input demand in favor of fertilizer and against labor. Roads, on the other hand, create biases in favor of coarse cereals and against other crops. They likewise create biases against fertilizer and in favor of tractor demand. It should be noted, however, that this variable, and perhaps others, may be reflecting geographical factors and one should not presume therefore that it is easily subject to policy manipulation. The rainfall variable is a strictly geo-climate variable and not subject to policy modification.

Irrigation intensity and net cropped area, on the other hand, are subject to policy manipulation. Increasing irrigation investment increases all outputs and inputs

Table 1: Variables Dictionary: North Indian Data Set Observations on 22 Regions, 1959-74.

Variable Definitions	Means: Wheat Region	Means: Rice Region	Means: All
1. Variable Farm Outputs			
Wheat	20676.19	10124.76	16360.88
Rice	4319.35	22083.35	11586.44
Cereal Grains	5660.20	4467.06	5172.10
Other Crops	25833.99	16114.35	21857.78
2. Variable Farm Inputs			
Labor	22006.25	41818.24	30111.16
Animal Power	21841.10	50139.95	33417.90
Tractor Services	1038.04	256.74	718.42
Fertilizer	4155.17	2641.76	3536.05
3. Prices			
Wheat	2.215	2.291	2.246
Rice	2.058	1.879	1.984
Cereal Grains	2.174	2.390	2.262
Other Crops	2.898	3.288	3.058
Labor	2.041	2.111	2.070
Animal Power	1.790	1.371	1.619
Tractor Services	1.577	1.577	1.577
Fertilizer	1.278	1.307	1.290
4. Structure Variables			
Rural Electrification (percent of villages electrified)	38.99	15.25	29.28
Roads (km of roads per 10 km^2)	2.08	1.11	1.68
Research Expenditures (cumulative expenditures, 1955 to t-2)	9.56	4.61	7.54
Research Intensity (current expenditures/net cropped area)	1.49	.865	1.23
High Yielding Varieties (percent of gross cropped area under high yielding varities of rice, wheat and maize)	10.79	7.09	9.27
Irrigation Intensity (percent of gross cropped area irrigated)	40.97	35.31	34.57
Net Cropped Area (000 hectares)	1293.03	1771.52	1467.78
Farm Size (net cropped area/number of cultivators)	.0017	.0012	.001
Agricultural Laborers/Cultivators	.265	.430	.332
Literacy (percent of rural males who are literate)	25.80	27.13	26.34

Table 2: Elasticity Estimates: North Indian District Data Set 1959-1975.

Elasticity with Respect to	Elasticities of Output Supply: Wheat	Rice	Coarse Cereals	Other Crops	Elasticities of Input Demand: Fertilizer	Bullock Labor	Tractors	Labor
Wheat Price	.370**	-.207**	.224*	-.031	-.007	.016	.010	.001
Rice Price	-.128**	.392**	-.076	-.030	-.198*	.008	-.051	-.060**
Coarse Cereal Prices	.073*	-.040	.040	-.040*	-.155	-.005	.112	.093**
Other Crops Price	-.058	-.090	-.227*	.176**	.348**	.006	-.016	.011
Fertilizer Price	.001	.042*	.062	-.024**	.195*	-.038**	.160	.122**
Bullock Price,	-.025	-.019	.025	.005	-.440**	-.010	-.010	.048**
Tractor Price	.001	.003	-.011	.001	.038	-.001	-.084	-.155**
Labor Price	-.232**	-.079	-.038	-.046	.217**	.023**	-.103	-.061**
Electrification	-.025	.011	.057*	.084**	.245**	.006**	.034	-.026**
Roads	-.110	-.465**	.373**	-.362**	-.325**	-.086**	.291*	.029
Rainfall	.161**	.407**	-.173*	.019	.456	.012*	.208*	.055**
Irrigation Int.	1.123**	.271*	.919**	.276**	1.203**	.056**	1.851**	.117**
Net Cropped Area	-.139	1.485**	1.048**	.609**	.289	-.022	-1.266**	.042
Farm Size	.224*	.379**	-.027	-.210**	-.744**	.060**	.693**	-.285**
HYV's	.278**	.109**	-.074**	-.128**	.259**	.012*	-.122**	.030*
Indian Research	.023	-.085**	-.102**	.176**	.249**	-.002	.537**	-.084**

*Asympotic "t" < 2.0 >> 1.5
**Asympotic "t" > 2.0

but quite clearly favors wheat and coarse cereals and fertilizer and tractor use. As net cropped area in the typical district expands, holding farm size constant, it becomes biased in favor of rice and coarse cereals and against wheat. It increases the demand for fertilizer but decreases the demand for tractors. An increase in average farm size, holding total net cropped area constant, on the other hand, is biased against labor and employment. Conversely, a decrease in farm size would reduce the demand for fertilizer and tractors and increase the demand for labor.

Much has been written about the 'Green Revolution' and general technical advances in India. The general presumption of much of the literature is that the introduction of high yielding varieties did not have biases on the input side, though it was clearly biased in favor of wheat and rice on the output side. The *HYV* variable clearly confirms the bias in favor of wheat and rice. It also shows that when high yielding wheat and rice varieties are made available, the supply of coarse cereals and other crops is reduced. The results also show a bias in favor of fertilizer on the input side.

The Indian agricultural research system, on the other hand, has a strong bias in favor of other crops. It also appears to have quite strong biases on the input side. It produces technology that is fertilizer- and tractor-using and labor-saving.

This line of analysis has relevance to rural development planning and programming in that it enables a more consistent way of evaluating the actual impact of rural development type programs on the demand for farm inputs. Many policy-makers are concerned with programs to increase employment in the agricultural sector. It is often presumed, for example, that irrigation investment will increase the demand for labor. There is no *a priori* basis for knowing if this is the case. Studies such as this one allow the measurement of this effect. In North India, it appears that investment in irrigation has a small impact on the demand for labor. It has a huge impact on the demand for tractors and fertilizers.

Studies of this type can be helpful in identifying the response of farmers to rural development projects. They are suited for example to measuring the effects of credit programs, supply restrictions, input subsidies, etc. In a later section (4), the issue of the macro or market effects of farmer behavior, will be taken up.

2. Economics of the Family and Household

The household (usually the family) is now recognized as an important economic unit engaged in both consumption and production activities in the economic literature. Twenty years ago, households and families were seen by economists simply as consumers. The production of goods and services was seen as taking place on farms, or in shops, factories and service centers (banks, etc.).

Margaret Reid and others, particularly in other social service disciplines, recognized many years ago that households also produced goods and services that were not really different from those produced by farms and firms. Food preservation and preparation, household maintenance, health and child care activities are undertaken by both households and organized firms in most countries. T.W. Schultz, Gary Becker and others developed formal analyses of these activities for households and encouraged a body of studies popularized for a time as the "New Home Economics".

In addition to providing a more formal treatment of production activities in the household, this literature also enabled a broader definition of relevant goods. In particular, it provided a clearer way to analyze the production and consumption of goods that are never (or seldom) marketed and for which no prices can be (or should be) observed. Children and child health and child schooling represent goods of this type. They are clearly "valued" by parents but are not marketed or priced. Modern household analysis allows one to state in a rigorous way, however, how the production and consumption of these goods will be affected by income, wealth, the prices of marketed goods and labor time.

The chief relevance of this for rural development projects and programming is that the chief objectives of rural development projects are usually or often stated in terms of these non-marketed goods. Modern household economics allows one to formulate an association between child health, schooling, leisure, etc. and rural development variables in empirical work. To date, the major application of modern household economic analysis has been in the analysis of fertility (or contraceptive) behavior. A large literature now exists dealing with determinants of family size. A related literature addresses the question of investment in health and schooling in the context of the household model. In addition, a number of studies of time allocations have been made.[3/]

Appendix 2 sketches some of the more technical aspects of the household model. The model treats the household as both a utility maximizing unit and a producing or cost-minimizing unit. In the production of household goods such as child health, prepared food, etc., it attempts to produce at a minimum cost. It then chooses the mix of household goods according to their marginal costs or "shadow" prices rather than market prices. It is of course constrained by household technology, home management skills, the time of family members, market goods prices, wages and non-labor income. This process allows the derivation of household demand equations for household produced goods.

These demand equations relate endogenous choice variables (i.e., the household produced goods) to a set of exogenous variables measuring conditions beyond the control of the household in the short run. These exogenous variables include prices, wages, household capital, land, skills, home technology and community services. Many of these variables are in fact rural development policy instruments in one form or another.

One of the contributions of this type of modelling is that it shows that households, no matter how poor, still make choices and that a given program variable is likely to cause a response by the household in all or most of the things over which it has some control. For example, a food aid or food supplement program targeted to children is likely to change the food consumption of other family members and even of time allocation and the consumption of non-food goods. Similarly, the availability of schools for children will not only evoke a response in school attendance but in child work and other factors as well. A rise in the wages that women can earn in the market will induce changes in fertility, breast feeding, and child health as well as in the mother's time allocation

A further contribution of the household model is that it illustrates that causality cannot be inferred between one endogenous variable (say child health) and another (time spent in breast feeding). Even when the production relationship is known (i.e., that reduced breast feeding has adverse health consequences), one cannot conclude that a program impact that produces a change in one variable will have the impact predicted by the production relationship because it may have other impacts as well.

For example, a rise in wages and work opportunities for women will reduce breast feeding. Even if reduced breast feeding itself has adverse child health consequences, it cannot be concluded that the rise in wages will have adverse child health consequences. This is because it has income effects and fertility and related effects.

There are many studies that have utilized the household framework. Table 3 illustrates its use in a study of fertility and child health in Panama. Data from the 1976 World Fertility Survey (WFS), the 1973-76 Contraceptive Use Survey in Panama and the 1980 National Nutrition Survey were used in the study. The endogenous variables analyzed are numbers of pregnancies, months last child was breast fed, contraceptive use and indexes of acute and chronic malnutrition of children.

The point discussed above can now be illustrated. Completion of schooling (primary, secondary, and university) by women clearly produces a reduction in the number of pregnancies, and an increase in contraceptive use. (The schooling variables are dummy variables with the left-out class having less than primary schooling. Thus, in the 1976 WFS, mothers with primary schooling had an average of .403 fewer children than mothers who did not complete primary school.) Schooling also clearly impacts negatively on breast feeding periods. Even though this has adverse health consequences per se (as estimated in the study), the data show that schooling of mothers significantly reduces the probabilities of both acute and chronic malnutrition.

Although Table 3 will not be discussed in detail here,[4/] one can say that this serves to illustrate the point just discussed. It also shows that work experience prior to marriage impacts negatively on fertility. An effort was also made in the study to measure the impact of different levels of social security coverage and provision of government health services on fertility and child health. The evidence indicates that the provision of health services lowers fertility but may have little impact on child health. Social security services also lower fertility and reduce the incidence of malnutrition but not for the poor. This is because they are not covered by the system.

This type of analysis can provide insights into the consistency issue. It can show that health and social security programs have an impact and the form it takes. However, it cannot provide insights on the effectiveness of management and design of these systems except in an indirect fashion.

Table 3: Econometric Estimates of the Household Model for Panama (*1.5>"t"<2. xx"t">2,0)

Dependent / Exogenous Variables	Number of Pregnancies 76WFS	Number of Pregnancies 73-6CUS	Number of Pregnancies 80NNS	Months Breast Fed 76WFS	Induced Abortions 76WFS	Induced Abortions 73-6CUS	Contraception Use 76WFS: Sterilization	Contraception Use 76WFS: Pills IUD	Contraception Use 76WFS: Last Closed Interval	Contraception Use 76WFS: Last Open Interval	Malnutrition 80NNS: Acute	Malnutrition 80NNS: Chronic
1. Parental Schooling												
Mother's Comp. Primary	-.403**	-.784**	-.769**	-.782**	.012	-.076**	.153	.447**	.370**	.258*	.313	-.702**
Mother's Comp. Secondary	-.808**	-1.213**	-1.239**	-1.262**	.080*	-.078**	.246	.888**	.792**	.662**	-.543*	-1.269**
Mother's Comp. University	-.919**	-1.787**	-1.616**	-1.500**	.082**	-.026	.137	.866**	1.092**	1.013**	-.347	-2.543**
Father's YRS Schooling	-.070**			-.087**	.0058**		.038	.034*	.012	.035*		
Father's YRS X Mother's YRS	.000			-.000	-.00058**		-.005**	.001	-.000	.001		
Mother's Comp. Prim. X POOR	-.417**		.170	-.076	-.011		.162	.199	.247	.178	-.827*	.271
2. Mother's Prior Work Exp.												
Professional	-1.252**			-1.325**	.017		.110	.127	-.018	-.283		
Skilled	-.839**			-.903**	.007		-.285*	.418**	.256*	-.051		
Sales Related	-.545**			-.739**	-.004		.056	.447**	.344**	.072		
Unskilled Work	-.239**			-.267*	.005		.046	.166*	.117	.069		
3. Income & Wages												
Income Class Poor	.177	.679**	1.492**	.242	-.005	.018	-.115	.174	-.471**	-.247*	.714	.537*
Income Class Medium		.413**	1.095**			.03					.415*	.167
Income Class High		.062	.259			.05					.300	-.394*
Mother's Wage			-.010								.006	-.013
Father's Wage			-.036**								-.012	-.016
Child Wage			.039**								-.001	.025*
4. Location												
Metropolitan Rural	1.308**			.167	-.082*		.264	.037	.049	.183		
POOR X Rural	.213			.232	.023**		.513**	-.203	.247	-.136		
Other Rural	1.087**			.218	-.041		.140	-.347	.313	.271		
Other Urban	.847**		.003	.799	-.077*		-.063	-.374	-.336	.181	.015*	-.001
Moved Rural-Urban	.433*			.217	-.015		-.69	.029	-.193	.212		
Town-Urban	.338			.311	.019		.009	.215	.094	.013		
5. Public Services												
Health Services			-.0069*								-.001	.000
Social Security			-.0079**								-.016**	-.009**
Health X POOR			-.0051								.001	-.007
Social Security X POOR			.0110**								.001	.014**

Studies of time allocation and home production in rural Philippine households measured ordinary income, the value of home production and full income.[5/] Full income-- the sum of ordinary income and the value of home production-- was roughly double ordinary income. The relative contribution of women and children differed greatly according to whether it is measured as ordinary income or full income. These measurement conventions affect the perception of the contribution of women to development. Home production, home management and home technology are not high priority areas of concern for policymakers even though home production in most of the rural parts of the developing world is at least as important as farm production. Were full income to be accepted as a more meaningful measure of real income, this situation would probably change.

It may be further noted that full income is more evenly distributed than is ordinary income and that the ratio of full income to ordinary income is highest in the poorest economies. As development takes place, many home production activities become industrialized. As a consequence, the ratio of full income falls from over 2 in the poorer economies to 1.3 or so in the high income countries. As a result, income growth is overstated when ordinary rather than real full income is measured.[6/]

3. Rural Markets and Institutions

Many rural development projects are designed to provide services not currently available to rural households. Credit, insurance and input markets may function poorly. Incomplete markets and high "transactions cost" environments have been the focus of a number of studies by economists in recent years.[7/] Studies dealing with contractual choice in the presence of incomplete markets have shown that such markets are "interlinked". For example, Braverman and Srinivasan (1984) show that when tenant farmers do not have sources of credit and employment other than through interlinked transactions with a landlord, a ceiling on land rents may be ineffective. Landlords will simply make up for reduced land rents by paying lower wages and charging more for credit. If the tenant can be provided with institutional credit, the landlord will not be able to charge higher interest rates and the link will be broken.

A new literature on the agricultural household has emerged in recent years as well.[8/] It focuses on the link between production and consumption. In the previous section, the household model included a farm production function. With low transaction cost environments, farmers will operate their farm enterprise independently of their consumption decisions. If they are price takers in all markets, one simply puts net profits in their full income constraint (see Appendix 2). Thus, farm income will affect consumption but not the reverse. When markets have high transaction costs, this "recursiveness" is lost. Farm production will be affected by consumption decisions and this can produce different outcomes than would occur in the presence of perfect markets.

Labor markets, in particular, tend to have high transaction costs.[9/] In some rural areas, formal labor markets do not exist (Chayanov analyzed this situation). In others, there are very high costs of searching for work, searching for workers and supervising their work. These high transaction cost environments can markedly change rural development program impacts. They constitute an important feature of economic development. In the poorest economies with poor communication and transport means, and limited development of financial institutions, much production is carried out in family enterprises. The family itself provides the means for controlling "shirking" on the job by workers and related costs. As transport, communication and other infrastructure investments are made, firms move away from a family labor system and specialize. A large part of the productivity gains realized in many countries is attributed to these gains from specialization.

High transaction cost environments affect family behavior as well. Recent work based on Philippine data show that the fertility of households with little land is lower relative to the fertility of households with larger farms.[10] This is so because for households where family members work off the farm, high transaction costs reduce the economic contribution that an added family member makes to the household. By contrast, for households with sufficient land where they hire labor on the farm, the economic contribution of an added family member is increased by high transaction costs. This is because the family member displaces hired labor and the supervision and other cost accounts involved with the hired worker.

A second line of work dealing with institutional change is now emerging. This research is concerned with the forces that shape institutions such as irrigation systems and other public and private investments. Recall that in Section 1 of this paper (Tables 1 and 2), a set of structure variables were included in the farm production analysis.

These variables fall into two broad classes, neither of which is determined by simple profit maximization. The first class includes variables determined as the outcome of a political process. Public sector investment in research (and extension), roads, electrification and credit programs are in this class. The second class includes variables that are the consequences of long-run market processes based on farmer's investment decisions.

Population density, along with other fundamental characteristics of the economy, influences (through political process) the investment in the first class of variables. Population density also directly influences the long run market process variables. Since public sector stocks of the first class of variables (i.e., cumulated past investment in public sector activities) can affect long run market processes, population pressure also has an indirect effect on the second class of variables.

Table 4 reports elasticities of structure determinants for both classes of variables for North India. (These estimates will be further utilized in Section 5 of this paper.) The first panel shows determinants of public sector investments. All determinant variables are defined as "lagged" variables (i.e., they are measured for the average of the 5 years preceding the year for which investment is measured) which also allows a recursive model interpretation.

Population density (defined as rural population per one thousand has. of arable land) is of particular interest. It appears to have a negative impact on research investment, rural electrification and credit provision. Higher consumption gini ratios are related to higher spending on research. Urbanization (at the district level) has very small effects. The level of literacy, however, has large positive effects on research, extension and credit spending. Imported HYVs appear to reduce local research spending while the "borrowable" stock of research investments in other states in similar geo-climate regions appears to stimulate research and extension spending. Finally, as total net cropped area in the district is expanded, research spending expands less than proportionately.

The second panel of Table 4 provides elasticity estimates for determinants of three long-run investments and market process variables, farm size, irrigation intensity and net cropped area. As with the first panel, all determinant (or dependent) variables are lagged.

Table 4. Determinants of Structure: Indian Agriculture

I. Determinants of Public Sector Investments (Class I)

Determinants	Research Expenditures	Extension Expenditures	Changes in Roads	Changes in Electrification	Provision o Agri. Cred
Population Density	-1.465**	.10	.02	-.03**	-.08**
Consumption Gini	1.29*	-.59	.09	-.06	.06
Urbanization Ratio	-.02	-.19*	.07	.02**	.06
Literacy Level	1.95**	2.05**	.01	.12	.21**
HYV's	-.20**	-.01	-.01	-.02	.04**
Borrowable Research	.83**	.52**	.02*	.04	.01
Net Cropped Area	.71**	1.17**	-.28**	-.01	-.01*
Change in Net Cropped Area	.02	.00	.00	.03	.04**
R^2	.583	.719	.182	.044	.768
F	3.07*	56.4	4.9	1.9	73.2

Table 4 (continued)

II. Determinants of Long-Run Market Processes (Class II)

	Farm Size	Irrigation Intensity	Net Cropped Area
Population Density	-.24*	.61**	.67**
Consumption Gini	1.25**		1.66*
Literacy Level	.87**		5.00**
High Yielding Varieties	-.10**	-.24**	.11**
Research Intensity	.47**	.32**	.11**
Extension Intensity	-.21**	.32**	
Roads	.08	2.51**	
Rural Electrification	.01	.69**	
Credit Provision	-.71	-.01	
1^2	.671	.562	.550
F	82.7	51.1	45.23

Notes: *Asymptotic "T" > 1.5 and < 2.0
**Asymptotic "T" > 2.0
All values are elasticities computed at sample means

Population density, as shown in the second panel, affects farm size negatively and has strong positive effects on irrigation intensity and on net cropped area. Farm size is positively affected by consumption inequality, literacy and research intensity but negatively affected by HYVs, extension and credit.

Since each structure equation contains a population density variable, its elasticity is the total effect of population density. Other variables, such as net cropped area in the research investment equation may have a population induced component as shown in panel two, but this is controlled for so that the coefficients for these variables are picking up effects not associated with the other independent variables.

The population density effects measured in Table 4 can now be "traced" through Table 2 in Section 1 to obtain population induced shifts in output supply and variable factor demand.

Table 5. Population Induced Shifts in Output Supply and Factor Demand

Output Supply		Factor Demand	
Wheat Supply	.531	Fertilizer Demand	1.033
Rice Supply	1.080	Bullock Labor Demand	.004
Coarse Cereal Supply	1.300	Tractor Demand	- .008
Other Crop Supply	.575	Labor Demand	.189
Total Crop Supply	.670	Variable Factor Demand	.174

Table 5 reports these population induced structure effects in terms of elasticities. It is clear that population-induced effects are important. An increase in population density induces changes in structure that have quite large output effects. A 10 percent expansion in population density induces structural changes that produce a 6.7 percent increase in output. The same changes induce a 1.74 percent change in variable input use. Of course, the changes in structure are not costless. Irrigation, expansion of area cultivated, and research and other public investment require real resources.

This line of research is relevant to rural development programming because it indicates that governments of developing countries have a highly structured choice of mechanism for determining which programs they will pursue. Consequently, aid to support a new type of rural development effort may result in displacement of existing programs rather than in a net increment to activities. In fact, aid may accomplish little of its objectives if it is not administered in such a way as to not cause substantial displacement. This issue will be considered in the next section regarding investment in research and extension. The estimates in Table 4 will also be utilized in the fifth section of the paper to illustrate developments in policy modelling.

4. Research, Extension, Rural Development Projects and Productivity Change

Agricultural production grows when: (a) more factors of production, land, irrigation water, labor, fertilizer, etc. are used; and (b) output per unit of aggregate factor productivity increases. If land is relatively abundant, production growth through factor expansion may be relatively low-cost. However, as countries exhaust their stocks of cultivable land, they must turn to more costly forms of growth, particularly to irrigation investment. There is now a large economic literature that concludes that productivity enhancing activities constitute a low-cost source of growth. Investment in research has been shown to have a high pay-off.[11] The evidence for extension is mixed with some studies showing high returns and others not. There is, however, very little evidence that rural development projects such as the Integrated Rural Development Program have very much of a pay-off in terms of productivity.

Table 6 summarizes research and extension investment by subregion and country group for 1959, 1970 and 1980. The measure used is research intensity, i.e., the ratio of expenditures to the value of agricultural product at the farm level.

The table shows that research intensities vary from close to one percent in North America/Oceania to the .10 - .15 percent range in Southeast Asia and Central America in 1959 (also refer to Table 2). The higher spending in Africa reflect much higher costs or prices of researchers. By 1980, this pattern had been altered substantially. Japan and Oceania are spending more than 2 percent of agricultural product on research. Northern and Central Europe are not spending more than 1.5 percent. The Asian region, excluding East Asia, had by 1980 moved close to the ½ percent of product level.

Table 6: Research & Extension Expenditures as a Percent of the Value of Agricultural Product

	Public Sector Agricultural Research Expenditures			Public Sector Agricultural Extension Expenditures		
Subregion	1959	1970	1980	1959	1970	1980
Northern Europe	.55	1.05	1.60	.65	.65	.64
Central Europe	.39	1.20	1.54	.29	.43	.45
Southern Europe	.24	.61	.74	.12	.15	.28
Eastern Europe	.50	.81	.78	.32	.36	.40
USSR	.65	.73	.70	.28	.32	.35
Oceania	.99	2.24	2.83	.42	.76	.98
North America	.84	1.27	1.09	.42	.53	.56
Temperate South America	.30	.46	.70	.07	.50	.43
Tropical South America	.22	.47	.58	.34	.71	1.19
Caribbean & Central America	.15	.22	.65	.09	.18	.33
North Africa	.36	.62	.59	1.27	2.21	1.71
West Africa	.37	.61	1.19	.58	1.24	1.28
East Africa	.19	.53	.83	.67	.88	1.16
South Africa	1.13	1.10	1.23	1.64	.67	.46
West Asia	.28	.37	.47	.25	.37	.31
South Asia	.12	.19	.43	.20	.23	.20
Southeast Asia	.18	.28	.52	.24	.37	.36
East Asia	.69	2.01	2.44	.19	.67	.85
China	.09	.68	.56	n.a.	n.a.	n.a.
Country Group*						
Low-Income Developing	.15	.27	.50	.30	.43	.44
Middle-Income Developing	.29	.57	.81	.60	1.01	.92
Semi-Industrialized	.29	.54	.73	.29	.51	.59
Industrialized	.68	1.37	1.50	.38	.57	.62
Planned	.33	.73	.66	-	-	-
Planned - excluding China	.45	.75	.73	.29	.33	.36

Source: Evenson, Judd and Boyce, 1983.

The data by country group show this pattern more clearly. The industrialized countries have roughly doubled research intensities to 1.5 percent in 1980. The low income developing countries have increased their research intensity by 3.3 times but are still roughly 1/3 the industrialized level. Middle income and semi-industrialized countries have research intensities roughly double those of the low income countries in 1959 and roughly half those of the industrialized countries in 1980.

Extension investment, on the other hand, shows a very different pattern. In 1959, the low income countries were spending twice as much on extension as on research. This is in sharp contrast to the spending by industrialized countries. By 1980, spending and extension and research were rougnly equal in developing countries as a whole. (There are no detailed rural development expenditure data for projects other than research and extension.) International agencies have, however, been supportive of such projects at quite high levels in many countries for a number of years. Since the mid-1970s, the World Bank has provided extensive lending for such projects. Some rather provisional calculations based on World Bank and USAID data indicate that broadly defined, rural development spending other than on research and extension is probably more than 2 percent of agricultural GDP for many countries.

A recent study of investment patterns for research and extension shows that developing countries in general have responded to economic forces in determining investment in research and extension. Commodity-oriented research investment by national governments responded to production of the commodity, though less than proportionately. More spending on research is undertaken on commodities that are traded in international markets. Countries respond to the relative costs of undertaking research and extension work. One of the reasons for relatively high levels of spending on extension relative to research in developing countries is that research scientists are scarce and require costly training in developing countries. They are thus expensive relative to extension workers. This is also a factor considered when high emphasis is given to rural development facilitators and staffing in rural development projects. Most developing countries have large numbers of potential field staff who can be given training at low cost. Hence, many rural development programs are highly intensive in low level field staff.

The study also found that national research programs spend more, the more the International Agricultural Research Center (IARC) spends on the commodity. They respond positively to the opportunities for adoptive research created by the research of the IARC.

The productivity of both IARC and national research investment was demonstrated in the India study. Table 2 reported estimates of the impact of several structure variables including HYVs and Indian research investment. Table 7 provides calculations of the impact of these variables on output, inputs and productivity.

Table 7. Output and Productivity Effects

	Output	Variable Input	Variable Factor Productivity
Electrification	.03357	- .00859	.02450
Irrigation Intensity	.58752	.23477	.35275
Net Cropped Area	.61071	- .04438	.65509
Farm Size	.26243	- .16189	.22232
HYVs	.04796	.02265	.02531
Indian Research	.04929	- .02037	.06966

Source: Computed from Tables 2 and 4.

It would appear that rural electrification has a modest effect on productivity. Irrigation intensity has a substantial effect. An expanded net cropped area, holding irrigation intensity constant, has an effect approximately the same as the irrigation intensity effect. This implies that an expansion of irrigated land has an effect on production approximately twice that of an expansion of unirrigated land.

This analysis implies very large returns to investment in Indian research. In the absence of an extension variable in this analysis, it is probably reasonable to suppose that the research variable is getting both a research and an extension effect. Spending on research and extension combined represented approximately .70 percent of the value of agricultural product in the late 1970s. A 10 percent increase of this spending (.07 percent of output) is estimated to produce a 0.7 percent increment to net output. This can be converted to a rate of return by noting that an expenditure of .07 percent of output generates a stream of net output amounting to 0.7 percent of output after seven years. This implies an internal rate of return to this investment of 72 percent.

In spite of the large number of studies showing the scope for productivity gains in regions (where new technology suited to the region's geo-climate and economic and social conditions is very low), one still observes many rural development projects based on the idea that the "technology is available" but is not being utilized because of socio-economic factors. Almost all such projects fail to stimulate significant productivity growth and, to the extent that they do it, the growth is very short-run. Such projects usually quickly exhaust the potential for productivity growth.[12/]

In the long run, there simply is no substitute for the development of new technology suited to the local environment in producing productivity and real income growth. If a region does not pursue a technology policy, it is not going to realize broad real income growth. Actually, many recent rural development projects that have been evaluated show that they have had a net loss of productivity gains. Interventions in markets to move prices away from equilibrating efficiency prices cause productivity losses. Subsidies, for example, to rural credit markets unless they are correcting for pre-existing market failures, lead to inefficient use of capital and productivity losses. Yet these programs are generally believed to be instigators of productivity increases. There is virtually no evidence to support this belief. Even when new technology is biased in favor of fertilizer and mechanization, there is little reason to subsidize credit.

It is almost universally the case that in economies where some government intervention would improve efficiency, the practice is to intervene too far. There is a case for public sector irrigation projects. Yet, the world over, where such projects are developed, water rates to farmers are far below efficiency rates. Similarly, where rural credit programs are established, interest rates are invariably below efficiency rates. This is an example of contamination of development objectives and income distribution objectives.

For many of the poorest economies in the world, there is generally little policy intervention in favor of farmers and rural credit and irrigation. Related projects do not have large social costs in terms of inefficient allocation of resources. In middle income countries, this situation is quite different. The emergence of a broad range of agricultural policy interventions that have huge efficiency losses has been evident. Many rural development projects in these economies can actually increase these losses.

5. Rural Development Projects, Technology Population Growth and Real Income Distribution

Real income distributive effects are important outcomes on impacts of rural development projects. Many analyses of income distribution effects of programs do not consider price effects, i.e., they do not take into account changes in prices induced by the policy. Economists are developing improved tools for such analysis. The India study discussed in the previous section can again be used to illustrate these tools and to draw some conclusions regarding policies designed to reduce population growth, and to invest in technology development, in land expansion and in irrigation.

The analysis of the preceding sections identified only the producer core responses, i.e., the output supply and factor demand responses of profit maximizing farmers (Table 2). In order to analyze the full effects of population, one must model the complete markets. In order to complete the other side of the product markets, a demand for product structure is required. Similarly, in order to complete the missing side of the factor markets, factor supply relationships are required. When these markets are completely modeled, prices themselves can be treated as endogenous to the model, i.e., determined in the markets. With a specification of the complete markets, it is possible to calculate the effect of a resource base change (say, an increase in irrigation) not only on the product supply and factor demand functions but on the equilibrium prices and quantities in each market.

The demand side of the product markets in India has been estimated by Quizon, Binswanger and Swami, (1982). Using methods similar to those used in estimating the producer core, a system of demand equations was used to estimate demand relationships. The number of consumers, i.e., population, as well as incomes and prices determined aggregate demand in the products markets. A reduction in population shifts all demand curves to the left. This will then result in a decline in prices if no other shifters, including structure components, change. When population changes, the supply of labor to the labor market will also change. Population is thus a shifter variable in the labor market as well.

The specification of the labor market is based on a study by Dhar (1980) and takes into account not only the effects of population change but of migration between regions and sectors as well. Thus, when rural wages decline relative to urban wages, workers will migrate from rural to urban jobs. (Dhar estimated these migration responses in his study). The urban-based demand for labor thus becomes a shifter in the rural labor market. A reduction in population growth among urban families can thus have an effect on rural families through rural-urban migration.

The supply side of the animal power market is closely related to the supply of feed and is specified as a value weighted aggregate of the crop supply estimates of Evenson, (1982). Fertilizer and tractor supply elasticities are set at 4.0, reflecting international trade opportunities.

The completion of the specifications of the eight markets allows one to calculate the effects of a large number of shifters on equilibrium prices and quantities in each market. Rural incomes are determined by payment to labor and other owned factors such as bullocks, less payments to purchased chemical and power factors, plus a residual rent to fixed resources (in this case, land). Consequently, changes in rural incomes can be inferred from changes in prices and quantities in the seven markets depicted. Furthermore, by adjusting for price changes, a price deflator can be constructed to convert nominal income changes to real income changes.

Quizon and Binswanger (1982) have grouped the Indian population into five groups:

a) landless and near landless rural households with less than one acre of operated land,

b) small farmers with one to five acres of operated land,

c) medium farmers with five to 15 acres of operated land,

d) large farmers with more than 15 acres of operated land, and

e) urban households.

For each group, consumption weights and income weights were determined. Consumption weights showing the shares of the four agricultural products (and non-agricultural products in the typical consumption basket) were computed. Income weights based on the shares of income from agricultural labor, animal power, land rent and non-agricultural labor in each group's income were also computed.

With this information, it is possible to translate changes in equilibrium quantities in the eight markets (plus residual land rents) into changes in nominal and real income per capita for each of the five groups.[13]

Table 8 reports the effects of a simulated ten percent decrease in population growth on the endogenous variables of the system including real income effects for the five population groups. The induced-structure or "Boserupian" effects are calculated separately. In addition, the effects of a 10 percent increase in the "technology base" (i.e., a 10 percent increase in the expenditures on research and extension and HYV in production) in irrigation intensity, and in areas under cultivation are shown for comparative purposes.

The simulation should be interpreted as short-run consequences of population change, technology, irrigation and land investment. The basic elasticities in the model are estimated with methods that do not attempt to distinguish between short-run and long-run effects. Given their nature, it seems reasonable to interpret them as short-run elasticities.

This study contains calculations of five sets of population effects. The first is termed a "Malthusian" calculation. In this simulation, it is supposed that over an extended period, policies that reduce population and labor force growth are put in place such that at the end of the period, both the size of the population and the labor force would be 10 percent lower than

Table 8: Simulated Economic Effects of Population Growth Decline, Technology Investment, Land Investment and Irrigation Investment In North India

Effect on:	10% Decline in Population					10% Increase In		
Real Per Capita Income	Malthusian	Boserupian	Total	Rural Landless Only	Urban Only	Technology Base	Land Base	Irrigation Base
a) All Groups	7.77	-2.80	4.97	2.18	.83	.26	2.60	1.78
b) Rural Landless Households	14.72	-8.36	6.36	7.68	1.69	1.12	6.64	6.58
c) Small Farm Households	11.82	-.59	11.29	3.31	-.15	1.10	-.11	-.30
d) Medium Farm Households	6.78	.39	7.17	.73	-1.11	-1.35	-3.19	-4.18
e) Larger Farm Households	.69	1.44	2.13	-1.93	-13.45	-3.54	-11.26	-13.52
f) Urban Households	7.06	-1.47	5.59	1.06	10.24	3.36	13.01	12.52
Agricultural Employment	-4.80	-2.95	-7.75	-1.95	-2.29	-.44	-.30	-.07
Real Agricultural Wages	12.94	.38	13.32	7.33	-.66	.22	-1.86	-.10
Real Land Rent	-25.18	40.26	15.08	-5.42	-7.40	-10.20	-31.45	-38.15

they would be in the absence of the policies. The simulation thus takes into account the reduction in demand for products and in the supply of labor.

This first calculation is of considerable interest because it shows that the effects of these policies are large and <u>progressive</u> in terms of distribution. Real incomes of the population at large rise by 7.77 percent. For the poorest group, landless laborers, real incomes rise by 14.72 percent, while for the relatively high-income and large farmers, real incomes do not rise appreciably. The 10 percent reduction in labor supply produces a 4.8 percent reduction in agricultural employment and a 12.84 percent rise in real wages. Real land rents (calculated as a residual in this model) actually fall by 25.18 percent. It is this rise in real wage and decline in returns to land holdings that produce most of the progressiveness in the real income consequences.

The second column is the simulated Soserupian effects associated with the decline in population. Because population density is lower, population density induced effects (Tables 4 and 5) are lost. These Boserupian effects are also important. When they are considered, the gain in real income for the population as a whole falls by 2.8 percent so that the net gains are 4.97 percent.

The Boserupian effects are themselves pro[illegible] nature, i.e., an increase in population [illegible] investments that favor the poor. Their [illegible] regressive. In these calculations, their [illegible] the 14.72 percent gain by the landless by [illegible] leaving a net gain of 6.36 percent. Afte[illegible] for Boserup effects, however, a decline [illegible] is observed to have important and progre[illegible] The rural landless and small farmers gai[illegible]

This study also simulated two rathe[illegible] population growth effects in columns [illegible] same table. Here, the population of a p[illegible] is simply reduced by 10 percent (there a[illegible] effects). One way to visualize this sim[illegible] interpret it as a reduction in the popul[illegible] [illegible]s due to a labor recruitment program [illegible] [illegible]le Eastern countries. Column 4 show[illegible] recruitment is directed only to the land[illegible] worker group, it has a large and progres[illegible] real incomes. The landless agricultural gains more from this specialized effect [illegible] more general population reduction. (Actu[illegible] workers were recruited while families are real wages would rise even more.)

For comparative purposes, the effects of investments in technology, land expansion and irrigation investment are likewise calculated in this paper. In these simulations, Boserupian effects are not being measured. These can be looked upon as policy options available as alternatives to population policy. Each option has very different costs and these costs are not considered in the simulation. For example, a ten percent increase in the technology case (the HYV Research stock) is much less costly than a ten percent expansion in the land or irrigation stock (in fact, only about 1/40 as costly).

Interestingly, all three forms of investment have similar effects. They lower food prices, raise real wages and reduce land rents (note that these land rents do not include rents to new land or irrigation. Public ownership of these rents is presumed). Urban consumers benefit most from these programs and large farmers lose most (provided they do not collect newly created rents from the investment).

6. Concluding Comments

Economic studies relevant to rural development have achieved some advances in the way rural households, farms and markets are visualized. The studies and methods reviewed here are generally not evaluation studies. Most are motivated by an interest in understanding economic behavior, although a number of studies have been motivated by an interest in specific program impact. This author did not attempt at a more direct review of the growing number of evaluation studies *per se*. Such evaluation studies have generally utilized the methodological framework discussed in this paper. Their conclusions are broadly consistent with those referred to here as regards economic effects. They have, however, identified a number of issues regarding project design and management as well as many broader social indicators.

As conclusion, the following generalizations are being made:

1) Many specific rural development projects with short-term objectives continue to be poorly designed. Short term objectives are given priority over long term objectives. Field staff are often poorly trained and ill-suited to the task at hand. Nonetheless, some slow improvements have been made. The nature of the response of households and farms to program effects is better understood today.

2) The overall structure of development programming has improved markedly. More attention is being given to the rural sector in most countries. Attention is being given to institutional development. Markets, roads are being improved.

3) The foundation for long-term economic growth has been laid in many, perhaps, most countries. Investments in schooling have been massive. These have short term and long term impacts. The fact that in many countries, near universal primary schooling has been achieved has important implications for the future. Investment in technology production has been impressive although not as widespread as investment in schooling. This investment will almost certainly change the character of rural economics in future years.

4) Much has been accomplished in rural development, even though the goals set in virtually all rural development projects have not been met. One needs only to look at the widespread decline in infant mortality rates and increase in life expectancy for evidence that progress has been made. Virtually every country in the world has made progress on this score and most have also experienced more general health improvements.

5) Progress has been made inspite of rapid population growth. Furthermore, much of the world has made progress in moving toward a reduction in population. All of Latin America, East and Southeast Asia and parts of South Asia (the progressive parts of India) have experienced significant declines in population growth. Most of Africa and parts of the Middle East and South Asia have not done so yet and these regions are the serious problem regions for the next decades.

6) Economic growth and development imposes adjustment costs. People migrate and change occupations, contracts change, prices change, and new consumer goods are encountered. The only way to avoid these costs entirely is to avoid development. Many economists tend to ignore these costs. Many other social scientists weigh them so heavily as to attempt to block growth producing activities. Neither side is right. Effective local political institutions are required to allow the people directly affected to have a voice in policies to achieve development with acceptable adjustment costs.

7) Economists have not been as "close" to rural development as have other disciplines, particularly sociology. Sociologists have been more adept at program and project design and at data collection. The contribution of economists have largely been in terms of interpretation and measurement of certain economic relationships. The general conclusion is that economic studies have contributed to the consistency of rural development projects. There is, however, a significant scope for both sociologists and economists to learn from each other in the future.

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APPENDIX 1

PROFITS FUNCTION METHODOLOGY

Suppose farmers can produce three possible crops, C_1, C_2, and C_3, using three variable factors V_1, V_2, and V_3 on a given fixed amount of land L, and with given technical and infrastructural environments, T and I. One can characterize their production possibilities by a transformation function (1).

$$(1) \qquad (C_1, C_2, C_3, V_1, V_2, V_3, L, T, I) = 0$$

This function simply shows the <u>maximum</u> product of one crop (say C_1) for any level of production of other crops and use of variable factors.

Farmers then seek to maximize variable profits (2).

$$(2) \qquad TT = P_{C_1} C_1 + P_{C_2} C_2 + P_{C_3} C_3 - P_{V_1} V_1 - P_{V_2} V_2 - P_{V_3} V_3$$

where P_{C}, P_{C}, etc. are prices that they take as fixed.

They choose that combination of crops and variable factors (such as labor and fertilizer) that maximizes (2) subject to (1). This maximization activity leads to "optimal" levels of C_1, C_2 - C_3, V_1 V_2 and V_3 that can be expressed as functions of the prices farmers face and the fixed environments that they must work and live in. Thus maximized profits, TT^*, can be expressed as functions of process and fixed environments. (First order conditions for maximizing (2) subject to (1) can be substituted into (2) to yield (3).

$$(3) \qquad TT^* = TT^* (P_{C_1}, P_{C_2}, P_{C_3}, P_{V_1}, P_{V_2}, P_{V_3}, L, T, I)$$

Expression (3) is known as the "profits function" and it is said to be a "dual" solution to the transformation function (1). This function is important because we can derive from it a supply function for each crop and a demand function for each variable factor. This is done by applying the Shephard-Hotelling lemma which says that the partial derivative of (3) with respect to each output price produces the supply function for that output.

$$(4) \qquad \partial TT^*/\partial P_{C_1} = C_1 = C_1 (P_{C_1}, P_{C_2}, P_{C_3}, P_{V_1}, P_{V_2}, P_{V_3}, L, T, I)$$

$$\partial TT^*/\partial P_{C_2} = C_2 = C_2 (P_{C_1}, P_{C_2}, P_{C_3}, P_{V_1}, P_{V_2}, P_{V_3}, L, T, I)$$

$$\partial TT^*/\partial P_{C_3} = C_3 = C_3 (P_{C_1}, P_{C_2}, P_{C_3}, P_{V_1}, P_{V_2}, P_{V_3}, L, T, I)$$

/over

$$\partial TT^*/\partial P_{V_1} = V_1 = V_1\ (P_{C_1}, P_{C_2}, P_{C_3}, P_{V_1}, P_{V_2}, P_{V_3}, L, T, I)$$

$$\partial TT^*/\partial P_{V_2} = V_2 = V_2\ (P_{C_1}, P_{C_2}, P_{C_3}, P_{V_1}, P_{V_2}, P_{V_3}, L, T, I)$$

$$\partial TT^*/\partial P_{V_3} = V_3 = V_3\ (P_{C_1}, P_{C_2}, P_{C_3}, P_{V_1}, P_{V_2}, P_{V_3}, L, T, I)$$

In this way, a "system" of equations (six in this case) is derived. Each is a function of all prices and fixed environments. These in turn are all exogenous to the form, i.e., beyond the control of the farm. Taken together they jointly determine C_1 thru V_3.

Estimation of a system such as (V_1) with farm level data allows computation of many effects of interest. For example, one can compute the effect of an increase in a price (say P_{C_1}) not only on its own supply (C_1) but on the supply of C_2 and C_3 and on the demand for V_1, V_2 and V_3 as well. If the technology environment can be characterized, say by a research stocks measure, One can then calculate the effect of a change in research invesments on all six equations in (4).

APPENDIX 2

THE HOUSEHOLD MODEL

The structure of the modern household model parallels that discussed for farm production in the previous section.

One begins in this case with a household utility function defined over household goods

$$(5) \qquad U^n = U(Z, Z, \ldots, Z_n)$$

This function simply relates levels of utility as satisfaction to a set of goods. These goods need not be exchanged in markets, indeed it may be impossible to exchange them because they are personalized goods such as health and leisure. Accordingly they do not have prices. They do however have "shadow prices" or cost of production.

The household produces these goods (Z_i) using the time of household member, (T_{ji}) purchased goods, (X_i) and household capital (K). This production depends on home technology and home management skills (S_H) and community infrastructure (C_I).

$$(6) \qquad Z_i = Z_i(X_i, T_{ji}, K, S_H, T_H, C_I)$$

(This could be written as a tranformation function as in (1).)

If the household is a rural farming household, it will also be producing farm goods as depicted in equations (1) - (4) in the previous section. The household model postulates that it produces home goods, Z_i, in the same way that it produces farm products. For any level of production of either Z_i goods in the home or farm goods, C_i, it will attempt to produce at minimum cost. Having done this, it then knows the shadow price or cost of producing an added unit of child health, child services or other goods. These shadow prices then guide its choice of household goods Z_i.

The household must undertake this production and consumption activity subject to constraints. One constraint is the time constraint of its members.

$$(7) \qquad T_j = T_z + T_m + T_c + \ell$$

The fixed total time of any family member, T_j, is the sum of time spent on home production, T_z, working for wages, T_m, working on crop production T_c and leisure.

In addition, there is a monetary constraint

$$(8) \qquad \pi T_c + V + \sum_j T_{jm} W_j = \sum_i P_{xi} X_i$$

which says that money income from new wage sources V, net farm profits, TT_c, and wage income must equal spending or market purchased goods. Equation (8) is thus the standard definition of income (and GNP). However, by substituting (7) into (8), one can obtain an expanded definition of income generally called full income:

$$(9) \qquad TT_c + V + \sum T_{jm} W_j + \sum T_{jm} W_i \; = \; S P_i Z_i$$

Full income is thus defined as regular income (T) plus the time inputs into home production valued at wages reflecting the alternative uses of this time (these may be the market wages).

The household can then be viewed as choosing a consumption bundle of household goods subject to this full income constraint.

The relevance of this formulation for rural development projects is that rural development projects can be seen as changing skill levels in home production, adding to household and community capital and lowering the price of goods such as medical services (or in some cases providing more non-priced goods to households). One can derive explicit demand functions for the Z_i goods, for the X_i goods and for time allocations T_{ji} from the above model:

$$(10) \qquad Z_i = Z_i\,(P_i, K, W_j, W_j', S_H, \hat{T}_H, V, TT_c)$$

$$X_i = X_i\,(P_i, K, W_j, W_j', S_H, \hat{T}_H, V, TT_c)$$

$$T_{ij} = T_{ij}\,(P_i, K, W_j, W_j', S_H, \hat{T}_H, V, TT_c)$$

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FOOTNOTES

1/ See Johnston and Clark, 1982, for a review of rural development experience. Johnston and Clark, while not as severe as many other critics, nonetheless regard the field as a "mess" with little in the way of a solid scientific foundation.

2/ See Evenson, 1982.

3/ See an issue of the Philippine Economic Journal for early works on this topic in the Philippines.

4/ See Evenson, "Poverty, Fertility, Infant Mortality and Malnutrition in Panama", Economic Growth Center, October 26, 1984.

5/ See Evenson, Popkin and Quizon.

6/ See Schultz, 1984, for a discussion.

7/ See Roumassett, Braverman and Srinivason, Rosengwing and Binswanger.

8/ Strauss, Singh and Squire, 1984, provide a summary of this literature.

9/ See Evenson, Roumassett and Martin.

10/ Op cit.

11/ See V.W. Ruttan, Agricultural Research Policy, University of Minnesota Press, 1983.

12/ There are many reasons for this. Scientists would like to avoid responsibility for failure to produce technology and hence blame markets and stupid farmers for lack of adoption. Bureaucrats and politics have a short time horizon and do not wait for the long term investments in research. They also have mixed objectives for productivity which disables many programs that could otherwise achieve productivity gains.

13/ The model includes non-agricultural goods implicitly. Their price seems as a numerous price. The system is first solved for equilibrium prices and quantities. This equilibrium can be expressed in the rate of change (i.e., all equations with respect to time are differentiated) as a system of eight equations.

This equation system can be expressed as

$$GU^1 = K^*$$

where G in a matrix of elasticities, U^1 a vector of equilibrium rates of changes in exogenous variables (prices and quantities) and K^* a vector of shifter type variables. The effects of shifters on rates of change in endogenous variables can be solved as:

$$U^1 = G^{-1} K^*$$