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Agricultural Policies and Development: A Socioeconomic Investigation Applied To Sri Lanka

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This paper explores the interrelationship between agricultural policies and development by means of a dynamically recursive, computable general equilibrium model applied to Sri Lanka. The agricultural policies investigated include elimination of the food subsidy, land reform, and technical change in agriculture. The goals considered are the levels and growth rates of GNP and employment, the distribution of income, and the real income level of the lowest income group. The study provides a quantitative assessment of the association between policies and goals and identifies the key economic mechanisms in this association.

INTRODUCTION

It is frequently argued that, to generate more rapid and more equitable growth, the poorest countries, characterized by a large agricultural sector, should (a) promote yield-increasing technical change in agriculture, (b) invest more heavily in agricultural infrastructure, (c) redistribute land and associated assets from large farmers to small farmers, (d) remove consumer subsidies on staple foods, and (e) remove taxes on traditional agricultural exports. It is anticipated that these policies will, to varying degrees, raise rural incomes, increase employment, improve the balance of payments, and encourage industrial expansion and overall GNP growth. One is never sure, however, what the net effect of any one of these policies will be after economy-wide and intertemporal adjustments have taken place.

This study is an attempt to provide a quantitative assessment of the impact of these policies on multiple goals in an economy-wide model with intertemporal linkages. The country of application, Sri Lanka, is indeed a country to which these policies might be applied; and, as a relatively small and homogeneous country, it lends itself more easily to the aggregative characteristics of the analysis. It should be understood

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from the beginning that the purpose of the study is not to prescribe a set of agricultural policies for Sri Lanka. Indeed, the economy has recently undergone significant structural change, and results obtained on the basis of 1970 data would have to be carefully evaluated. Rather, the study should be viewed as a means of identifying and exploring the nature of the association of selected agricultural policies with specific goals relating to employment, GNP, the distribution of income, and the real income level of the lowest income group.

Section 2 presents a simplified version of the model, and Section 3 describes the application of the model to Sri Lanka. Section 4 presents the results of five agricultural policy experiments in terms of a set of policy objectives. Finally, Section 5 draws some general conclusions from the experiments.

A SUMMARY DESCRIPTION OF THE MODEL

The model used in this study belongs to the class of computable general equilibrium (CGE) models which feature decentralized optimization by consumers and producers. It is a full consistency model and as such permits direct comparison among alternative policy experiments. The static model presented below is composed of a system of nonlinear simultaneous equations that determines prices endogenously through a Walrasian-type tâtonnement process in both product and factor markets.[1] The time period covered by the static model is assumed to approximate a year. Between periods, the static model is updated through a series of dynamic linkage equations that are solved recursively. As with most planning models, the relations are generally specified in real terms. A brief statement of the salient characteristics of the model is given in the Appendix. For a presentation of the complete model see de Melo (1978).[2]

A simplified version of the static model is given in Table 1. The variables determined endogenously are shown following the identifica-

[1] The solution algorithm for the model was obtained from Sherman Robinson. For a good explanation of solution techniques for this type of model, see Adelman and Robinson (1978).

[2] For the reader not familiar with CGE models, the equilibrium concept requires some explanation. An obvious concern is whether this model is compatible with the substantial *disequilibrium* that is observed in developing countries. To the extent that the disequilibria observed are short-run, however, one can say that the equilibrium solution exerts a "pull" on the economy. Indeed, many short-run adjustments would take place within the 1-year time frame of the static model. To the extent that the disequilibria observed are structural and long-term, these can be incorporated directly into the specification of the relationships of the model. Examples of such structural disequilibria included in the model are sectoral wage differentials and the fixed real wage for urban unskilled labor.

tion of each equation. Variables and parameters are defined following the equations in the order in which they occur. Imported intermediate and investment goods with their corresponding taxes, income taxes on households, producer taxes, capital flows, and the role of firms (including agricultural estates) in the economy are not shown, although the model used for the policy experiments incorporates these relationships. Also omitted from Table 1 are side equations determining the labor effort parameter, farmers' reservation demand, and the normalization rule. This last is formulated with an index of producer prices using base year quantity weights and implies the maintenance of a constant price level.

As shown by the equation system in Table 1, sectoral gross outputs are given by a Cobb–Douglas production function with fixed and variable inputs and constant returns to scale (1). The supply of unskilled labor is a function of the real wage and the labor effort parameter, where the latter falls below unity as household consumption expenditure falls below the cost of subsistence (2). Sectoral demand for unskilled labor is found by equating the sectoral wage for each type of unskilled labor with the marginal product valued at the producer's net price, i.e., net of intermediate inputs and indirect taxes (3). Sectoral demand for intermediate goods is given by fixed coefficients. When full employment is assumed, the economy wide equilibrium wage for unskilled labor is found by clearing the labor market, and sectoral wages are related to these equilibrium wages by constant sectoral wage differentials (4). When full employment is not assumed, a fixed real wage above the equilibrium level is introduced, and unemployment is determined as the excess of supply over demand. The sectoral supply of all factors other than unskilled labor is assumed fixed within period. Sectoral returns to these fixed factors are determined residually, as quasirents. Household income is determined through a factor ownership matrix which maps all factor rewards into consumer groups (5), and average household expenditure is obtained on the assumption of constant average savings rate for each consumer group (6).

On the demand side, the import shares of consumer goods are determined by the relative domestic versus the imported price (7), and the final consumer price is in turn dependent on the import share (8). Per capita sectoral consumption demand is determined through the spliced Linear Expenditure System (LES) proposed by McElroy (1975) and allows for different marginal budget shares for rich and poor (9). Reservation demand by farmers is incorporated by adjusting farmers' subsistence minima for food products upward as their real income increases. Domestic sectoral consumption demand is then defined as total minus imported consumption (10). Government revenue is ob-

Table 1: A Simplified Version of the Static Model[a]

Sectoral production functions (X_i)

$$X_i = \bar{A}_i\left(\prod_{q=1}^{r} L_{qi}^{\alpha_{qi}}\right)\left(\prod_{q=r+1}^{m} \bar{F}_{qi}^{\alpha_{qi}}\right); \quad \sum_q \alpha_{qi} = 1 \tag{1}$$

Supply of variable labor (L_q)

$$L_q = \nu_q (w_q/I_q)^{\eta_q} \sum_s \theta_{qs} \bar{N}_s \tag{2}$$

Sectoral demand for variable labor (L_{qi})

$$L_{qi} = P_i^*(\alpha_{qi}/w_{qi})X_i,$$

where (3)

$$P_i^* = [1 - (X_i'/X_i)\tau_i^*]P_i - \sum_j \bar{a}_{ji} P_j$$

Equilibrium wage for variable labor (w_q)

$$\sum_i L_{qi} = L_q; \quad w_{qi} = \lambda_{qi} w_q \tag{4}$$

Total income by socioeconomic group ($\tilde{Y}_s$)

$$\tilde{Y}_s = \sum_q \sum_i \phi_{sqi} w_{qi} L_{qi} + \sum_{q=r+1}^{m} \sum_i \phi_{sqi} w_{qi} \bar{F}_{qi} \tag{5}$$

Household expenditure ($\tilde{y}_s^*$)

$$\tilde{y}_s^* = (1 - \sigma_s)\tilde{Y}_s/\bar{N}_s \tag{6}$$

Import share of sectoral consumption (m_i)

$$m_i = \mu_i[P_i/(\pi_i R(1 + \tau_i'))] \tag{7}$$

Consumer prices (P_i')

$$P_i' = (1 + \tau_i)[(1 - m_i)P_i + (1 + \tau_i')m_i \pi_i R] \tag{8}$$

Sectoral household demand for above and below subsistence (c_{si})

$$\begin{aligned} c_{si} &= \delta_{si} + \epsilon_{si}/P_i'(\tilde{y}_s^* - \sum_i P_i'\delta_{si}) \qquad \text{for } c_{si} > \delta_{si} \\ c_{si} &= \delta_{si} + \epsilon_{si}'/P_i'(\tilde{y}_s^* - \sum_i P_i'\delta_{si}) \qquad \text{for } c_{si} \leq \delta_{si} \end{aligned} \tag{9}$$

Sectoral consumption of domestic and imported goods (C_i, C_i')

$$C_i = (1 - m_i)\sum_s c_{si}\bar{N}_s; \quad C_i' = m_i(\sum_s c_{si}\bar{N}_s) \tag{10}$$

Total government revenue ($\tilde{G}$)

$$\tilde{G} = \sum_i \tau_i^* X_i' + \sum_i \tau_i' C_i' \pi_i R + \sum_i \tau_i[P_i C_i + (1 + \tau_i')C_i' \pi_i R] \tag{11}$$

Sectoral demand for government current expenditure ($\tilde{G}_i$)

$$\tilde{G}_i = \bar{g}_i \overline{G'} \tag{12}$$

(continued)

Table 1 (*continued*)

Government savings ($\tilde{S}$)

$$\tilde{S} = \tilde{G} - \overline{\tilde{G}'} \tag{13}$$

Determination of the exchange rate (R)

$$\sum_i (P_i/R)X_i' - \sum_i \pi_i C_i' = \Delta \tag{14}$$

Sectoral investment demand (Z_i)

$$Z_i = \beta_i(\sum_s \sigma_s \tilde{Y}_s + \tilde{S} - R \cdot \Delta)/\sum_i \beta_i P_i; \quad \sum_i \beta_i = 1 \tag{15}$$

Convergence criterion for price determination (P_i)

$$X_i = \sum_i \bar{a}_{ij} X_i + Z_i + C_i + G_i + X'_i \quad \text{for nonexport dominant sectors.} \tag{16}$$

Price determination for export dominant sectors (P_i)

$$P_i = \pi_i R;$$
$$\pi_i = \mu_i/(X_i')^{1/\xi_i} \quad \text{for export dominant sectors only.} \tag{17}$$

List of variables and parameters

Variables	
X_i, C_i, G_i, Z_i	Sectoral gross output, domestic private consumption, government consumption, and investment demand.
L_{qi}, $\overline{F}_{qi}$	Sectoral use of unskilled labor and fixed factors.
L_q	Economy-wide supply of unskilled labor.
w_q	Economy-wide wage for unskilled labor.
w_{qi}	Sectoral factor wages.
I_q, I_s	Consumer price indices by labor and household type.
P_i, P_i^*, P_i', π_i	Producer price, producer net price, consumer price, and international price.
$\tilde{Y}_s$, $\tilde{y}_s^*$	Total income and average household expenditure.
$\overline{N}_s$	Number of standardized households per consumer group.
c_{si}	Per capita household sectoral consumption.
X_i', C_i'	Sectoral exports and imported sectoral private consumption.
$\tilde{G}$, $\overline{\tilde{G}'}$	Total government revenue and current expenditure.
$\tilde{S}$	Public savings.
R	Exchange rate.
Δ	Fixed balance of trade surplus in international prices.
Parameters	
α_{qi}, $\overline{A}_i$	Output elasticities and shift parameter for sectoral production functions.
ν_q	Labor effort parameter.
η_q	Supply elasticity for unskilled labor.
θ_{qs}	Per household labor force participation rate by consumer group.
$\bar{a}_{ij}$	Intermediate input coefficients.

(*continued*)

Table 1 (*continued*)

τ_i, τ_i', τ_i^*	Consumer tax, consumer tariff, and export tax.
λ_{qi}	Sectoral wage differentials.
ϕ_{sqi}	Share in sectoral factor income by consumer group.
σ_s	Savings rate by consumer group.
m_i	Share of sectoral private consumption imported.
μ_i, ξ_i	Trade constant and elasticity.
δ_{si}	Subsistence minima for spliced LES.
ϵ_i, ϵ_i'	Marginal budget shared for rich and poor.
$\bar{g}_i$	Government expenditure shares.
β_i	Sectoral investment demand shares.

[a] Subscripts i and j refer to sectors, q to factors, and s to socioeconomic (consumer) groups. A tilde (~) indicates monetary value, e.g., $\tilde{G}_i = P_i G_i$. All greek letters, with one exception, and italic letters with a bar represent parameters and variables that are exogenous to the static model. All roman letters without a bar are determined endogenously. The exception to the exogenously determined greek letters is the endogenous determination of the world price π_i of exports where these are dominant [see (17)].

tained by summing all taxes (11), and government consumption is determined by constant expenditure shares applied to an exogenously determined expenditure level (12). Public savings are determined residually (13). The exchange rate is solved for to maintain internal and external balance, assuming a fixed trade surplus (14), and sectoral investment demand is found by allocating total real investment according to fixed investment shares (15). For nonexport sectors, the material balance equations are used to determine prices endogenously (16). For export sectors, where external demand is dominant (as in the case of tea and rubber in Sri Lanka), exports are equal to the difference between supply and internal demand (16), and the domestic price is determined by the exchange rate and the international price, where the latter is in turn dependent on the elasticity of demand for exports (17).

In the dynamic linkages, not shown here in equation form, factor stock adjustments are made. Sectoral capital stocks change in accordance with sectoral depreciation rates and sectoral allocations of gross investment. The latter are determined endogenously and are assumed to be partially responsive to sectoral profit rates. Sectoral land stocks are assumed to expand at historically observed rates. A uniform and constant population growth rate takes place throughout the economy; however, household mobility among socioeconomic groups is incorporated through the specification of rural–urban migration and a relatively faster (slower) increase in the households of the rich to the extent that the growth rate in skilled labor employment, which is assumed to grow at a constant fraction of the growth of capital, exceeds (falls short of) the population growth rate.

APPLICATION OF THE MODEL TO SRI LANKA

The application of the model to Sri Lanka was facilitated by the availability of a social accounting matrix for 1970 developed by Pyatt et al. (1978). The Appendix provides a brief discussion of the data base and the calibration procedures. The sectoral aggregation distinguishes three primary sectors (agricultural exports, rice, and other agriculture), two secondary sectors (light manufacturing and MIMCON—modern industry, mining, construction), and two tertiary sectors (trade and transport, services). Factors of production include five categories of labor, land, and capital.[3] Households are divided into six mutually exclusive socioeconomic groups (urban rich and poor, rural rich, small farmers, landless laborers, estate workers), which also serve as consumer groups. Involuntary employment, produced by the existence of an institutionally determined fixed real wage above the equilibrium level, is assumed to exist only among urban unskilled labor.

It should be clear from this aggregation scheme that the model does not focus on institutional relationships at the micro level. It should also be noted that important events since 1970, such as weather, national elections, communal disturbances, and the oil crisis, are not captured. As mentioned earlier, the purpose of this study is not to forecast, but rather to determine the *relative* effects of alternative policies, given the economic structure in the base year.

EFFECTS OF SELECTED AGRICULTURAL POLICIES

In 1970, the agricultural sector in Sri Lanka provided 31% of gross output, 36% of value added, 55% of employment, and 71% of exports (primarily tea and rubber). Another 10% of employment was provided by the light manufacturing sector, which relies heavily on agricultural inputs. These characteristics persist, and the buoyancy of the economy is thus heavily dependent on agriculture. The government's policies toward agriculture since independence in 1948 have been to tax the traditional agricultural exports, which were formerly dominated by foreign interests, to provide food subsidies to the population, and to increase the domestic production of rice through both improvement in yields and expansion of the cultivated area. This last policy was

[3] A distinction is made between urban and rural skilled and unskilled labor. A majority of the workers on the tea and rubber estates are Indian rather than Ceylonese. They are treated as a separate factor of production, as they have very limited mobility within the economy and receive lower wages than other categories of unskilled labor.

successful in the 1960s, but rice production in the 1970s has failed to increase.[4]

This section investigates the impact of the five agricultural policies mentioned in the introduction on a hypothetical set of policy objectives for Sri Lanka. The five policies are elimination of the rice subsidy (RIC), elimination of the tax on agricultural exports (EXP), land reform (LAN), increased investment in agriculture (INV), and technical change in agriculture (TEC). Although the last two policies are often considered to be complementary, they are investigated independently here in order to distinguish their separate effects.

In the agricultural policy experiments that follow, reference is made to the initial base year solution, which reproduces the Sri Lanka economy in 1970, and to a basic growth path (BGP). The experiments consist of running the model over a 10-year period and comparing the new quantities and values for the first and last years to the initial base year values and to year 10 under the BGP. Only the most prominent interactions will be discussed here, and the focus will be on the mechanisms affecting key policy objectives and selected indicators of socioeconomic change.

The quantitative assessment of the short-run effects is shown in Table 2, where column 1 shows the value of each objective or indicator in the base year, and the remaining columns show the effects of the agricultural policies as compared to these initial base year values. Neither the urbanization rate nor the growth rates of GNP, employment, and capital are included in Table 2 since they are not relevant to the short-run analysis. Also no change is shown for the INV and TEC experiments since the effects of investment and technical change are introduced with a 1-year time lag. The assessment of the longer-run effects is given in Table 3, which is similar in format to Table 2 except that column 2 shows the percentage change in each indicator over the 10-year period.

Experiment RIC: Elimination of the Rice Subsidy

Description. Food subsidies in developing countries are criticized for imposing a severe burden on government budgetary resources. They are justified on account of their favorable impact on the standard of living of the poor, who spend a significant share of their income on food products. In this experiment, the Sri Lanka government's 39% average subsidy on rice is removed. The resulting increase in public savings increases total investment.

Results. The short-run effects of removing the rice subsidy show that the consumer price of rice increases by approximately 85% of the former subsidy, and the producer price and output decline because of the

[4] The poor performance of the rice sector in the first half of the 1970s is in part due to unfavorable weather conditions. No attempt is made to capture this or other exogenous events—such as changing world market prices—in the comparative policy simulations.

Table 2: Policy Objectives and Economic Indicators—Values in Base Year

	Initial base year value	Ratio of experiment value to initial base year value (%)				
		RIC	EXP	LAN	INV	TEC
Objectives						
GNP—level[a]	11617	99	103	100	100	100
Employment—level[b]	3423	98	101	100	100	100
Rich/poor expenditure gap	2.79	107	96	93	100	100
Expenditure of poorest group[c]	2.90	93	107[d]	105[d]	100	100
Indicators						
Urban unemployment	0.161	103	88	103	100	100
Urban/rural expenditure gap	1.78	111	95	92	100	100
Agricultural terms of trade	1.02	90	102	104	100	100
Exchange rate	1.00	96	96	101	100	100

[a] $\times 10^6$ rupees.
[b] $\times 10^3$ effective man-years.
[c] $\times 10^3$ rupees per household per annum.
[d] Poorest consumer group is the rural (nonestate) landless.

Table 3: Policy Objectives and Economic Indicators—Comparison with Basic Growth Path in Year 10

	BGP value	BGP change[a]	Ratio of experiment value to BGP value (%)				
			RIC	EXP	LAN	INV	TEC
Objectives							
GNP—level[b]	15455	133	105	100	99	97	105
GNP—average growth	0.029	100	121	90	93	88	118
Employment—level[c]	4049	118	100	100	100	100	101
Employment—average growth	0.017	100	108	96	99	99	105
Rich/poor expenditure gap	2.58	92	97	101	97	112	102
Expenditure of poorest group[d]	3.36	116	102	100[e]	99	89	101
Indicators							
Physical capital—average growth	0.047	100	126	86	90	91	101
Urban unemployment	0.290	180	107	96	100	103	85
Urbanization	0.191	106	104	99	99	102	103
Urban/rural expenditure gap	1.61	90	102	99	96	105	102
Agricultural terms of trade	1.17	115	101	97	99	76	87
Exchange rate	1.12	112	105	93	99	88	93

[a] Ratio of value in year 10 to value in year 1 (%).
[b] $\times 10^6$ rupees.
[c] $\times 10^3$ effective man-years.
[d] $\times 10^3$ rupees per household per annum.
[e] Poorest consumer group is the rural (nonestate) landless.

negative substitution and income effects on the demand side. The prices and outputs of other consumer goods—particularly those which are important consumption goods for the poor—decline, and the relative prices and outputs of investment goods increase substantially as the funds formerly used for the rice subsidy are channeled into public investment. Unemployment among urban unskilled labor increases due to lower demand for the more labor-intensive consumer products (i.e., rice and light manufacturing). The drop in employment results in lower GNP and, together with the relatively higher cost of living for the poor and a 10% drop in the agricultural terms of trade, contributes to a larger gap between real household expenditure of the rich and poor. In addition, the real purchasing power of estate workers, the lowest income group, declines by 7%.

By year 10, many of these trends are reversed. Total employment is higher because the larger capital stock generates an increased demand for labor, more than offsetting the switch away from labor-intensive to more capital-intensive goods. As a result, GNP growth and GNP level are higher. The deterioration in the distribution of income has also been reversed, due largely to a higher rate of rural–urban migration, which also stimulates a significant improvement in the agricultural terms of trade. In addition, higher growth in skilled labor employment, which grows at a constant fraction of the growth in capital stock, pulls in more households to the socioeconomic group designated "rich" and, by sharing the assets of this group, lowers the average household income.

There are several points of interest in this experiment. First, the reversals in movement toward the objectives over time, which are due primarily to the substitution of investment for consumption, illustrate the importance of distinguishing separately the short-run and the long-run effects of any given policy intervention. Second, both the short-run and the longer-run effects show complementarities, rather than trade-offs, among the GNP, employment, and income distribution goals. Third, this experiment points out that a favorable impact on selected aggregate policy objectives may have undesirable effects at a more disaggregated level. Thus, although real household expenditure of the lowest income group is the same as under the BGP, total rice consumption—which dropped by 10% in the first year—is still 8% lower in RIC than under the BGP. If intragroup income distribution were included in the analysis, this lower aggregate level of rice consumption would undoubtedly be accompanied by nutritional deficiencies among some households.[5]

[5] Although the drop in domestic rice consumption is indicative of a nutritional problem, it is not possible in this context to assess the impact of alternative policies on nutritional goals in a consistent manner.

Experiment EXP: Elimination of the Export Tax

Description. In 1970, the estate workers in Sri Lanka were the lowest income group. In an effort to increase the incomes of estate workers and to encourage export growth, the 17% tax on agricultural exports is eliminated. In contrast to the elimination of the rice subsidy, public savings drop in this experiment, and total investment is lower by the amount of foregone tax proceeds.

Results. This policy intervention also shows a reversal between short-run and longer-run effects with respect to national objectives. The direction of the reversal is opposite to that under RIC. Leaving to the reader the problem of sorting out the short-run impact of this policy, analysis of the longer-run effects shows that the initial increases in GNP and employment are eroded by a slower growth over time. Whereas in RIC investment is substituted for consumption, here consumption is substituted for investment, resulting in slower growth in physical capital and hence GNP. Initial improvements in the agricultural terms of trade and urban unemployment are also eroded over time, by the effective revaluation of the exchange rate, which causes a relative decline in the price of agricultural exports. Thus, the initial improvement in income distribution is eroded over time.

Experiment LAN: Land Reform

Description. Land reform is often recommended as a means of increasing the incomes of small farmers through asset redistribution. In this experiment, the ownership of land and part of the associated capital stock is transferred from large farmers and estates to small farmers. The reform is patterned after the one engaged in by the Sri Lanka government in the early 1970s and is assumed to involve 25% of the tea and rubber land, 4% of the rice land, 10% of other agriculture, and two-thirds of the associated capital in each of these sectors. The efficiency of both land and capital is assumed to remain the same under changing ownership.

Results. As would be expected, the distribution of income becomes more equal and the share of agriculture in GDP goes up as household income shifts in favor of the rural poor, whose consumption expenditures are intensive in agricultural goods. In the short-run, both the exchange rate and the agricultural terms of trade increase somewhat. Reservation demand on the part of the rural rich declines slightly, due to the redistribution of productive assets, but this is more than offset by the increase in reservation demand on the part of small farmers. The expenditure gap between rich and poor households declines by 7%, and

real household expenditure of the poorest consumer group increases by 6%. The level of GNP and employment remains roughly the same as in the prereform economy.

As in previous experiments, the medium- to long-term effects show some reversals when compared to the short-run effects. The redistribution of income results in lower savings and hence lower investment and GNP growth. Thus, by year 10, it appears as if a "trade-off" between growth and equity exists; i.e., equity has improved at the cost of lower growth. On close inspection, however, not only has growth slowed down but income distribution—though better than under the BGP—has worsened in relation to the first year of the reform. The improvement in both the rich/poor expenditure gap and the income of the lowest group has been eroded through the "trickle up" effect that occurs in response to (a) a small effective revaluation and (b) a slowdown in the growth of skilled labor employment. A disaggregation of the income distribution effects shows that, although a substantial improvement in small farmer incomes has been obtained, average real household expenditure of other "poor" income groups *with* land reform is lower than *without* land reform.[6]

Experiment INV: Increased Investment in Agriculture

Description. Although the production structure of the agricultural sectors tends to be less capital-intensive than that of the nonagricultural sectors in low-income countries, it has been suggested, for example by Hayami and Ruttan (1971), that substantial capital investment may be required to maintain adequate food levels for a growing population. In this experiment, it is assumed that the government designates 15% of total investment for supplementary investment in agriculture, the remaining 85% of investment funds being allocated as before. Forty percent of the supplementary funds is allocated each to agricultural exports and other agriculture and 20% is allocated to rice.

Results. As expected, this policy causes more rapid capital accumulation in the agricultural sectors—with capital in rice and other agriculture more than doubling over the 10-year period—and slower capital growth in the nonagricultural sectors. The most striking consequences are (a) a sharp decline in the agricultural terms of trade and (b) the failure of agricultural exports and rice to grow significantly faster than under the BGP. The two are, of course, related. As investment is biased toward

[6] There are, of course, conditions under which land reform may have more favorable medium- to long-term growth effects, e.g., (a) where the productivity of small farms is higher than the productivity of large farms and estates and (b) where the government generates increased public savings to offset the decline in private savings.

agriculture and away from industry, the relative price of investment goods rises, slowing down the rate of increase in physical capital and the demand for investment good imports. Also, as the secondary sector expands more slowly, the demand for imported intermediate goods drops relative to the BGP. The improvement in the balance of trade resulting from these trends leads to a significant revaluation, lowering the domestic price of agricultural exports and discouraging growth in output. The failure of rice to show significant growth can be explained by the relatively faster increase in the cost of the factor used intensively, namely, rural unskilled labor, than in product price. Also, the demand for rice is weakened by the fall in incomes of rural households who have a higher propensity to consume rice.

Not only do the agricultural sectors fail to expand significantly, but also the rate of total physical capital accumulation and GNP growth both fall. The lower investment in the nonagricultural sectors sets off a cumulative interaction, as the resulting higher price of capital goods leads to a slower growth in physical capital that in turn maintains the higher price of investment. The negative effect of the lower growth in capital stock on skilled labor employment is compounded by the shift of capital toward the agricultural sectors which have a low ratio of skilled labor to capital. As a by-product of the overall slower growth in skilled labor employment, fewer households are drawn into the ranks of the rich. When combined with the decline in real household expenditure of estate workers following the revaluation, this trend causes a substantial increase in the rich/poor expenditure gap.

Experiment TEC: Technical Change in Agriculture

Description. The availability of chemical inputs and high-yielding grain varieties has made it possible for many low-income countries to introduce technical change into a predominantly traditional agriculture through increasing adaptive research and improved extension. In this experiment, neutral technical change is set at 1% in each of the three agricultural sectors. Identical adoption rates of change producing technology are assumed for small and large farmers. The annual cost of technical change is assumed to be one-third of the actual increase in production (valued at base year prices) times an index of the relative price of agricultural research and extension, which is largely determined by the cost of personal services.[7]

Results. Under technical change, the growth rates of both agricultural output and GNP increase significantly; by year 10, the level of GNP is

[7] These assumptions are consistent with typical research costs as discussed in Arndt et al. (1977).

5% higher than under the BGP. The higher GNP is due in part to small increases in factor use and in part to the increased efficiency of production. Higher total employment reflects a 15% decline in urban unemployment that takes place in spite of a 3% higher rate of urbanization.

The increased agricultural output leads to a 13% decline in the agricultural terms of trade; as a result, the share of agriculture in GDP declines and the shares of industry and services increase. Somewhat surprising, however, is the fact that, despite the substantially lower agricultural terms of trade and exchange rate, the indicators of income distribution have not changed significantly in relation to the BGP. This is due in part to the drop in the cost of living of the poor because of lower food prices, in part to higher levels of rural–urban migration in response to a lower rural wage rate, and in part to higher income to the rural landless from rural capital. Thus, by year 10, although real household expenditures of small farmers are slightly lower than under the BGP, real household expenditures of all other consumer groups are higher.

CONCLUSIONS

The medium- to long-term association of policies and goals, discussed above, is summarized in Table 4. It can be seen that RIC and TEC have a strong favorable impact on GNP level, and TEC also has a favorable impact on the employment level. RIC and LAN generate a small improvement in the rich/poor expenditure gap, while TEC generates a small improvement in the income of the poorest group but a small deterioration in the rich/poor gap. EXP and INV do not have a favorable impact on any of these objectives, and INV has a strong

Table 4: Impact of Policies on Selected Goals by Year 10[a]

	GNP level	Employment level	Rich/poor expenditure gap	Income of poorest
RIC	++		+	+
EXP			−	
LAN	−		+	−
INV	−		−−	−−
TEC	++	+	−	+

[a] A single plus (+) indicates a weak favorable effect, and a double plus (++) indicates a strong favorable effect (≥5%). A blank indicates a neutral effect, and a minus (−) [or double minus (−−)] an unfavorable [or strong unfavorable] effect.

negative effect on two of the three goals. In fact, a comparison of INV and TEC points clearly to the preferability of factor neutral (TEC) over factor biased (INV) growth in agriculture where aggregate investment is heavily dependent on a capital-intensive domestic investment goods sector. Although not indicated in the table, TEC has additional appeal in that it generates a high level of average real household expenditure and food consumption, as a result of (a) declining food prices, (b) a lower rate of urban unemployment, because of the higher demand for labor-intensive consumer goods, and (c) an effective revaluation of the exchange rate, suggesting that Sri Lanka would be able to liberalize import regulations.[8]

The most important mechanisms affecting the level and growth of GNP in the experiments are physical capital accumulation, employment growth, and the rate of technical change. Physical capital accumulation is, in turn, affected by the relative price of capital goods, and employment growth is affected by its complementarity with physical capital growth and by changes in the demand for labor-intensive consumer goods and exports. The rich/poor expenditure gap is affected by the rate of capital accumulation, through the growth in skilled labor employment, and by the agricultural terms of trade. A fall in the latter has both a positive effect, in that it lowers the cost of living for the poor who spend a larger share of their income on food, and a negative effect, in that it lowers the wages of agricultural workers. The effect on wage incomes dominates. Finally, the impact of policies on real expenditure levels of the lowest income group depends very much on who is in this group. If it is estate workers, as it normally is in Sri Lanka, incomes are increased by an effective devaluation or by an elimination of the export tax—both of which raise the value added in the tea and rubber sector. If it is the landless, incomes are increased by faster GNP and employment growth in general and by higher rural–urban migration—both of which raise the wages of rural unskilled labor.

In addition to the implications for policy formulation of these mechanisms, two conclusions emerge at a more general level. First, a dynamically recursive, general equilibrium analysis is useful in capturing the important economic mechanism relating agricultural policies to

[8] The robustness of the association of policies and goals has been tested by selective sensitivity analysis. Sensitivity analysis has been performed on parameters for which data are poorest and on distinctive specifications such as the reservation demand function, the labor effort parameter, and the relation between skilled labor and capital growth. The results show that, although the parametric and specification variations change the solution values of the model for any given experiment, the association between policies and goals in most cases is virtually the same.

multiple goals and in thereby assessing the short- and long-term effects of a given policy intervention. Neither the direction nor the magnitude of these effects is obvious, especially as the short-term policy impact may be vitiated by dynamic interactions. Second, the results of this study suggest that a trade-off among goals is not inevitable. Of the five agricultural policies investigated here, two (LAN and TEC) show a trade-off among the goals shown in Table 4, two (RIC and INV) show complementarity in movement toward (or away from) these objectives, and one (EXP) shows that movement toward (or away from) one goal may involve little or no change in others. Also, where a trade-off does exist, some indication of the size is available. With this type of information it may be easier for the policy maker to arrive at a balanced judgment and to introduce compensating measures where necessary.

APPENDIX

Compared to other economy-wide planning models, this model has several distinctive characteristics. First, there is a greater focus on agricultural sectors and differential rural–urban behavior patterns. Second, household mobility is captured in some detail in the model since rural–urban migration responds to the rural–urban wage differential and socioeconomic mobility between rich and poor depends on the relative growth rates of skilled labor, employment, and population growth. Third, the treatment of trade is distinctive in that the model incorporates both a flexible exchange rate and the possibility of intrasectoral substitution through a changing ratio of imported to domestic consumer goods. Finally, the model accounts are closed by assuming an endogenously determined level of investment.

Over three-quarters of the data base was taken from the Pyatt et al. (1978) study which developed the social accounting matrix (SAM) for Sri Lanka in 1970. The SAM is in many ways the ideal data base for an economy-wide model since it provides a set of consistent data showing all the important economic relationships among production activities, factors of production, and institutions (i.e., households, firms, and government). The remaining data requirements have been gleaned from various sources, including cross-country data and a few guesstimates. For a fuller explanation of data sources and calibration techniques, see de Melo (1978).

As is customary with mathematical planning models, the parameters for the static model equations are calculated directly from the base year data; they are not estimated through time-series or cross-sectional analysis. Growth rates of population, land expansion, capital inflow, and the urban real wage are based on average rates for the 1970–1976 period. Actual growth rates assumed under the basic growth path are 1.8% population growth, 1.0% land expansion in rice and 0.5% in other agriculture, 10% in capital inflow, and 1.5% growth in real wages for urban unskilled labor. Annual rates of technical progress of 0.5% are assumed

for the two industrial sectors, with a resulting average annual real growth in GNP of 2.9%. The parameters for rural–urban migration are calibrated to generate, after six periods, the level of urban unemployment observed in 1976.

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