Agricultural Pricing and Marketing Policies in an African Context

A Framework for Analysis

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The paper describes an analytical framework designed to address some of the important agricultural pricing issues that frequently arise in many African countries. The paper contains a description of producer, consumer, and marketing characteristics common to African countries (Section 1), presents an analytical framework designed to capture these characteristics (Section 2), outlines the policy uses of the framework (Section 3), and discusses a series of policy results derived from a prototype application of the framework (Section 4). Two annexes complete the paper. The first contains a rigorous, mathematical description of the model. The second describes data requirements and potential sources.
SUMMARY AND CONCLUSIONS

Agricultural pricing issues are becoming increasingly important as African economies adjust to changes brought about by the oil and debt crises. Many on-going projects and structural adjustment loans increasingly include specific provisions on pricing issues, or policy advice on changing various agricultural prices. The tools available at present to evaluate the impact of pricing policies remain inadequate, however.

The most widely used methods on which policy advice is often based are static measures of "price distortions", including nominal and effective protection coefficients (NPC, EPC), domestic resource costs (DRC), and associated welfare measures like consumer and producer surpluses. NPCs and EPCs measure "distances" between market and shadow prices but they fail to measure the welfare cost of inappropriate pricing policies and provide no guidance whatsoever on the effect of changes in policy on variables of interest to governments. Governments are confronted with a variety of often conflicting goals -- minimizing parastatal losses, increasing government revenues, increasing export earnings, promoting growth and output response, increasing allocative efficiency, assuring adequate nutrition and food security in urban areas, and increasing regional and inter-household equity. These multiple and often conflicting government objectives form the basis for the "policy dialogue" in most of the country and economic sector work at the Bank and other donor agencies. What policymakers want to know via this dialogue is the likely impact of recommended pricing policies on
these objectives and the explicit tradeoffs that might be involved. To accomplish this one needs to go beyond mere static measures of distortion.

Consumer surplus/producer surplus analysis does examine the consequences of policy changes on at least some government objectives but it is confined to single price changes in independent markets. It fails to capture the effects of multiple price changes in interdependent markets. It neglects cross-substitution effects in production and consumption, cannot evaluate policies that involve pricing interventions in multiple markets and fail to account for the joint household-firm aspects of agricultural households. To capture these effects, the analyst needs a multi-market framework. In this approach, one models explicitly all those markets that are closely linked but stops of a full general equilibrium model. In this way, it is hoped that the major interactions are captured while avoiding the complexity of an economy-wide model.

This paper presents an analytical framework for such a multi-market analysis of the impact of pricing policies in the agricultural sector. It is specially geared to taking account of some of the realities in the African context -- pervasive government interventions via marketing boards and parastatals and the existence of dual and segmented formal and informal markets that often result from such interventions. The model is tested for a "prototype" African economy using synthetic data, to show that such a model could be actually made operational. The model simulations yield a rich variety of results --
many of them counter-intuitive. The welfare implications of this "full model" approach are compared with those of a "simple model" based on measures of consumer and producer surpluses. The simple models are found to give results that are of the wrong magnitude or in the wrong direction, particularly where substitution in production and consumption are important and where price changes in multiple markets are involved. Policy advice to resort to "border pricing" for example, must be modified if the government wishes to generate revenue from the agricultural sector. Once one departs from the "border-price" rule, however, it is necessary to consider questions such as -- should outputs be taxed at the same rate? Should fertiliser be subsidised to offset disincentives arising from the taxation of outputs? Should export crops be taxed at a different rate from domestic food crops? In such cases the use of a limited general equilibrium model like the one developed in this paper will yield the relevant information and, one hopes, lead to a richer dialogue and better policy advice.

The next step is to test these models in an actual country specific context. This is now being done at the Bank with studies in Malawi, Sierra Leone and Senegal.
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I. INTRODUCTION

Agricultural pricing issues are of critical importance in all African countries and are becoming a central concern in both project and program lending. In project lending, for example, many on-going agricultural projects include specific legal provisions on pricing issues. ¹ These include joint reviews by Bank and borrower of any price changes, provisions for maintaining minimum producer price levels, prohibitions on regulating prices in project areas, and establishment of project prices in relation to world markets or with a view to promoting sound financial operations of parastatals. In program documents the level of domestic agricultural prices, either in relation to import or export parity prices or to domestic prices of inputs or other commodities, are constantly cited as a major source of "distortion" and a barrier to both domestic and export growth. In Kenya, for example, the Structural Adjustment Loan (SAL) program explicitly proposes that "marketing and pricing policies pay closer attention to the structure of domestic and international prices and that the marketing system be made more competitive and efficient to improve prices for farmers". ²

¹ In Zaire, for example, there are provisions that require annual reviews or specific consultations on prices for beef (First Livestock Development Project), for seed cotton, cotton fiber and lint (Cotton Rehabilitation Projects), for palm oil (Oil Palm Project), for sugar (Kwilu-Ngonjo Sugar Project), for maize (Smallholder Maize Project) and livestock (Ituri Livestock Development Project). Similar examples can be cited for other countries in the region.

the second SAL in Kenya, a major focus of the structural adjustment strategy was the improvement of marketing and pricing policies in order to ensure adequate incentives to producers.

Governments in Africa effectively regulate prices and commodity flows via monopolies granted to parastatal/marketing boards, via commodity and export taxes, via control of wholesale and retail prices to processors and consumers, via control of imports and exports of agricultural goods and via the exchange rate. The problem of "getting the prices right" in agriculture is not, therefore, a simple one. Often the constant plea to get "producer incentives right" is not supported by an analytical framework capable of treating the pervasive effects of government regulations on prices and markets. A continuing problem with giving "operationally relevant" advice on agricultural pricing policies is the difficulty of anticipating the effects of price changes in a broad enough framework where many interactions and their effects can be incorporated and measured. In many cases price programs go awry, not because the intended objectives of the programs are unclear (though this may also be the case), but because their quantitative effects are inadequately understood and measured.

1.1 The Linkages in the System

A change in relative product prices has implications for a variety of economic agents in a country.

Producer behavior is affected by changes in producer prices both in terms of the response of agricultural output at the farm level, as well as in terms of the surplus marketed. Typically one needs to
distinguish the response of the commercial (usually large-scale estate) sector from the response of traditional smallholders, not only because the former has better access to inputs, and uses different technologies and factor proportions, but also because of differences in marketing behavior. Large farmers usually produce solely for market and generally market through formal channels. To the extent that these are "controlled", either via marketing boards for export crops or through parastatal purchases for domestic distribution of food crops, the large scale commercial producers will face controlled prices. If the government sets a floor price at which it agrees to buy output and there is no other outlet, this sector effectively responds to changes in the "floor price".

In contrast, traditional smallholders respond differently both because they have less access to inputs and use different technologies and because they market most of their surplus through informal channels. The effective price faced by small producers may be higher or lower than the government "floor price" set in the formal market. If the free market price is higher (say in a 'bad harvest' year), most if not all of the marketed surplus will flow through informal channels. If, on the other hand, smallholders face a lower price than that offered by the marketing board (say in a 'good harvest' year) then there is a tendency for some of the marketed surplus to flow from informal to formal markets. The extent of this leakage will depend primarily on the perceived price differentials between the "free market" and the "floor price" and on transportation and marketing costs.
It is possible that in the case of export crops, smallholders have no outlets other than formal market channels controlled by marketing boards. The recent experience in some African countries of export crops being smuggled across national boundaries, however, suggests that this control is far from perfect. In this case a form of reverse leakage may occur from formal to informal markets. The extent of this leakage will depend primarily on the price differentials between world market prices evaluated at the black market exchange rate and domestic prices and on transportation and marketing (smuggling) costs. Because domestic prices offered by marketing boards for export crops have not in general reflected the overvaluation of the exchange rate, parastatals/marketing boards are losing control of the domestic output of export crops as a result of smuggling. The profits to be earned by such transactions, especially if consumer goods can be smuggled back to sell at a premium, are potentially enormous.

Consumer behavior of both urban and rural households is also affected by relative price changes. Urban demand for foodgrains is often supplied from the formal market (i.e. from parastatal purchases, inventories and imports) and governments often set a ceiling price which they attempt to enforce. These prices frequently have a high element of subsidy (purchase price plus transportation and marketing costs minus the sales price) that has to be absorbed either through parastatal losses or government deficits. If the ceiling price at which the government sells food in urban areas is below the import parity price (plus transportation), the loss accrues to the agency that deals with imports.
The demand for food crops by rural households depends on their dual function as households and as firms. As households, their demand depends on incomes, household size and relative prices, but unlike urban and other consumers their incomes are not independent of changes in relative farm prices, because a change in relative farm prices also changes their farm incomes. Thus for example, an increase in the price of a staple crop will reduce the demand for that staple in urban and landless rural households. But in traditional smallholder households, which produce both for own-consumption (subsistence) and for the market, two countervailing effects are evident: first, an increase in the relative price will lead to a reduction in demand and, second, an increase in the relative price will increase farm profits and hence income and will lead to an increase in demand for the staple. The net effect (and hence the amount of output retained for home consumption) will depend on the relative strength of these factors. 1/ The marketed surplus response to prices will also change because it depends on the joint response to price variations of the farm as producer and the household as consumer.

Parastatal marketing behavior and budgets are affected because parastatals and marketing boards are the main agencies involved in procurement, government sales, and in some cases imports and exports.

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1/ There is ample empirical evidence for this based on the integrated theory of consumption-production responses in agricultural households in many LDCs. See Barnum and Squire, A Model of an Agricultural Household: Theory and Evidence, World Bank Staff Occasional Paper No.27, 1974, and Ahn, Singh and Squire (1981) for two recent studies.
The procurement or floor prices set by parastatals are their marginal costs while the "ceiling prices" at which they are allowed to sell are their marginal revenues. The difference between these two (the markup by definition) should cover transportation, storage and administrative costs if the entity is to make a profit. More often than not, parastatals incur heavy losses because their markup is insufficient. Transportation and storage costs can be especially high where there is a policy of pan-territorial or pan-temporal pricing imposed on parastatals. Deficits also occur if imports are sold at a price below import parity plus handling costs. The losses are covered either through government loans (that are written off after they accumulate for several years) or through government budgetary allocations. In either case there is a substantial impact on parastatal budgets and operations.

Government budgets and foreign exchange earnings are affected by price changes because governments support parastatal deficits and because commodity taxes are levied on imports and exports. The extent of parastatal deficits depends not only on the declared floor and ceiling prices but also on the volume of procurement and sales undertaken. But both procurement and sales are unpredictable because they depend on producer and consumer response to declared prices. If producer prices are set too low (in relation to the informal or free market) the levels of procurement will be low and demand at declared ceiling prices will have to be met through imports. On the other hand if these prices are set too high, procurement will be heavy and the excess of procurement over sales will have to be stored (at a cost) or
exported (perhaps at a loss). If imports are sold at a price below import parity plus handling costs, there will be a budgetary loss. If export parity prices are below the procurement price plus handling (transportation plus administration) costs there will also be a loss. These losses will have to be borne by government budgets.

In addition, government revenues as well as foreign exchange earnings are affected by commodity taxes. Commodity taxes on export crops are a major source of government revenue in the region. The higher the commodity tax, however, the lower the proportion of the export parity price that can be passed onto producers as an incentive. When high commodity taxes are combined with transportation, marketing and administrative costs, little is left by way of incentives for export producers. As a result, high commodity tax rates usually imply lower production and procurement levels and lower total government revenues. Commodity taxes are, therefore, an essential element of "pricing policies" affecting production, exports and government revenues.

It is clear from this discussion that an analysis of pricing and marketing policies in the real world is complicated. There are multiple instruments that can be manipulated: producer prices, input prices, consumer prices, commodity taxes and exchange rates. Also, a large number of "institutions" may be involved: government parastatals involved in domestic procurements and sales in addition to private traders and "unofficial" or "black" markets. Furthermore, in evaluating the impact of policy interventions governments are seldom interested in single-criterion objectives, be they "assuring self-sufficiency", 
increasing producer incomes or promoting efficiency. Instead they are often concerned with a set of multiple objectives -- promoting efficiency and welfare, increasing government revenues, reducing parastatal losses, increasing foreign exchange earnings, assuring food security -- that are often in conflict. To evaluate the impact of pricing choices, they wish to know the "trade-off" between multiple objectives. Any actual policy dialogue with policymakers makes this clear.

So what at first instance seems merely a matter of "providing producer incentives" or "getting the prices right" actually involves a large number of detailed policy instruments and institutions. Government intervention in agricultural markets raises many of the questions -- urban vs rural income distribution, the role of commodity taxes, parastatal efficiency, the role of private traders, the level of incentives to farmers, the budgetary cost of food subsidies, the role of agriculture as a source of foreign exchange -- that are central to the policy discussions underway in most East African countries. Specific policy advice, however, needs to be based on a careful analysis of the set of multiple but interlinked policy instruments as they affect a set of multiple objectives that are of interest to policymakers. This requires an integrated analytical framework within which the quantitative impact of alternative prices, commodity taxes, subsidies and exchange rates can be evaluated on a set of alternative objectives.

The purpose of this study is to develop an integrated analytical framework that can be used to trace the impact of
agricultural prices, commodity taxes and subsidies on agricultural production, domestic procurement and consumption, parastatal and government revenues and the levels of domestic and foreign trade in the main agricultural commodities. To demonstrate the usefulness of this framework as an operational tool, we present an application based on a prototype African economy.

II. THE ANALYTICAL FRAMEWORK

In developing an analytical framework to examine these issues at least three broad components can be identified: the supply system, the demand system, and the marketing or intermediation system. These categories are not mutually exclusive and may overlap but they help us identify components that need to be modeled. What follows is a brief description of each system for an illustrative African case.

2.1 The Supply System

We begin by distinguishing two broad categories of agricultural commodities -- food crops and export crops. The main

1/ We try to capture some of the main features of the supply, demand, and marketing systems that are common to many African countries. But in any particular country, the specific organization of markets and institutions will differ from those described here.

2/ Again these are illustrative; food crops could include cassava, millet, rice or any other item produced on the farms while export crops could be cotton, groundnuts, oilseeds, or cocoa depending on the country under consideration.
reason for this is that, whereas the former are grown mainly for domestic consumption, the latter find their final markets abroad. In our example, the main food crops are maize, wheat and beans and the illustrative export crops are coffee and tea. Although in any real economy there are many crops, the intention is to focus on the major crops only. 1/

These commodities are produced by two broad categories of producers -- traditional smallholders (the small farm sector) and large-scale (usually mechanized) commercial farms (the large farm or estate sector). 2/ The small farms are assumed to produce mainly maize and beans as food crops and the main part of their output is for on-farm subsistence consumption. They also produce export crops -- tea and coffee -- for cash sales to marketing boards but destined eventually for exports. The large farms produce maize and wheat, mainly for commercial

1/ For example, in Kenya coffee and tea accounted for 57.6% of total exports in 1977. Maize and beans (in pure and mixed stands) accounted for 79% of the total crop hectarage in the small farm sector, while coffee and tea accounted for another 7.4%. In the large farm sector wheat and maize (in pure stand) account for 76.8% of the crop hectarage and tea and coffee another 7% (p.40-43). See Growth and Structural Change in Kenya, A Basic Economic Report, Annex II: Issues in Kenyan Agriculture, Report No. 3350-KE, August 1982.

2/ In practice, there may be many producing agents differentiated by farm type or region. Drawing on Kenyan data again, there were in 1977-78 some 1.704 million small farms cultivating 3.5 m ha of farm land and varying in size from less than 0.5 ha-8 ha; 93% of them were less than 5 ha in size. The average size was around 2 ha. There were some 2,406 large farms cultivating around 2.5 m ha with an average size of around 1000 ha. Another 2,275 were classified as 'mixed farms' or plantations with an average size ranging between 400-500 ha. There were also 100 commercial farms with an average size of around 6,500 ha each. Together this large farm sector (some 4,835 units) farmed some 4.235 m ha of land (54% of total area) p.25-27 op.cit.
sale in domestic markets via a National Marketing Board, and tea and coffee, for export through a National Export Agency.

Thus the production system for major agricultural commodities in our illustrative example can be characterized as follows: 1/

<table>
<thead>
<tr>
<th>Commodities</th>
<th>Producers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food Crops</strong></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>Small and large farms</td>
</tr>
<tr>
<td>Wheat</td>
<td>Large farms</td>
</tr>
<tr>
<td>Beans</td>
<td>Small Farms</td>
</tr>
<tr>
<td><strong>Export Crops</strong></td>
<td></td>
</tr>
<tr>
<td>Tea</td>
<td>Small and large farms</td>
</tr>
<tr>
<td>Coffee</td>
<td>Small and large farms</td>
</tr>
</tbody>
</table>

Given this broad breakdown we can now turn to the question of how the supply response (defined as a change in output as a consequence of changes in farm level prices) for each commodity is determined. In most general terms the output of any commodity on a given farm depends on the technology (that is, the conversion of variable factor inputs and fixed inputs like land into outputs), the expected profitability per acre of alternative crop outputs (i.e. alternative opportunities for the

1/ This type of breakdown may be typical in most countries in the Eastern Africa region. In general, a mapping of commodities by major producers is what is required and can be handled for any number of commodities and producers.
use of farm resources) and weather (or states of nature) that provide random exogenous shocks that change the pattern of yields and output but which are mainly outside the farmer's control.

Abstracting for a moment from weather effects \textsuperscript{1}, the area that a farmer allocates to a given crop will depend upon its relative profitability and technology. In making land allocation decisions, profits per hectare will have to be equated for each land type at the margin. We assume here that the land available for tree crop production (tea and coffee) is given and fixed in the short run and is different from the land available for food crop production, which is allocated according to the marginal profit maximizing rule. Total cultivated land in the short run is also fixed and given.

Further, we assume that farmers are price takers in input and output markets (that is, no production group is capable of exercising monopsonist behavior in input or monopolist behavior in output markets).\textsuperscript{2} Under these assumptions profits depend on the relation of input to output prices and on technology. Technology, however, may be different for small and large farms. This is so not only because of

\textsuperscript{1} To the extent that weather effects cannot be controlled at the farm level (apart from irrigation) they are not a decision variable for the farmer. He incorporates weather into his "yield expectations" and hence profit expectations. But at the aggregate level, the realized state of nature--a good or bad harvest--very much determines the total supply response. We treat this later.

\textsuperscript{2} These assumptions simply imply many buyers and sellers in input and output markets. The existence of marketing boards that may fix input and output prices still leaves farmers as price takers as long as all input demand is met at the fixed prices and all output is bought at these prices.
different techniques of production but also because of differences in farm-specific input and/or output prices (large farmers may have "better access" to cash inputs giving different input prices, or better access to markets giving different output prices), and because of differences in access to knowledge and in management capabilities. We cannot treat these differences for each farm, but we can distinguish the differences in technology and other factors by broad representative farm groups -- large and small farms in our case.

This discussion can be presented formally as follows. 1/

Consider the specific case of maize on large farms. In our application, the farmer can allocate his land to maize or wheat. This allocation will depend on the relative profitability per acre of each crop. From the above discussion, we know that profitability will depend on input and output prices and on technology. The profit per acre for maize is defined as:

\[
\text{Profit per acre of maize} = \frac{\text{Value of Output of maize}}{\text{Value of Inputs}}
\]

Since the relationship between output and inputs is described by the production function (or technology), we can rewrite this expression as:

\[
\text{Value of Output of maize} = \text{Value of Inputs} \times \text{Profit per acre of maize}
\]

1/ The precise functional forms of the model equations can be found in Annex 1. This model relies heavily on two earlier efforts presented in R.K. Sah (1982) and Braverman, Hammer and Ahn (1983) to build a general equilibrium framework for analysing pricing decisions in the rural sector. Our model attempts to extend this work to incorporate the dual markets and parastatal intermediation common in East and West African countries.
that is, profits per acre of maize \( \pi_m \) depend on the input and output prices \( P_m \) for maize and on maize technology \( T_m \). Note that this is not simply an accounting relationship. It includes a very important behavioral assumption -- that farmers seek to maximize profits. Equation 1a shows the maximum level of profits consistent with the available technology \( T_m \) and given the existing prices \( P_m \). Of course, farmers are never able to maximize profits precisely. Equation 1a is meant, therefore, to capture the idea that farmer behavior tends towards profit maximization. There is, in fact, ample empirical evidence to support this contention.

Whatever the maximum value of maize profits per unit of land, the farmer will only choose to allocate land to maize production if maize profits exceed those of other possible crops. In our example, we have assumed that wheat is the only feasible alternative to maize on large farms. 1/ Implicitly, therefore, we can imagine a farmer constructing a relationship for wheat similar to the one depicted in equation 1a for maize. Armed with this information, he can now compare relative profitabilities and make his land allocation decision. This relationship may be expressed as:

\[
\pi_m = \pi_m(P_m, T_m)
\]

1/ In principle, any number of crops can compete for any given type of land.
where the area allocated to maize \( A_m \) is shown to depend on the profitability of maize \( \pi_m \) relative to that of wheat \( \pi_w \). Assuming the total amount of land available for wheat and maize cultivation is \( A \), then, if \( A_m \) is allocated to maize, the remainder, \( A-A_m \), is used for wheat.

Multiplying profit per acre \( \pi_i \) by area \( A_m \) provides a measure of total profits from maize production. Similar calculations can be performed for wheat and for the export crops -- tea and coffee -- grown on large farms. This allows us to arrive at a measure of total farm profits:

\[
\text{Total Farm Profits} = \sum_{i} \pi_i A_i
\]

\( i = \text{maize, wheat, tea, coffee} \)

That is, total farm profits equal the sum of profits from each of the four crops. This expression is founded in the microeconomic behavior of farmers. It allows us to explore the consequences of an increase in the price of, say, fertilizer which may affect the profitability per acre of each crop differently and may affect the allocation of land among crops. These interactions and substitution possibilities are captured by this approach.

We have developed the argument in financial units. Underlying the measures of profitability, however, are physical measures of inputs
and outputs. For example, corresponding to equation 1a for profits per acre, we can write a yield equation. That is, implicit in equation 1a is the profit-maximizing yield. For example, for maize we can write:

$$\text{Maize Yield} = y_m = y_m(P_m, T_m)$$  \hspace{1cm} -1d-$$

where $y_m$ is the profit-maximizing maize yield. If we multiply yield by area operated ($A_m$), we, of course, have total supply. Since area operated depends on the relative profitability of maize and its possible substitute, wheat, we know that the total supply function for maize from large farms will depend on the input and output prices of both crops as well as technology:

$$\text{Total Farm Supply} = y_m A_m = s_m(P_m, P_w, T_m, T_w)$$  \hspace{1cm} -1e-$$

We thus arrive at the traditional farm-level supply function in which supply depends on own-price, the price of substitutes, the price of inputs, and technology.

To arrive at total supply of maize, we also have to allow for maize production on small farms. Their supply also depends on relative profitabilities, but, in this case, the alternative is beans. We can, therefore, write a total economy-wide supply function of maize as:

$$\text{Total Maize Supply} = S = n_s L_m + k_s S_m$$  \hspace{1cm} -1f-$$
where \( n \) is the number of large farms, \( k \) is the number of small farms, and \( s^L \) and \( s^S \), the supply from a representative large and small farm, respectively.

Similar arguments apply to inputs. For example, implicit in equation 1a for profits per acre is a measure of, say, fertilizer per acre. We can, therefore, construct an equation which shows the profit-maximizing level of fertilizer per acre in exactly the same way we constructed an equation for the profit-maximising yield of maize (see equation 1d). This input of fertilizer will, therefore, depend on all input and output prices for maize \((P_m)\) and on maize technology \((T_m)\). This exercise can be repeated for each crop, and, given the allocation of land among different crops, we can arrive at a total farm demand for fertilizer that parallels equation 1e for the total farm supply of maize. Finally, we can aggregate over all farms to obtain total fertilizer demand:

\[
\text{Total Fertilizer Demand} = D_f = nd^L_f + kd^S_f
\]

where \( n \) is the number of large farms, \( k \) the number of small farms, and \( d^L_f \) and \( d^S_f \), the demand from a representative large and small farm, respectively. Similarly, total demand can be estimated for other inputs -- seeds, insecticides, labor and machinery.

Equations 1a - 1g describe the supply side of the model. They are, of course, repeated for each crop and for each type of farm. The
development of a model which both specifies farm-level behavior (e.g., equations 1a through 1e) and allows the consistent derivation of total, economy-wide supply (equation 1f) has two advantages. First, information on microeconomic variables -- farm budgets, input-output relations -- can be used to estimate the farm-level equations. These are sufficient for the derivation of total supply response. Alternatively, one can work backwards from total supply response elasticities to arrive at the farm-level equations. Ideally, both kinds of information can be used to increase confidence in the model's numerical values. Second, the approach yields the results of greatest interest to the policymaker. The model indicates the effect of alternative pricing policies on total farm profits (equation 1c) and thus elucidates the consequences for equity, and on total supply (equation 1f) thereby providing insight into the consequences for self-sufficiency, the balance of payments, and government revenues. These equations are discussed further in Section 3.

2.2 The Demand System

The demand system can be divided into two broad domestic groups -- urban and rural consumers -- and foreign demand via exports. It is useful to identify the demand for each commodity by different income (expenditure) classes, because both income and price elasticities may differ as incomes rise. In urban areas three broad (but arbitrary) income classes are identified on the basis of per capita income or
expenditure levels: high income, middle income, and low income. 1/ Urban households consume all the major food crops with high income groups showing a preference for wheat (which is a 'superior' crop while beans is an 'inferior' crop) in their diets. They derive these incomes from wages, salaries and other sources. Nominal incomes are given and not affected by changes in agricultural prices.

In rural areas three separate but distinct consumer groups can also be identified: the small farm households, with 'lower incomes', the larger farm households with 'higher incomes', and landless households. 2/ While the first two groups derive their income primarily from farming, the last group depends mainly on wage and salary incomes. 3/ The demand for food crops is differentiated not only by group (income class) but also by the type of commodity they are likely to consume. We assume that wheat and maize are consumed by all classes of urban and rural households, but beans are a subsistence crop consumed mainly by lower income groups.

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1/ In principle, any number of income groups can be used. Three groups may be sufficient, however, to illuminate the effects of policy on equity.

2/ Again, any number of rural household groups can be specified according to farm type, size, region or other characteristics.

3/ In Kenya for example in 1970 about 11% of all rural households were classified as landless. Not all the landless are poor and they consist of a heterogenous group including agricultural laborers (17% of total), government salaried workers (28%), shopkeepers, traders and those involved in handicrafts and transportation (16%) and a group listed under "other employment" (30%), p. 19, Annex 1, op.cit.
The demand for export crops -- tea and coffee -- is assumed to come from abroad, domestic demand being insignificant.  

As most of the output moves through formal channels via marketing boards which purchase at a fixed -- often pre-announced -- price, it is reasonable to assume that whatever output is forthcoming is absorbed by these boards at that price (producers face an infinitely elastic demand at the fixed price). The marketing boards are then faced with the problem of selling abroad the output they have secured. But again, unless there are monopsonist elements involved and a particular country can influence the world price by varying the amount of its exports, the foreign demand faced by the country may be assumed perfectly elastic at the world price.

As with the production system, we can write the main components of the illustration demand system as follows:

1/ This is generally the case for beverage exports. In the case of other non-food exports -- fibers like cotton for example -- there may be extensive demand from domestic industries. This has to be treated explicitly.

2/ We shall return to the issue of informal markets for export crops in a later section.
The domestic demand for food crops by urban and rural households depends on per capita incomes, the price of the food crop, and the prices of close consumption substitutes. Thus, we can write the demand for, say, maize, by a representative urban household in the low-income group as:

\[ \text{Maize Demand} = d_m = d_m(P, Y) \]  

where \( d_m \) is the quantity demanded, \( P \) stands for prices, and \( Y \) for total household income. This function is derived by assuming that consumers maximize utility. \(^1\) The consumer is assumed to allocate his

\(^1\) The demand equations are based on the Almost Ideal Demand System detailed and Muellbauer (1980).
expenditure among different items in order to maximize his utility (or satisfaction) given the set of prices confronting him and given his income. It follows that his level of maximized utility (u) is dependent on the configuration of consumer prices and on his income:

\[ \text{Utility} = u = u (P, Y) \]

The estimation of a system of demand curves allows us to retrieve the underlying utility function. This would be of no special significance, except for the fact that changes in well-being can be measured explicitly and more accurately through the utility function. For example, the loss in consumer welfare from a price increase is usually measured by the loss in consumer surplus. Consumer surplus, however, only provides an approximation to the true measure and is very difficult to calculate when more than one price is changed. The change in utility, on the other hand, can be calculated very easily for a change in any number of prices. Moreover, it can be given a very precise monetary interpretation. It is known as the compensating variation and is the amount of money which makes a household just as well off at the new configuration of prices as it was at the old one. The effect of a change in prices, can, therefore, be expressed as the amount of income necessary to restore the individual's previous level of welfare. Once the demand system has been constructed, the model is able to measure compensating variation for any set of price changes without further
reference to utility. We return to the concept of compensating variation in Section 3.

Total demand for maize can be obtained by adding up the demand from each group of consumers:

\[
\text{Total Maize Demand} = D_m = \sum_{i} d_{mi}
\]

where total demand \((D_m)\) is shown to be the sum of demand \((d_{mi})\) by the representative house in the \(i^{th}\) group times the number \((n_i)\) of households in the \(i^{th}\) group. For this application, \(i\) stands for three urban income groups and three rural groups.

For an analysis of agricultural pricing policy, the incomes of urban households and rural, landless households can be considered independent of pricing policy. The incomes of farm-households, however, are affected by changes in agricultural prices since these prices influence farm profits and farm profits contribute to rural incomes. We can write total income as:

\[
\text{Household Income} = Y = R + W + \sum_{i} \Sigma A_i \pi_i
\]

where \(R\) is the net return from capital assets, \(W\) is labor earnings, and \(\Sigma A_i \pi_i\) is total farm profits (see equation 1c). For urban households and rural, landless households, \(\Sigma A_i \pi_i\) is zero. For farm-households, however, a change in food prices will affect demand directly through \(P\) (see equation 2a) but it will also affect demand indirectly through \(Y\)
(see equation 2a) because a change in food prices will affect farm profits ($DA_i^{\pi_i}$) and hence household income, $Y$ (see equation 2d).

For example, an increase in the price of maize will reduce consumption of maize by all households as a result of its effect through $P$. The same price increase, however, will increase farm profits for those households cultivating maize. The resulting increase in income will tend to increase maize consumption. The net effect on maize consumption in farm-households is thus indeterminate. The model, however, works out the net effect automatically; changes in farm profits are fed in through $Y$. Theoretical as well as empirical work has shown that the joint treatment of these production-consumption interactions does make a considerable difference when calculating consumer response to price changes. 1/

This discussion of farm-households leads naturally to a consideration of marketed surplus. For example,

$$\text{Marketed Surplus of Maize} = n(L_m^L - d_m^L) + k(s_m^S - d_m^S) - 2e-$$

In this equation we draw on both the supply and demand systems for both large farms and small farms. The first term [$n(s_m^L - d_m^L)$] is the marketed surplus from large farms and the second term [$k(s_m^S - d_m^S)$] is that from small farms. The derivation of marketed surplus is thus based on a careful description of both supply and demand behavior and allows

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1/ Again see Barnum and Squire (1979) for empirical results from Malaysia and Ahn, Singh and Squire (1981) for results from Korea.
explicitly for the indirect effect of price changes on farm profits and hence demand in farm-households.

As with the supply side, the demand system represented by equations 2a through 2c provides information at both the household level and the market level. At the household level, the most important information provided by the model is the compensating variation or the change in income that is necessary to fully compensate for any change in prices (see equation 2b). This is important from an equity standpoint. Increasing producer incentives may entail higher prices for urban consumers. Compensating variation provides a monetary measure of the gains and losses to different groups of urban consumers and rural producers. And at the market level, the model provides information on total demand (see equation 2c) which, together with total supply, will yield implications for the balance of payments and the budget. The model also yields estimates of marketed surplus (see equation 2e). These estimates can, of course, be made for each crop.

2.3 Market Intermediation

Demand and supply for agricultural commodities do not automatically balance, nor do markets simply clear at some "equilibrium price". In most African countries a great deal of intervention occurs in markets for agricultural commodities. This intervention takes many forms, has a wide variety of often contradictory goals and involves a number of government agencies. The purpose of this section is to describe how market intervention and intermediation occur in some
African countries. Then we try to "model" this intermediation for the major crops under consideration.

**Export Crops**

To start with, it is easiest to consider the export crops -- coffee and tea in our example. We assume that both these crops are grown primarily for export. Between producers and final exports are government authorized marketing boards. For tea, we assume that the Board inspects and buys leaf through widely dispersed centers and sells it to factories. It announces the price to be paid to growers, this price being paid at time of purchase. The green leaf is sold to factories for drying and packaging at a fixed price. The factories then return the dried tea to the board for export. Tea for export is sold via auction or private contracts. Tea exports are taxed. Thus the "board" is the main agency for intermediation between producers -- smallholders and estates -- and foreign buyers, and intervenes by setting the price facing both producers and processors. For coffee, the marketing structure is centralized through a second Board which is assumed to control the planting of coffee through a licensing system and to take delivery of all coffee produced and to sell it for export by auction. The board sets the prices for producers and, after processing, sells it to private exporters at what is a domestic export price (f.o.b.) which is essentially determined by international demand and the coffee quotas. Coffee exports are also subject to tax.

To summarize, the boards set prices to producers, have a monopoly of purchase (directly or via agents), process the purchased
output at some cost (again directly or via agent), and sell it for export as price takers. The producer price is fixed by the boards and the export price is governed by international markets and agreements.  

The differences between the prices paid to producers (plus transportation and intermediation costs) by the boards and the world prices (less any export taxes) determine the losses or surpluses of the marketing boards once we know the supply side. It is the supply response (at a given fixed price) that determines the volume of procurements for export by marketing boards. Too low a relative price means lower volumes of procurement, high unit costs of intermediation and parastatal losses. Too high a price may mean higher procurement but increased storage requirements and losses if export prices cannot support the marketing and storage costs. In either case, it is the supply response that is the critical determinant of the volume of procurement and hence the profits or losses of government agencies.

**Foodgrains**

Intermediation in foodgrain markets is usually more complex in most African countries. For maize, the main staple for low income rural and urban consumers and the most important smallholder crop, the market is assumed to be segmented. A controlled, formal segment of the market is assumed to coexist and interact with a flourishing informal segment. In the formal segment the main participants are licensed agents who are authorized to purchase for government depots which in turn sell grain to

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1/ Again this is illustrative. Different mechanisms may exist for different crops in different countries.
mills for processing or directly to urban consumers. The purchasing agents are licensed traders who buy at a fixed price and sell only to government depots. All government procured maize is sold in urban markets. Large maize producers deal mainly with the formal system via these agents. Smallholders, on the other hand, market the main part of their maize output via the informal system that consists of market traders who operate mainly, but not exclusively, at the local level. These private market agents play a critical role particularly in rural areas because they link surplus and deficit regions and conduct the inter-seasonal arbitrage via transportation and storage to take advantage of price differentials. Competition is vigorous and there are few barriers to entry. The links between the formal and informal segments of the maize market and the relationship between the fixed price of the formal segment and the free price of the informal segment are discussed in the next section. Maize is used to illustrate the effects of a partially controlled market that is segmented into formal and informal components.

The beans and wheat markets are more easily described. Beans are used to illustrate the effects of an entirely uncontrolled market. Beans are produced by smallholders, marketed by means of private traders, and sold at a price that clears the internal market. There are no exports or imports. Wheat, on the other hand, illustrates the effects of a completely controlled market. Wheat is grown entirely on large farms, is marketed through government agencies at a fixed price, and is sold, primarily to urban consumers, again at a fixed price. A shortfall
in supply relative to demand at the given prices is met by imports. The wheat agencies' trade in both domestic and imported wheat is assumed to result in substantial losses.

**Inputs**

Governments also intervene in the market for inputs. In our example, we focus exclusively on fertilizer. In particular, we assume that there is no domestic fertilizer industry and that all imports of fertilizer are handled by a state trading corporation. This market, therefore, is completely controlled. Fertilizer is sold to farmers at cost so that the accounts of the state trading corporation balance.

2.4. **Market Clearing Conditions**

It is possible to characterize the market structures and means of price determination for the various commodities in our example as follows:

---

1/ Other inputs can, of course, be included depending on their importance in production and the extent of government intervention.
Commodity Market Structure Price Determination

Export Crops

Coffee Formal Prices fixed by government
Tea Formal Prices fixed by government

Food Crops

Maize Segmented: Formal Prices fixed by government
                  Informal Prices determined by supply and demand
Beans Informal Prices determined by supply and demand
Wheat Formal Prices fixed by government

Inputs

Fertilizer Formal Prices fixed by government

For export crops the government Marketing Boards purchase all output at fixed prices from all producers. For maize and wheat, large producers sell all output to official procurement agents at fixed prices. For maize, smallholders sell partly to official procurement agents at a fixed price and market the rest in private informal markets where prices are determined by demand and supply conditions. For beans, smallholders sell on the free market. Fertilizer imports and sales are conducted exclusively by the public sector.

Coffee and Tea

Since all coffee and tea is exported by assumption, we can write for, say, coffee:

Coffee Exports = \( E = S_c \) = Coffee Supply

-3a-
where $E$ stands for exports. Prices are determined by the following equation:

$$\text{Procurement Price} = \bar{p} = p^e - t - a - h$$  \hfill (3b)$$

that is, the fixed price ($\bar{p}$) received by farmers equals the export price ($p^e$) less any taxes ($t$), less the administrative, handling and transport costs ($a$), and less any surplus ($h$) per unit of output realized from Board operations. Since the Boards often run at a loss, $h$ would usually be negative. The relationship described by equation 3b is often calculated in exercises to measure nominal or effective protection. Equations similar to 3a and 3b also apply to tea. Because supply ($S$) depends on, among other things, the fixed price ($\bar{p}$) offered to farmers, a change in that price will affect exports and hence the balance of payments through equation 3a. It will also affect government revenue both because total supply changes and because a change in the farmgate price implies, through equation 3b, a change in either the export tax ($t$) or the marketing board's surplus ($h$). The same price change will, of course, affect farm profits so that there may be repercussions on other outputs, on the use of inputs, and on the demand for food crops by rural households. These interactions are captured in the model and may or may not be quantitatively significant.
Maize

The maize market is the most complicated because of the co-existence of an informal and a formal segment. The formal segment operates much like the markets for tea and coffee:

Urban Maize Demand = \( D_u = n(s^L_m - d^L_m) + M + L \)  

that is, total urban demand for maize \( (D_u) \) is satisfied by the marketing board's control over the marketed surplus \([n(s^L_m - d^L_m)]\) from large farmers and by its ability to import \((M)\). Imports may be planned or in response to an emergency situation. In addition, some maize \((L)\) may leak from the informal market into the formal market (if procurement prices are sufficiently attractive) or into an urban black market. Before considering these possibilities further, however, we complete the description of the maize market. The procurement price is linked to the urban consumer price as follows:

Procurement Price = \( \bar{p} = p_u - a - h \)

where the fixed procurement price \((\bar{p})\) equals the fixed urban consumer price \((p_u)\) less all handling costs \((a)\) and less any surplus \((h)\) or deficit (if negative) incurred by the marketing board. Since the marketed surplus from large farms depends on, among other things, the procurement price, and since urban consumer demand depends on, among other things, the fixed urban price, changes in these prices will affect
both demand and supply and hence the balance of payments (through
equation 4a). They will also affect consumer welfare and producer
profits as well as government revenue. In addition, changes in formal
market prices may exert an influence on the informal market through
their effect on leakages (L) from the informal to the formal market (see
below) and may affect imports. This latter possibility implies a
balance-of-payments effect and, depending on the c.i.f. price, may imply
a revenue effect. Usually, the urban consumer price ($p_u$) is set below
the import price so that:

\[
\text{Urban Price } = p_u = p^m + a + h
\]

where $p^m$ is the import price, $a$ represents handling costs and $h$ is the
surplus (or deficit if negative) per unit of imports.

The informal market operates like a free market. Supply and
demand are brought into balance through price adjustments:

\[
\text{Rural Maize Demand } = D_r = k(s^m - d^m) - L
\]

That is, the demand from rural, landless households ($D_r$) is brought into
balance with the marketed surplus from smallholders [$k(s^m - d^m)$] less
any leakage (L) to the formal market by means of price adjustments.
Unlike the formal market where producer and consumer prices are fixed
and demand and supply are brought into (approximate) balance through
adjustments in imports (or possibly exports), in the informal market,
price is determined from the market-clearing condition represented by equation 4d.

A critical question, however, is the role of leakage from the informal system to the formal system, and hence the proportion of smallholder output that is likely to end up being marketed through official procurement agents. Since large producers of maize market exclusively through the formal system, it is the behavior of smallholders that is of particular interest. Although only a small proportion of their marketed output may be sold via the formal system, one cannot assume that the proportion is fixed. More realistically, one would expect the level of procurement from smallholders to be higher the greater the difference between the fixed price offered by procurement agents and the free market price in rural areas. If the fixed price offered by agents is lower than the price offered by private traders, one would not expect smallholders to sell any output via the formal marketing channels. It is only when free market prices fall below the fixed prices offered by the procurement agents that one would expect a positive leakage from informal to formal markets.

Whether or not a positive price differential exists between fixed procurement prices and free market prices depends partly on the level at which prices are set by policy and partly on what happens to free market prices. In order to capture this relationship, we consider two cases of market conditions. First, in the case of a good harvest year, it is very likely that a large smallholder output will induce significant marketed surpluses in the rural areas. These in turn will
depress free market prices to a level very likely below the fixed procurement price, so that there will be an inducement to smallholders to bring their output to official procurement agents for sale. In the case of a bad harvest year, the free market prices will tend to be much higher and unless procurement prices are changed in response to the free market price, smallholders will not bring their output to the procurement depots, preferring instead to sell to private agents. In such a case official procurements will begin to fall and, if the government has "target commitments" to meet urban consumer demand, maize will have to be imported. Indeed this is what happened, for example, in 1978-79 in Kenya. Maize production fell, this reduced official procurement, and this, in turn, induced large-scale imports in 1979-80. 1/ In the event that imports are insufficient to meet urban demand at the fixed selling price, a black market may develop in urban areas. Private traders will switch supplies into the urban market as long as the black market price exceeds the rural free market price by more than enough to compensate traders for transport costs and any risks associated with this illegal activity. The leakage in a bad harvest year, therefore, is an illegal one from rural producers to buyers in the urban black market.

In order to capture these relationships, we define a leakage function which relates the amount of surplus that smallholders will sell

1/ Purchases of the National Cereals and Produce Board fell from 250,000 m. tons in 1977-78 to 205,000 m. tons in 1979/80; maize sales increased from 369,000 m. tons to 685,000 m. tons. Maize imports rose from nothing to 438,000 m. tons in the same period. See Kenya: Grain Sector Survey, Report No. 4106-KE, September 9, 1982, p.44
to procurement agents in a good harvest year to the price differential between the fixed procurement price less the costs of transport and the rural free market price as follows:

\[ \text{Good Year Leakage} = L = L \left( \frac{p - c}{p_r} \right) \]  

where \( p \) is the official procurement price, \( c \) is the cost of transport borne by the farmer, and \( p_r \) is the price prevailing in rural markets.

In a good year, the leakage (\( L \)) is via official procurement agents. This is legal. In a bad harvest year, however, smallholder surpluses may be moved into the urban market to take advantage of high black market prices. This is illegal. In this event, the leakage function is:

\[ \text{Bad Year Leakage} = L = L \left( \frac{p_b - c}{p_r} \right) \]  

where \( p_b \) is the black market price, and \( c \) is the cost associated with this illegal activity. No doubt actual marketing conditions and interactions between formal and informal markets are far more complex, but this way of modeling market behavior captures the essential features.  

\[ \text{Smuggling, although not treated in this example, can be handled in a similar manner. Now, however, the important differential is that between domestic and foreign prices evaluated at some "black market" exchange rate.} \]
The existence of a large informal or uncontrolled market has important implications for the conduct of pricing policy. For example, in a good harvest year, a procurement price which exceeds by a substantial margin the rural, free market price will induce smallholders to deliver unusually large quantities of foodgrains to the official procurement depots. With more than sufficient foodgrains to meet urban needs, the government will either have to incur storage costs or export. Since f.o.b. prices are often below the government's procurement price, this latter possibility also entails a cost. These costs impose effective constraints on the government's ability to manipulate its procurement price. In a bad harvest year, the emergence of an urban black market may serve to alleviate the market imbalances that might otherwise occur if the procurement price is set too low. In this case, the main effect of the government's pricing policy will be a transfer of income from large farms to urban consumers approximately equal to the difference between a free market price and the official procurement price multiplied by the quantity actually procured.

**Beans**

The market for beans is assumed to be free of all intervention. It is similar, therefore, to the informal market for maize. In particular, price is determined by the interplay of demand and supply:

$$\text{Beans Demand} = D_u + D_r + nd_b^L = k(s_b^s - d_b^s) = \text{Beans Marketed Surplus}$$
Equation 5a shows that, the demand for beans by urban consumers ($D_u$), landless rural households ($D_r$), and large farms ($n_d^L$) must equal the marketed surplus [$k(s^s_b - d^s_b)$] supplied by smallholders. Price adjusts until demand and supply are in reasonable balance.

**Wheat**

The wheat market is entirely controlled. It corresponds, therefore, to the formal market for maize. With producer and consumer prices fixed, supply and demand are brought into approximate balance by recourse to imports:

$$\text{Wheat Demand} = D_u + D_r + k_d^s = n(s^L_w - d^L_w) + M$$

Total demand for wheat by urban consumers ($D_u$), rural, landless consumers ($D_r$) and smallholders ($kd^s_w$) is equated, therefore, with the marketed surplus from large farms [$n(s^L_w - d^L_w)$] plus imports ($M$). The procurement price for wheat is determined as follows:

$$\text{Procurement Price} = \bar{p} = p_u - a - h$$

where $p_u$ is the fixed consumer price (in both urban and rural markets in this case), $a$ represents all handling costs per unit of procurement incurred by the marketing agency, and $h$ represents its surplus (or deficit if negative) per unit of procurement. Assuming that imports are
subsidized, the link between the consumer price and the import price is given by:

\[
\text{Consumer price} = p_u = p^m + a + h^m
\]

where \( p^m \) is the import price, \( a \) represents all handling costs, and \( h \) the surplus (or deficit if negative) per unit of imports. A change in the procurement price and the consumer price will, therefore, affect both producers and consumers (through equation 6a), government revenue (through equations 6b and 6c), and the balance of payments.

**Fertilizer**

The demand for fertilizer is supplied entirely by imports:

\[
\text{Fertilizer Demand} = D_f = M = \text{Fertilizer Imports}
\]

All imports are handled by a state trading corporation and sales to farmers may be subsidized. The farmgate price (\( \bar{p} \)) is, therefore,

\[
\text{Farmgate Price} = \bar{p} = p^m + a + h
\]

where \( p^m \) is the import price, \( a \) is all handling charges, and \( h \) is negative and represents the subsidy per unit of imports. A change in the farmgate price of fertilizer, therefore, will affect producers. It
will also affect the balance of payments (through equation 7a) and
government revenue (through equations 7a and 7b).

The system of equations describing the market clearing
conditions -- equations 3 through 7 -- are accounting relationships.
The behavioral content of the model is captured in the supply system
(equation 1) and the demand system (equation 2). The data requirements
of equations 3 through 7 are, therefore, not very demanding. At most
one requires data on national aggregates -- wheat production, maize
consumption, fertilizer imports -- and on price relations -- for
example, the link between the import price of fertilizer and its
farmgate price. Most agricultural sector reports contain information of
this kind. Unlike most sector reports, however, the model presented
here places these quantities and prices in an overall analytical
framework and explicitly treats their underlying behavioral content --
supply and demand curves. In this way, various important interactions
are allowed for explicitly. This aspect of the model is discussed
further in the next section which describes the uses of the model.

III. MODEL USES

3.1 Policy Instruments and Objectives

The basic purpose of the model is to provide the link between
a set of policy instruments and a set of objectives. In our
application, the main policy instruments are input and output prices and
consumer prices. These prices can, however, be influenced in different
ways. For example, a change in the rate of export taxation will affect the farmgate prices of tea and coffee. Alternatively, a change in prices may be accomplished by changing the maize marketing board's mark up. This could result in a change in both consumer and producer prices and will certainly affect the net profits of the board. In addition, however, the prices of all internationally traded commodities -- inputs and outputs -- could be changed by adjusting the nominal exchange rate. Obviously, an agricultural pricing model is not an appropriate framework in which to explore all the consequences of an exchange rate adjustment. Nor can it serve as a means of predicting the speed and extent of the adjustment. Nevertheless, since the alleged overvaluation of many currencies is thought to have an especially damaging effect on agriculture, it is of interest to consider the consequences of a common percentage increase in the prices of all tradeable commodities. This percentage could then be interpreted as the lasting, real effect of a larger percentage change in the nominal exchange rate. Finally, producer and consumer prices can be changed through a combination of changes in taxes, mark-ups, and the exchange rate.

To be of value, the model must be able to explore the consequences of any change in pricing policy on the government's major objectives. In our example we consider the following objectives. First, the government is assumed to be interested in the effect of its pricing policies on the real incomes of household groups in both urban and rural areas. That is, the government is assumed to have an equity objective which implies the need to be able to estimate changes in real
income by household group. Second, the government is assumed to have a revenue objective. It is, therefore, interested in the effect of its policies on the budget both directly through taxes and subsidies and indirectly through parastatal surpluses and deficits. Third, we assume that the government has a balance of payments objective. The model should, therefore, be able to predict the effect of different price structures on agriculture's net contribution (possibly negative) to foreign exchange earnings. A fourth objective of the government is to secure self-sufficiency in its basic food crop, maize. It is necessary, therefore, to explore how the country's dependence on maize imports varies as prices are changed. Finally, the government is assumed to be concerned that the country's resources are used as efficiently as possible. That is, governments are anxious to ensure that the incomes derived from a given quantity of agricultural inputs are as large as possible. Obviously, there is no reason to suppose that any particular price policy will achieve all objectives simultaneously. The essential purpose of the model, therefore, is to illuminate the trade-offs among the different objectives as revealed by the adoption of alternative pricing policies.

3.2 Household Incomes and Equity

The supply system (equation 1) and the demand system (equation 2) yield important information about the effect of pricing policy on different household groups. Recall that these systems have microeconomic foundations. For example, the effect on farm profits of any exogenous change in input or output prices at the farmgate can be
calculated through equation 1c. Since this equation allows for changes in both yield and the allocation of land among crops, it captures the important (first-round) substitution effects. Thus, a reduction in the price of, say, fertilizer can be expected to increase total farm profits and the supply of those crops that make intensive use of fertilizer (see equation 1e).

These first-round effects, however, are not the end of the matter. The increase in farm profits will imply an increase in total household income (see equation 2d) which will, in turn, increase demand for all food crops. The change in the marketed surplus of food crops, therefore, depends on both the supply response and the demand response (see equation 2e) in farm households. Assume that the marketed surplus of both wheat and beans is increased as a result of the original reduction in the price of fertilizer. Since the consumer price of wheat is set by the government, demand by urban consumers and the rural landless will be unaffected. The increase in marketed surplus will, therefore, allow the government to decrease wheat imports. The price of beans, however, is free to adjust to changes in demand and supply. For this crop, therefore, the increase in marketed surplus will elicit a reduction in the free market price. But a change in the price of beans will imply a second round of adjustments in yields and land allocation. These second-round effects may or may not be quantitatively significant. A significant attribute of the model is that they are captured automatically at no cost to the analyst. The model yields a solution that corresponds to the ultimate resting place of the system following
any exogenous price change. It is possible, therefore, to test the
significance of allowing for these interactions and second-order effects
by comparing the results of the model with those of simpler approaches.

Once the model has been solved, the analyst can report the
changes in farm profits (see equation 1c) for each representative
household. This is important information and the consequences for farm
profits of several alternative pricing policies are reported in our
simulation results. This information is not sufficient, however, in the
event that consumer prices also change. What the analyst or policy-
maker really needs is a measure indicating whether or not a household
group has benefited by a particular policy change, and by how much.
Changes in nominal incomes do not provide this information when consumer
prices are also changing. And for some households -- rural landless and
urban households -- nominal incomes may have remained unchanged but any
change in consumer prices for basic foods would obviously affect these
households in a very real sense. We, therefore, need a method of
measuring changes in well-being when consumer prices change whether or
not nominal incomes are also changing.

One relatively simple procedure involves deflating nominal
incomes by some price index. Then, even if nominal incomes do not
change, real incomes -- nominal income deflated by the price index --
will still be affected by changes in prices. One difficulty with this
approach is that the choice of weights for the price index is
arbitrary. An alternative procedure is to take advantage of the fact
that the utility function underlying the demand system offers a precise
means of measuring changes in well-being. Moreover, this measure can be
given a simple monetary interpretation -- it is the amount of income
which makes a household just as well off at the new configuration of
prices at it was at the old set. This, of course, is a well-known
concept in welfare economics and is usually described as the compen-
sating variation. Since it is calculated by keeping constant the
household's level of satisfaction as prices change, it requires that:

\[ u(P^0, Y^0) = u(P^1, Y^0 + \varepsilon) \]  

-8a-

where \(u(P^0, Y^0)\) is the level of utility at the old set of prices \((P^0)\) and
with income \(Y^0\), and \(u(P^1, Y^0 + \varepsilon)\) is the same level of utility at the
new set of prices \((P^1)\) and with income \(Y^0 + \varepsilon\). In this case,
therefore, \(\varepsilon\) measures the change in income required to compensate for
the change in prices. \(\varepsilon\) may, of course, be either positive or nega-
tive. Since for some households -- smallholders and large farms -- farm
profits may also change, the measure of \(\varepsilon\) is obtained from:

\[ u(P^0, Y^0) = u(P^1, Y^1 + \varepsilon) \]  

-8b-

where the introduction of \(Y^1\) on the right hand side allows for the
price-induced change in household income.

The simulation results in Section 4 report the effect of a
price change on the nominal incomes of smallholders and large farms. In
particular, we report the change in nominal farm profits from equation
lc. In addition, we show the effect on real incomes defined as nominal incomes deflated by a simple price index. These results are reported for all household groups and are a good measure of the effects of a price change on equity. In this application, we have not calculated the measures of compensating variation.

3.3. Budget Revenues, Foreign Exchange and Self-Sufficiency

The system of market-clearing equations -- equations 3a, 4a, 6a and 7a -- for the crops and inputs controlled or partially controlled by the public sector provides information on quantities of exports for tea and coffee, of procurement and imports for maize, and of imports of wheat and fertilizer. As can be seen from equations 3b, 4b, 4c, 6b, 6c, and 7b, all these activities are either taxed or subsidized. These equations can be used, therefore, to measure the overall budget deficit or surplus associated with any particular agricultural pricing and marketing policy. Government revenues are derived from agriculture through export taxes or through profits from market intermediation:

\[
\text{Net Revenue} = NR = E_c t_c + E_T t_T \\
+ [n (S_m^L - d_m^L) + L]h_m + (S_m^L - d_m^L)h_m \\
+ M_m^M h_m + M_w^M h_w + M_h^M h_h
\]

where the first line represents tax revenues from coffee (c) and tea (T), the second line shows marketing revenues from maize (M) and wheat
(w), and the third line indicates marketing revenues from imports of maize, wheat, and fertilizer (F). Usually, the marketing board's price margin will be insufficient to cover its costs, so the unit revenues (h) from marketing, and the contribution to net revenue, will be negative. This assumes that any profits or losses incurred by the parastatals ultimately accrue to the central government. Accepting this assumption, equation 9a provides the most realistic assessment of the fiscal burden generated by the government's agricultural pricing policy. Our simulations report the changes in equation 9a induced by changes in pricing policy.

We can, of course, conduct a similar exercise to identify the effect of any change in prices on the balance of payments. The government's foreign exchange earnings are generated by coffee (c) and tea (T) exports. Therefore, gross foreign exchange earnings are:

\[
\text{Gross Foreign Exchange Revenues} = \text{GFER} = E_C P_C^e + E_T P_T^e
\]

-9b-

The model allows for the possibility of maize and wheat exports, which would contribute to foreign exchange earnings. These rarely occur, however. From its transactions in the international market for maize (m), wheat (w) and fertilizer (F), gross foreign exchange expenditures are:

\[
\text{Gross Foreign Exchange Expenditures} = \text{GFEE} = M_m P_m^m + M_w P_w^m + M_F P_F^m
\]

-9c-
The net balance-of-payments effect, therefore is:

$$\text{Net Foreign Exchange Revenue} = \text{GFER} - \text{GFEE}$$ \[9d\]

The effect of alternative pricing policies on equation 9d is also reported in the simulation exercise. There is no reason, of course, to suppose that policies which yield benefits in terms of budget revenues will also necessarily yield benefits in terms of foreign exchange revenues.

Many governments are also interested in self-sufficiency, especially with respect to their food crops in urban areas. To illustrate this point, the model computes the urban self-sufficiency index for maize. This index is defined as the ratio of domestically procured production to total urban consumption at the official consumer price in urban areas.

That is,

$$\text{Maize Urban Self-Sufficiency Index} = \frac{ns_m^L - nd_m^L + L}{D_u(P_{u})} \times 100\%$$ \[9e\]

where $(ns_m^L - nd_m^L)$ is procurement from large farms, $L$ is procurement from small farms, and $D_u$ is urban demand evaluated at the official price $P_u$. A ratio of 100% indicates complete self-sufficiency in urban areas. A ratio of 95% implies that 5% of domestic urban consumption has
to be imported. Efforts to secure a higher urban self-sufficiency ratio may, of course, imply costs in terms of the other objectives. This trade-off is analyzed in our results.

The market-clearing equations and their associated price relationships thus provide information on several objectives usually considered important by policymakers. Moreover, the consequences for government revenue, the balance of payments, and urban food self-sufficiency are calculated when full allowance is made for interactions between outputs and inputs and for substitution possibilities in production and consumption. As we shall show in the simulation exercise, this point becomes extremely important when more than one price is changed.

3.4 Resource Allocation

Governments, and the World Bank, are also concerned with efficient resource allocation. In particular, one would like to know whether or not a change in pricing policy improves the allocation of resources. Since an improvement in resource allocation implies a net increase in real incomes, one wants to know whether or not a change in pricing policy increases net real income aggregated over all affected parties in the economy. In our particular application, a change in prices affects rural farm households (through a change in producer income and a change in consumer prices), all rural, landless and all urban households (through a change in consumer prices), and the government (through a change in its net revenues). If the sum of (a) changes in the real incomes of all private agents affected by the policy
change and (b) the induced change in government revenue is positive, net real incomes have increased, and overall resource allocation has improved.

The results given so far contain all the information necessary to measure the change in resource allocation. Thus, the change in real income or the compensating variation -- that is, that amount of income necessary to compensate for a given change in prices -- has already been calculated for pure consumers (equation 8a) and for consumer/producers (equation 8b). Similarly, the change in net revenue (measured by equation 9a) provides an approximate measure of the change in real income accruing to the government. This measure is described as approximate because it does not allow for the fact that the prices of some commodities -- food crops and export crops -- have changed. However, since the measure of net revenue is calculated after allowing for the government's expenditure (i.e. subsidies) in the affected markets, it is reasonable to assume that its remaining expenditure is on commodities and services for which prices have not changed. In this event, our measure of nominal net revenue from equation 9a equals the increase in real government income.

The improvement in resource allocation or the increase in the country's overall level of welfare ($\Delta W$) following a policy change can be measured, therefore, as follows.

\[
\text{Change in Welfare} = \Delta W = \sum_{i} \Delta c_i + \Delta NR
\]
where $\epsilon_1$ is the change in real income or the compensating variation for the representative household of the $i^{th}$ type, $n_i$ is the number of households in the $i^{th}$ group, and $\Delta NR$ is the change in net revenue accruing to the government. Note that the efficiency of resource allocation is improved if the sum of all items on the right hand side of equation 10a is positive. This, of course, implies that some groups or even the government may suffer losses and yet the overall allocation of resources may still be improved. This measure, therefore, abstracts from equity considerations. The focus is exclusively on the efficiency of resource allocation. The success of a particular policy intervention with respect to this objective must, therefore, be evaluated by reference to the effect on other objectives. This task is undertaken in Section 4.

IV. SAMPLE MODEL SIMULATION RESULTS

The purpose of this section is to present some results from the prototypical model outlined in Section Two. These results should not be taken as representative of the region as a whole or of any particular country. The model, as section two pointed out, is a prototype. Its assumptions are hypothetical (as are the data used), and are intended to demonstrate the scope and flexibility of the modeling technique rather than its applicability to a particular country. Consequently, these model results demonstrate which types of information the model can provide, and how this information can be applied in policy
analysis. The particular results are not relevant except to check the direction of the predicted changes and the logic of the model.

The results from sample simulations of the prototype East Africa agricultural pricing and marketing model are shown in Tables 4-1 through 4-5. Table 4-1 summarizes the effect of a range of policy instruments on the five objectives outlined in Section Three. Table 4-2 shows in more detail the results of simulations of alternative maize pricing policies. Table 4-3 compares the effects of changes in the buying and selling prices for wheat. Table 4-4 shows the results of government policies to control formal maize market volume through imports and exports and the results of increases in taxes on export commodities. Table 4-5 shows the results of policies designed to equate domestic prices of inputs and outputs to their border pricing equivalents and examines the effects of currency devaluations, both with and without compensating adjustments in the fixed agricultural commodity prices set by the government.

The prototype model reports the following information presented in Tables 4-2 through 4-5:

1. **Policy Variables** - the fixed government farm prices, consumer prices, export commodity taxes, currency exchange rates, and import and export quotas that affect the agricultural sector.

2. **Prices** - the equilibrium prices for each of the informal markets, and farm prices for export commodities.
3. **Demand and Supply** - the volume of consumption and production for each agricultural commodity by each major population sector (smallholders, large farmers, and urban dwellers).

4. **Imports and Exports** - the volume of each agricultural commodity and production factor entering or leaving the country, and the net balance of payments for agricultural commodities.

5. **Government Agricultural Commodity Revenues** - the net revenues or losses to the government resulting from its intervention in each market, and the net balance for all agricultural commodities.

6. **Factor Demand** - The demand for fertilizer for each crop.

7. **Farm Profits** - Farm cash incomes and profits from each crop, for small and large farms.

Some of the detailed results from Tables 4-2 to 4-5 are summarized in Table 4-1 as indices relating the five primary policy objectives to their base run value. With the exception of the urban self-sufficiency ratio, the indices are normalized in the base year to make comparisons among policy simulations more straightforward. The budgetary gain or loss to the government is represented by the net government revenues from agricultural commodities. The agricultural balance of payments represents the net foreign exchange revenue from agriculture.
The urban self-sufficiency ratio indicates how much maize would have to be imported, given current domestic production, to meet urban demand at the official price. This quantity of maize may not actually be imported, however, because the government may prefer to eliminate excess urban demand by means of an increase in the black market price for maize. The index, therefore, reports the quantity of imports that would be required to satisfy urban demand at the government's own selling price. A value of this ratio greater than 100 indicates that there is a surplus of maize at the official price which must be exported or stored. Real income per capita indicates the cash income of each group, adjusted for changes in food prices. The economic efficiency index is the sum of the net real income for the entire population and the net government revenue and measures the change in the efficiency of resource allocation or economic welfare.

The "base run", indicated in the first column of Tables 4-1 through 4-5, provides a point of reference with which the policy simulations can be compared. The base run is the same for each table. In a country-specific modeling exercise, it would represent the model's approximation of the current state of the agricultural sector, with the existing government policies in place. A comparison of the base run results with the current conditions of the country under study provides a check on the accuracy of the model's parameters and the consistency of its logic.

One feature of the base run worth noting is that only a small fraction of the food grains produced and consumed ever pass through the
government-controlled markets. For example, in the base run only 7% of the maize crop enters the formal market. The great majority of food crop production is consumed by the farm households themselves. Most of the remainder is traded through rural, informal markets. Consequently, some government policies will have an effect on the agriculture sector as a whole that is much smaller than would be expected from generalizations based on government-controlled markets and procurement data alone.

We focus our discussion on only some of the results summarized in Table 4-1 and on those policy objectives and interactions that help to illustrate the value of such a modeling exercise in understanding pricing and marketing outcomes in the agricultural sector. (Those interested in detailed results can of course look them up in Tables 4-2 to 4-5.)

4.1 Changing Procurement Prices

(a) Maize Procurement Price

Consider, for example, the effects of a 20 percent decrease in the government procurement price for maize. The 12% increase in government revenues in this simulation illustrates the conceptual richness of this type of modeling because it captures the interdependent effects on government revenues from a number of sources. Why do total government revenues increase when maize prices are cut? The direct and obvious answer is that government is now paying less for its maize and selling it at the previous price thereby increasing net revenues. But the obvious answer is incorrect. What in fact happens is that government revenues from maize actually decline, because although the government's
profit margin for maize is greater, its procurement volume has decreased even more. Partial equilibrium techniques will readily give us this result. However, in response to changing relative prices (and profits), farmers convert some of their cropland from maize to wheat. As a result, there is less maize and more wheat in the formal market. In fact, it is the increased production and procurement of wheat that boosts government revenues by diminishing the need for wheat imports, which are heavily subsidized. Models that omit the linkages between production, procurement, and demand systems for different crops would fail to account for this effect. By considering the supply and demand sides simultaneously, models of this type can capture a number of important interactions that would be overlooked by simpler analyses.

Next, consider the results of a 20% increase in the government procurement price for maize. The loss of government revenues in this case is much larger than one would expect as a result solely of the decrease in the maize profit margin. Much of the loss in revenues results instead from a dramatic increase in formal market maize supplies that is not completely offset by increases in formal market demand, making it necessary for the government to store or export the excess maize at a substantial loss. At the chosen procurement price, formal market supplies are more than sufficient to meet the demand from urban consumers at the official selling price. The urban black market for maize becomes very small, and the government is faced with the prospect of storing or exporting substantial quantities of maize.
<table>
<thead>
<tr>
<th></th>
<th>Base Run</th>
<th>Decrease Maize Purchase Price 20%</th>
<th>Increase Maize Procurement Price 20%</th>
<th>Decrease Wheat Procurement Price 20%</th>
<th>Increase Wheat Procurement Price 20%</th>
<th>Increase Rice Export Tax</th>
<th>Increase Coffee Export Tax</th>
<th>Border Prices: Wheat, Coffee &amp; Tea</th>
<th>Border Prices in wheat, coffee &amp; tea; also govt. subsidies black market price</th>
<th>&quot;Theoretical&quot; currency 20% but keep wheat &amp; coffee prices constant to compensate</th>
<th>&quot;Theoretical&quot; currency 20% &amp; change govt. prices to compensate</th>
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</thead>
<tbody>
<tr>
<td><strong>Net Government Revenues from</strong></td>
<td>100.0</td>
<td>112.4</td>
<td>-53.4</td>
<td>84.5</td>
<td>105.3</td>
<td>329.4</td>
<td>578.3</td>
<td>0.0</td>
<td>0.0</td>
<td>15.7</td>
<td>319.5</td>
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<td><strong>agricultural commodities</strong></td>
<td></td>
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<tr>
<td><strong>Balance of payments for</strong></td>
<td>100.0</td>
<td>102.0</td>
<td>105.4</td>
<td>99.3</td>
<td>102.5</td>
<td>95.4</td>
<td>92.8</td>
<td>109.36</td>
<td>107.2</td>
<td>142.7</td>
<td>145.6</td>
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<tr>
<td><strong>Urban maize self-sufficiency</strong></td>
<td>66.8</td>
<td>-13.0</td>
<td>303.0</td>
<td>102.7</td>
<td>28.1</td>
<td>67.1</td>
<td>67.3</td>
<td>7.9</td>
<td>99.6</td>
<td>10.8</td>
<td>118.3</td>
</tr>
<tr>
<td><strong>ratio</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Real Income per capita, rural</strong></td>
<td>100.0</td>
<td>99.3</td>
<td>100.0</td>
<td>100.0</td>
<td>99.7</td>
<td>100.0</td>
<td>103.0</td>
<td>99.2</td>
<td>99.6</td>
<td>98.6</td>
<td>98.5</td>
</tr>
<tr>
<td><strong>landless</strong></td>
<td>100.0</td>
<td>106.2</td>
<td>99.9</td>
<td>99.9</td>
<td>101.3</td>
<td>96.5</td>
<td>93.1</td>
<td>105.2</td>
<td>102.5</td>
<td>125.2</td>
<td>121.8</td>
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<tr>
<td><strong>smallholders</strong></td>
<td>100.0</td>
<td>95.3</td>
<td>103.7</td>
<td>103.2</td>
<td>103.7</td>
<td>98.2</td>
<td>97.2</td>
<td>103.3</td>
<td>103.8</td>
<td>108.7</td>
<td>110.5</td>
</tr>
<tr>
<td><strong>large farms</strong></td>
<td>100.0</td>
<td>96.8</td>
<td>106.4</td>
<td>106.4</td>
<td>96.1</td>
<td>100.0</td>
<td>100.0</td>
<td>96.7</td>
<td>103.4</td>
<td>95.2</td>
<td>100.9</td>
</tr>
<tr>
<td><strong>Real Income per capita, urban</strong></td>
<td>100.0</td>
<td>98.4</td>
<td>101.4</td>
<td>101.4</td>
<td>98.8</td>
<td>100.0</td>
<td>100.1</td>
<td>98.3</td>
<td>101.0</td>
<td>98.5</td>
<td>100.3</td>
</tr>
<tr>
<td><strong>poor</strong></td>
<td>100.0</td>
<td>99.5</td>
<td>100.5</td>
<td>100.5</td>
<td>99.5</td>
<td>100.0</td>
<td>100.0</td>
<td>99.3</td>
<td>100.3</td>
<td>99.4</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>middle income</strong></td>
<td>100.0</td>
<td>102.4</td>
<td>94.9</td>
<td>100.0</td>
<td>101.0</td>
<td>99.5</td>
<td>101.2</td>
<td>101.8</td>
<td>117.6</td>
<td>119.1</td>
<td></td>
</tr>
<tr>
<td><strong>high income</strong></td>
<td>100.0</td>
<td>94.9</td>
<td>100.0</td>
<td>101.0</td>
<td>99.5</td>
<td>101.2</td>
<td>101.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Economic Efficiency Index</strong></td>
<td>100.0</td>
<td>102.4</td>
<td>94.9</td>
<td>100.0</td>
<td>101.0</td>
<td>99.5</td>
<td>101.2</td>
<td>101.8</td>
<td>117.6</td>
<td>119.1</td>
<td></td>
</tr>
</tbody>
</table>
The effect of altering maize procurement on net foreign exchange earnings also merits discussion. A 20% decrease in the maize procurement price increases net foreign exchange earnings by almost 2%; a 20% increase in the same price also improves earnings by 5%. The reasons for these initially puzzling outcomes lie in the substitutions occurring in production and in the operation of the urban black market for maize. A decrease in the procurement price causes farmers to switch into wheat, thereby reducing the need for wheat imports. The reduction in maize production does not affect the balance of payments directly, because demand is brought into line with the lower level of production by means of an increase in the urban black market price. When the procurement price is increased by 20%, however, the urban black market, as noted above, disappears. Moreover, the government still has a maize surplus available for export earnings. In this case, therefore, the change in maize production does have a direct effect on the balance of payments which proves to be more than sufficient to offset the reduction in wheat production (and hence increase in wheat imports) occurring as farmers convert cropland to maize production.

Reading across the columns for the urban maize self-sufficiency index, it is clear that the maize procurement price is the most effective instrument for achieving this objective. In the base run, urban demand at the official selling price exceeds procurement by 33%. A decrease in the maize procurement price of 20% is sufficient to eliminate official procurement altogether leaving urban consumers to be supplied totally by imports or informal black markets, while a 20%
increase in the price results in official procurements three times as great as urban demand. No other instrument has such a powerful influence on the urban self-sufficiency ratio.

With respect to the equity objective, the only households to benefit from a reduction in the procurement price for maize are smallholders. They benefit because they can take advantage of the now-higher urban black market price for maize. All pure consumers -- the rural landless households and all urban households -- suffer because of higher consumer prices. This is especially true for the urban poor who suffer a 5% loss in real income. Unable to take advantage of urban black market prices, large farm-households also suffer because of reduced profits. Their profits from increased wheat production are not enough to offset declining profits from decreased maize production which has to be sold via formal markets at reduced prices. The results are exactly reversed for an increase in the maize procurement price.

The effect on the efficiency of resource allocation reflects the effects on the real incomes of private agents and on government revenues. Given the size of the smallholder group, the direction of the effect on overall resource allocation is usually the same as the direction of the change in real incomes for smallholders. Unfortunately, the incomes of smallholders tend to move in the opposite direction.

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1/ In the hypothetical case we have assumed that the number of smallholders are nearly ten times the number of large farms and cultivate just under 50% of the total area under food plus export crops. This is close to the actual proportion in Kenya, for example.
to those of the very poor. A change in maize procurement prices thus has the effect of influencing resource allocation and the real incomes of the poorest -- the urban poor and the rural landless -- in opposite directions.

(b) Wheat Procurement Price

The interaction between markets and supply systems is also illustrated in the results for changes in the procurement price for wheat. One notable effect is that when the procurement price is decreased, government revenues decrease as well, and when the procurement price is raised, government revenues increase. This arises because wheat supply is highly elastic, and because changes in wheat supply have an exaggerated effect on the budget, wheat imports (which must offset production fluctuations) being heavily subsidized. In this case, therefore, the main budgetary effect of a change in the domestic procurement price for wheat is felt indirectly through changes in the economy's need to resort to highly-subsidized imports.

In general, changes in the procurement price for wheat have a relatively limited impact on the agricultural economy. The changes in government revenue, net foreign exchange earnings, equity, and efficiency are all minor compared with those of other policy instruments. This reflects the insignificance of wheat in the economy. In the base run, for example, wheat production (in tons) is only 3% of maize production and wheat consumption is only 18% of maize consumption. Its relative unimportance notwithstanding, changes in the procurement price for wheat still have a sizeable impact on urban maize self-sufficiency.
This reflects the substitution possibilities in production on large farms. Maize production is sensitive to changes in the procurement price for wheat.

4.2 Changing Export Taxes

Export taxes have the expected effect since the interactions between export crops (tea and coffee) and other crops are very limited both in production and consumption. By assumption, export crops are not grown on land that is suitable for the cultivation of food crops, nor are they consumed domestically. Nevertheless, the model allows us to investigate the trade-offs between budget revenues and foreign exchange earnings and between budget revenues and farm incomes.

An increase in the export tax of coffee from 2 to 10% of the export price has a very substantial impact on government revenue. While budget revenues increase over fivefold, net foreign exchange earnings decrease by less than 10%. This may appear to be an attractive and relatively low-cost means of raising revenue. The increase in revenue, however, is obtained at the expense of a 7% cut in the real incomes of smallholders who are the predominant group in the population. A large increase in government revenue is being achieved, therefore, at the expense of a small decrease in incomes for a large part of the population.

The reason for these results is that coffee and tea have only small production substitution possibilities (we have assumed that the land cannot be used for other crops), so that supply response is relatively price inelastic. Raising export taxes while lowering prices paid
to producers has only a small impact on production in the short run. Lower prices maintained over a longer period could reduce production considerably. Alternatively, if other crops can be grown on the land on which export crops are grown -- as in the case of cotton in Sudan -- increased export taxes would reduce producer prices and, if substitution possibilities are significant, reduce production, government revenues and exports.

4.3 Border Pricing

A common policy prescription in African countries, where domestic price distortions are deemed to be very large, when measured in terms of international prices, is to recommend that domestic prices of inputs and outputs be made to conform to their border price equivalents. Policies of this type will inevitably involve multiple price changes. The impact of such changes is difficult to measure with simpler models, or (as we show later) if measurable could prove to be wrong. The model developed here can, however, easily handle the simultaneous changes in multiple input and output prices which are involved in border pricing recommendations.

Two simulations of border pricing policies were performed on the model. In the first border pricing simulation, tea and coffee prices are set at the export parity price, the government's markup of maize is set to just cover its expenses, and wheat buying and selling prices are set at the import parity prices. The maize price is not changed, because maize is being neither imported nor exported. Because the government has raised its buying price for wheat but not for maize,
large farms produce more wheat and less maize. Because government maize procurement drops, most of the urban maize demand is met through the black market, at over twice the urban formal market selling price. The fraction of urban maize demand met by the formal market (the maize self-sufficiency ratio) drops from 66.8% to 7.9%.

The shrinkage of the formal maize market, a rise in the government's selling price for wheat (to bring it to parity with the import price), and a rise in the rural prices of maize and beans all contribute to a drop in the real incomes of urban dwellers and the rural landless. By contrast, the real incomes of smallholders and large farms grow substantially due to the increases in producer prices, which are great enough to outweigh the effects of consumer price increases for these households.

The agricultural balance of payments improves because wheat imports have been sharply reduced, and because tea and coffee exports have increased slightly.

In both of the border pricing runs, the government nets no revenue from its parastatal activities. This results from the definition of border pricing: namely, that the government conducts each of its marketing operations at cost.

The second border pricing simulation is similar to the first, except the government buying and selling prices for maize are adjusted upward until the government selling price approximates the black market price for maize. Only a small increase in the government maize procurement is required to increase formal market supplies sufficiently to
dramatically decrease black market maize demand. As a result, the formal market and black market maize selling prices meet at a price only slightly greater than the formal market price in the first border pricing run, but substantially smaller than the previous black market price.

The results of this small shift in maize prices are substantial. As one would expect, the government maize price increase substantially improves the maize self-sufficiency ratio (from 7.9-99.6 %). The increase in maize output from large farms implies a slight decrease in wheat production and a corresponding rise in wheat imports and fertilizer imports (because net agricultural output has grown). Consequently, the agricultural balance of payments index drops slightly, from 109.3 in the first border pricing run to 107.2.

The most interesting shift, however, appears in real incomes. Whereas the first border pricing run improved rural smallholder and large farm real incomes, but decreased all other real incomes, the second border pricing run improves all real incomes except those for the rural landless group. Real incomes for smallholders and large farms increase because the effects of higher farm prices outweigh the effects of higher consumer food prices. Urban real incomes improve, despite increases in urban prices for wheat and beans, because black market maize prices and volumes have decreased substantially, lowering the average urban maize price significantly.
4.4 Devaluation

Another common policy prescription designed to offset the effects of overvalued exchange rates is devaluation. In order to demonstrate the ability of the model to treat multiple and simultaneous policy interventions, we have simulated the effect of a currency devaluation, which changes the prices of all tradeable commodities, including food crops, export crops and some agricultural inputs. Devaluation simulations were performed under two distinct sets of assumptions. The first was that the currency would be devalued but that fixed government prices for maize and wheat would remain unchanged in domestic currency terms -- that is, the government does not pass on the effects of the devaluation to producers and consumers of domestically produced maize and wheat. The increase in the prices of tradeables -- of tea, coffee and fertilizers -- is passed on. The second set of simulations assumes that the currency would be devalued and government wheat and maize prices would be increased by the same amount, so that the prices of these crops to producers and consumers remain constant in terms of foreign exchange. In other words, the prices of these commodities and export crops and fertilizers are increased and the full effect of the devaluation is passed on. In practice only a part of the devaluation effects may be felt by producers and consumers -- that is, only a proportion of the increase in the prices of export and food crops or inputs may be passed on. In the model any combination of price changes faced by producers and consumers as a result of devaluation can be analyzed.
The simulation results show that adjusting government maize and wheat prices to keep pace with the devaluation -- passing on the full effects of the devaluation -- dramatically increases government revenue and moves the economy to a position of maize self-sufficiency (see last column). The reason for this outcome is simple. If government food prices are allowed to increase to adjust to devaluation, demand will fall and production will rise. The production of export crops increases, but because they do not compete for land with food crops, this is done without a reduction in food crop production. Because the prices of non-tradeable farm inputs (such as labor) have declined relative to prices for tradeable commodities, farm output increases. Similarly, because food prices have increased relative to labor rates, demand for food crops declines. The resulting increase in maize supply is sufficient to produce a net surplus, and wheat imports are sharply cut, thereby improving net government revenues.

If, on the other hand, government and procurement prices are kept artificially low relative to the devalued prices (second to last column), the demand for maize and wheat will increase and production will drop simultaneously relative to other commodities. Consequently, the government must import greater volumes of wheat at greater rates of subsidy and excess urban demand for maize must be eliminated either through additional imports or through adjustments in the black market price with consequent loss in government revenues.

Apart from these differences, the two devaluation packages have very similar effects on other government objectives. For example,
<table>
<thead>
<tr>
<th></th>
<th>Base Run</th>
<th>Decrease Wheat Procurement Price 20%</th>
<th>Increase Wheat Procurement Price 20%</th>
<th>Decrease Wheat Procurement Price 20%</th>
<th>Increase Wheat Procurement Price 20%</th>
<th>Increase Tea Export Tax from 5% to 10%</th>
<th>Increase Coffee Export Tax from 5% to 10%</th>
<th>Border Prices in wheat, coffee and tea</th>
<th>&quot;Devolve&quot; Currency 20% but keep wheat and maize prices constant</th>
<th>&quot;Devolve&quot; Currency 20% and change government prices to compensate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net government revenues from agricultural commodities</td>
<td>100.0</td>
<td>112.4</td>
<td>-538.4</td>
<td>84.5</td>
<td>102.5</td>
<td>92.8</td>
<td>106.3</td>
<td>0.0</td>
<td>0.0</td>
<td>15.7</td>
</tr>
<tr>
<td>Balance of payments for agricultural commodities and inputs</td>
<td>100.0</td>
<td>102.0</td>
<td>105.4</td>
<td>99.3</td>
<td>102.5</td>
<td>92.8</td>
<td>106.3</td>
<td>0.0</td>
<td>0.0</td>
<td>142.7</td>
</tr>
<tr>
<td>Urban maize self-sufficiency ratio</td>
<td>66.8</td>
<td>103.0</td>
<td>102.7</td>
<td>28.1</td>
<td>67.1</td>
<td>67.3</td>
<td>7.9</td>
<td>99.6</td>
<td>10.8</td>
<td>118.3</td>
</tr>
<tr>
<td>Real income per capita, rural:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlords</td>
<td>100.0</td>
<td>99.9</td>
<td>100.0</td>
<td>99.7</td>
<td>100.0</td>
<td>99.2</td>
<td>99.6</td>
<td>98.6</td>
<td>98.6</td>
<td>98.3</td>
</tr>
<tr>
<td>Smallholders</td>
<td>100.0</td>
<td>104.2</td>
<td>99.9</td>
<td>99.5</td>
<td>101.5</td>
<td>95.1</td>
<td>95.6</td>
<td>105.2</td>
<td>105.2</td>
<td>125.2</td>
</tr>
<tr>
<td>Large farms</td>
<td>100.0</td>
<td>99.5</td>
<td>103.7</td>
<td>100.2</td>
<td>100.7</td>
<td>98.2</td>
<td>97.2</td>
<td>103.3</td>
<td>103.8</td>
<td>106.7</td>
</tr>
<tr>
<td>Real income per capita, urban:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>100.0</td>
<td>94.8</td>
<td>104.4</td>
<td>104.4</td>
<td>96.1</td>
<td>100.0</td>
<td>94.7</td>
<td>103.4</td>
<td>95.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Middle income</td>
<td>100.0</td>
<td>98.6</td>
<td>101.4</td>
<td>101.4</td>
<td>98.8</td>
<td>100.0</td>
<td>98.3</td>
<td>101.0</td>
<td>98.5</td>
<td>100.0</td>
</tr>
<tr>
<td>High income</td>
<td>100.0</td>
<td>99.6</td>
<td>100.3</td>
<td>100.3</td>
<td>99.5</td>
<td>100.0</td>
<td>99.3</td>
<td>100.3</td>
<td>99.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Economic efficiency index</td>
<td>100.0</td>
<td>102.4</td>
<td>96.6</td>
<td>100.0</td>
<td>99.5</td>
<td>103.2</td>
<td>101.8</td>
<td>117.6</td>
<td>119.1</td>
<td></td>
</tr>
</tbody>
</table>
both packages increase the real incomes of smallholders by around 20%, improve the allocation of resources significantly, and contribute to net foreign exchange earnings.

Although we have only investigated a very small number of possible policy packages, it is clear that a devaluation which is allowed to influence all tradeable prices, including those controlled by the government, emerges as the most desirable policy change from most perspectives. It increases government revenues substantially, it improves the balance of payments, it moves the economy to a position of maize self-sufficiency, it increases farm incomes, and it improves resource allocation. The only group to lose noticeably are the rural landless whose purchasing power from a fixed labor income has obviously decreased. Note that urban consumers, although also existing on fixed nominal incomes, do not suffer a loss of real income despite the effect of the devaluation on consumer prices. This apparently impossible result arises because the post-devaluation price of maize to urban consumers is still less than the pre-devaluation, black market price of maize. In this case, therefore, devaluation, which usually reduces the real incomes of those with fixed nominal incomes, has the opposite effect because of supply-side developments. That is, the increased supply of maize occurring as a result of devaluation effectively eliminates the urban black market, thereby ensuring lower prices at the margin for urban consumers.

In interpreting these results, however, three caveats should be kept in mind. First, we have not considered the effect of devalu-
tion on other parts of the economy. Second, we have assumed that the change in the relative prices of tradeables and nontradeables is sustained. We have not allowed for the erosion of a nominal devaluation as domestic inflation in excess of international inflation undermines the original gain in international competitiveness. Clearly, the model presented here has nothing to say on either of these points. And third, we have not considered the effect of an increase in the prices of nonfood, tradeable consumer goods. This would tend to reduce real incomes for all groups. It should, however, be possible to allow for this effect within the present structure of the model.

4.5 Comparison with Simpler Approaches

The analysis of export taxes offers an interesting example of the value of models that incorporate the possibilities for substitution in production and consumption. These possibilities are very limited in the case of coffee. We have, therefore, also computed the change in budget revenues and foreign exchange earnings by means of the consumer surplus/producer surplus approach. In this approach we have, therefore, calculated the effect on budget revenues and foreign exchange revenues by simply looking at areas under the supply curve for coffee. This method requires construction/estimation of only one supply curve. Nevertheless, the results of this approach for this simulation are remarkably similar to those obtained from the full model:
<table>
<thead>
<tr>
<th></th>
<th>Balance of Payments Index</th>
<th>Government Revenue Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Run</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Simple Model</td>
<td>89.4</td>
<td>577.5</td>
</tr>
<tr>
<td>Full Model</td>
<td>92.8</td>
<td>578.3</td>
</tr>
</tbody>
</table>

The above table reports the effects of an increase in the coffee tax from 2% to 10%. Clearly, in this case, it makes very little difference to the estimate of the budgetary effect whether one uses the full model or the simple model. It does make a small difference, however, as far as foreign exchange earnings are concerned because the reduced revenue from coffee exports is partially offset by the reduction in imports of fertilizer. This effect is not captured by the simple model. Moreover, the conclusion — that the simple model produces results similar to the full model — becomes less tenable as the range of substitution possibilities between crops in production increases. In cases where export crops compete for land with other crops (cotton, groundnuts, oilseeds, sugarcane, and tobacco are important examples in East Africa) there will be significant differences between the simple and full model for both government revenues and foreign exchange. The simple model breaks down entirely when the analyst wants to investigate the consequences of simultaneous intervention in more than one market.

Application of the "simple model" to the analysis of devaluation illustrates the value of the "full model" when more than one price is changed. Consider the case in which the government does not
pass on the effect of the devaluation to producers and consumers of maize and wheat. That is, "devaluation" is assumed to influence the farmgate prices of tea, coffee, and fertilizer but nothing else. We have calculated the effects of this policy change on budget revenues and foreign exchange for the "simple model" by focusing exclusively on own-price effects. That is, the effect of a change in the price of fertilizer is captured by examining only the demand curve for fertilizer and observing the change in the quantity demanded as the fertilizer price is changed. The effect of this change on budget revenues and foreign exchange is then recorded. The process is repeated for the tea supply curve and the tea price and so on. The results of the three independent calculations -- for fertilizer, tea, and coffee -- and an estimate of the increased cost of wheat imports are then summed to arrive at the simple model's approximation of the consequences of simultaneous price changes in three markets. These results can then be compared with those of the "full model" where these simultaneous price changes are treated jointly:

<table>
<thead>
<tr>
<th></th>
<th>Balance of Payments Index</th>
<th>Government Revenue Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Run</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Simple Model</td>
<td>179.9</td>
<td>87.3</td>
</tr>
<tr>
<td>Full Model</td>
<td>142.7</td>
<td>15.7</td>
</tr>
</tbody>
</table>
In the simple model, devaluation raises the prices of coffee and tea. The resulting increase in coffee and tea production boosts both balance of payments and government revenue. Devaluation involves an increase in the import prices of wheat and fertilizer which, in combination with the coffee and tea export effects, results in an 80% increase in balance of payments and a 13% decrease in government revenues. In the full model, however, the effects of devaluation are of entirely different proportions. The full model shows only a 43% rise in balance of payments and a drastic 84% drop in government revenues. The full model treats the price effects jointly rather than separately. For example, although coffee and tea prices have increased, fertilizer costs have risen also, tending to moderate the dramatic coffee and tea production increases forecast by the simple model. The fertilizer price increase also contributes to a decrease in wheat production and a rise in wheat imports, which are quite costly in terms of both government subsidies and foreign exchange. Finally, whereas the logic of the simple model requires that the rise in fertilizer prices will result in a drop in fertilizer demand, the full model finds that the expansion of coffee and tea production actually spurs a dramatic increase in fertilizer imports. Because the simple model treats price changes singly rather than jointly, it both exaggerates the foreign exchange benefits and underestimates the government revenue costs of devaluation.

These comparisons suggest that the quantitative results, and sometimes even the qualitative results, of simple models can be quite misleading. Of course, when using the simple model, the experienced
analyst will try to take account of the various interactions that are treated explicitly in the full model. But then the approach, and the data requirements, begin to approximate those of the full model. Moreover, we had considerable difficulty in deciding exactly what an analyst using the simple model would assume about substitution possibilities in production and consumption and about the operation of markets. In fact, we abandoned this effort when it came to analyzing the alternative devaluation package in which the effects of the devaluation are passed on to consumers and producers of wheat and maize. Now five producer prices and two consumer prices are changing. We were unable to arrive at a reasonable procedure to handle these price changes and yet maintain the simplicity of the simple approach. We conclude, therefore, that where one is investigating single-price changes and there is good reason to believe that substitution possibilities are limited -- the coffee example in our model -- the simple model is to be preferred. Where one is investigating multiple price changes or where, regardless of the number of price changes, substitution possibilities are thought to be important, the analyst would be well advised to base his policy recommendations on the results of the full model.
<table>
<thead>
<tr>
<th>POLICY VARIABLES</th>
<th>MALE FARMERS</th>
<th>POLICY TEST F4: INCREASE</th>
<th>MALE PRODUCER PRICE</th>
<th>POLICY TEST F3: INCREASE</th>
<th>MALE PRODUCER PRICE</th>
<th>POLICY TEST F1: DECREASE</th>
<th>MALE PRODUCER PRICE</th>
<th>POLICY TEST F4: DECREASE</th>
<th>MALE PRODUCER PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%E</td>
<td>%E</td>
<td>%E</td>
<td>%E</td>
<td>%E</td>
<td>%E</td>
<td>%E</td>
<td>%E</td>
<td>%E</td>
</tr>
<tr>
<td>Government buying price for maize (กก/กก)</td>
<td>1.11</td>
<td>1.00</td>
<td>0.89</td>
<td>1.22</td>
<td>1.39</td>
<td>1.11</td>
<td>1.11</td>
<td>1.11</td>
<td>1.11</td>
</tr>
<tr>
<td>Government buying price for wheat (กก/กก)</td>
<td>2.73</td>
<td>2.73</td>
<td>2.73</td>
<td>2.73</td>
<td>2.73</td>
<td>2.68</td>
<td>2.68</td>
<td>2.68</td>
<td>2.68</td>
</tr>
<tr>
<td>Government buying price for rice (กก/กก)</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
</tr>
<tr>
<td>Government selling price for wheat (กก/กก)</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
</tr>
<tr>
<td>Rice market (1,000 กก/yr)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Government maize surplus exported (1,000 กก/yr)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Export tax as % of export price</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Export tax on coffee (กก/กก)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Evaluation of currency (กก)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**PRICES (กก/กก)**

- **Rural informal market price for maize:**
  - Male farmers: 1.85
  - Female farmers: 1.89
  - Average: 1.90

- **Rural black market price for maize:**
  - Male farmers: 4.10
  - Female farmers: 4.11
  - Average: 4.11

- **Urban informal market price for maize:**
  - Male farmers: 3.16
  - Female farmers: 3.16
  - Average: 3.16

- **Urban informal market price for rice:**
  - Male farmers: 2.76
  - Female farmers: 2.76
  - Average: 2.76

- **Demand for rice for maine:**
  - Male farmers: 2.40
  - Female farmers: 2.40
  - Average: 2.40

- **Demand for rice for maize:**
  - Male farmers: 3.40
  - Female farmers: 3.40
  - Average: 3.40

- **Domestic price of coffee:**
  - Male farmers: 15.40
  - Female farmers: 15.40
  - Average: 15.40

**DEMAND AND SUPPLY (1,000 กก/yr)**

- **Rice supply from smallholders:**
  - Male farmers: 1093.3
  - Female farmers: 1093.3
  - Average: 1093.3

- **Rice demand by smallholders:**
  - Male farmers: 1093.3
  - Female farmers: 1093.3
  - Average: 1093.3

- **Rice demand from large farms:**
  - Male farmers: 177.1
  - Female farmers: 177.1
  - Average: 177.1

- **Rice demand in urban areas:**
  - Male farmers: 94.9
  - Female farmers: 94.9
  - Average: 94.9

- **Rice demand from smallholders:**
  - Male farmers: 0.2
  - Female farmers: 0.2
  - Average: 0.2

- **Rice demand from smallholders to market:**
  - Male farmers: 20.7
  - Female farmers: 20.7
  - Average: 20.7

- **Beans supply from smallholders:**
  - Male farmers: 256.5
  - Female farmers: 256.5
  - Average: 256.5

- **Beans demand by smallholders:**
  - Male farmers: 171.3
  - Female farmers: 171.3
  - Average: 171.3

- **Beans demand by large farms:**
  - Male farmers: 23.0
  - Female farmers: 23.0
  - Average: 23.0

- **Beans demand in urban areas:**
  - Male farmers: 93.3
  - Female farmers: 93.3
  - Average: 93.3

- **Beans supply from large farms:**
  - Male farmers: 34.6
  - Female farmers: 34.6
  - Average: 34.6

- **Beans demand by smallholders:**
  - Male farmers: 112.0
  - Female farmers: 112.0
  - Average: 112.0

- **Beans demand by large farms:**
  - Male farmers: 19.0
  - Female farmers: 19.0
  - Average: 19.0

- **Beans demand in urban areas:**
  - Male farmers: 24.6
  - Female farmers: 24.6
  - Average: 24.6

- **Beans supply from large farms:**
  - Male farmers: 109.9
  - Female farmers: 109.9
  - Average: 109.9

- **Beans supply from large farms:**
  - Male farmers: 27.0
  - Female farmers: 27.0
  - Average: 27.0

- **Coffee supply from smallholders:**
  - Male farmers: 175.1
  - Female farmers: 175.1
  - Average: 175.1

- **Coffee supply from large farms:**
  - Male farmers: 55.7
  - Female farmers: 55.7
  - Average: 55.7

**IMPORTS AND EXPORTS**

- **Rice imports (1,000 กก /yr):**
  - Male farmers: 194.4
  - Female farmers: 194.4
  - Average: 194.4

- **Rice exports (1,000 กก /yr):**
  - Male farmers: 139.5
  - Female farmers: 139.5
  - Average: 139.5

- **Coffee exports (1,000 กก /yr):**
  - Male farmers: 208.5
  - Female farmers: 208.5
  - Average: 208.5

- **Fertilizer imports (1,000กก /yr):**
  - Male farmers: 393.7
  - Female farmers: 393.7
  - Average: 393.7

**AGRICULTURAL COMMODITY REVENUES (1,000,000กก /yr)**

- **Rice revenues:**
  - Male farmers: 5.7
  - Female farmers: 5.7
  - Average: 5.7

- **Beans revenues:**
  - Male farmers: 30.0
  - Female farmers: 30.0
  - Average: 30.0

- **Coffee revenues:**
  - Male farmers: 91.8
  - Female farmers: 91.8
  - Average: 91.8

- **Net agricultural commodity revenues:**
  - Male farmers: 68.8
  - Female farmers: 68.8
  - Average: 68.8

**FACTOR DEMAND (1,000กก /yr):**

- **Demand for fertilizer for rice:**
  - Male farmers: 69.0
  - Female farmers: 69.0
  - Average: 69.0

- **Demand for fertilizer for beans:**
  - Male farmers: 2.9
  - Female farmers: 2.9
  - Average: 2.9

- **Demand for fertilizer for coffee:**
  - Male farmers: 11.4
  - Female farmers: 11.4
  - Average: 11.4

**FARM INCOME AND PROFITS (กก/座位/yr):**

- **Full income of smallholders:**
  - Male farmers: 3163.4
  - Female farmers: 3163.4
  - Average: 3163.4

- **Cash income from smallholder farm profits:**
  - Male farmers: 255.3
  - Female farmers: 255.3
  - Average: 255.3

- **Smallholder profits from rice:**
  - Male farmers: 65.4
  - Female farmers: 65.4
  - Average: 65.4

- **Smallholder profits from beans:**
  - Male farmers: 1.5
  - Female farmers: 1.5
  - Average: 1.5

- **Smallholder profits from coffee:**
  - Male farmers: 243.3
  - Female farmers: 243.3
  - Average: 243.3

- **Smallholder profits from coffee:**
  - Male farmers: 151.8
  - Female farmers: 151.8
  - Average: 151.8

- **Full income of large farms:**
  - Male farmers: 9207.3
  - Female farmers: 9207.3
  - Average: 9207.3

- **Large farm income from profits:**
  - Male farmers: 1081.5
  - Female farmers: 1081.5
  - Average: 1081.5

- **Large farm prices for rice:**
  - Male farmers: 96.8
  - Female farmers: 96.8
  - Average: 96.8

- **Large farm prices for beans:**
  - Male farmers: 36.8
  - Female farmers: 36.8
  - Average: 36.8

- **Large farm prices for coffee:**
  - Male farmers: 179.0
  - Female farmers: 179.0
  - Average: 179.0

- **Large farm prices from coffee:**
  - Male farmers: 766.9
  - Female farmers: 766.9
  - Average: 766.9
### AGRICULTURAL PRICING MODEL

**SIMULATION RESULTS**

<table>
<thead>
<tr>
<th>POLICY VARIABLES</th>
<th>BASE YEAR</th>
<th>POLICY TEST #1: DECREASE</th>
<th>POLICY TEST #2: INCREASE</th>
<th>POLICY TEST #3: DECREASE</th>
<th>POLICY TEST #4: INCREASE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10X</td>
<td>10X</td>
<td>10X</td>
<td>10X</td>
<td>10X</td>
</tr>
<tr>
<td><strong>Government buying price for maize (sh/kg)</strong></td>
<td>1.15</td>
<td>0.95</td>
<td>0.75</td>
<td>0.55</td>
<td>0.35</td>
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<tr>
<td><strong>Government selling price for maize (sh/kg)</strong></td>
<td>3.79</td>
<td>3.99</td>
<td>4.19</td>
<td>4.39</td>
<td>4.59</td>
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<tr>
<td><strong>Government buying price for wheat (sh/kg)</strong></td>
<td>1.44</td>
<td>1.56</td>
<td>1.68</td>
<td>1.80</td>
<td>1.92</td>
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<td>2.88</td>
<td>2.88</td>
<td>2.88</td>
<td>2.88</td>
<td>2.88</td>
</tr>
<tr>
<td><strong>Maize imports (1,000 MT/yr)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Government maize surplus exported (1,000 MT/yr)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Export tax on maize (S of export price)</strong></td>
<td>0.1</td>
<td>0.5</td>
<td>0.9</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>Export tax on wheat (S of export price)</strong></td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Devaluation of currency ($)</strong></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**PRICES (sh/kg)**

| Rural informal market price for maize | 1.83 | 1.83 | 1.83 | 1.83 | 1.83 |
| Urban black market price for maize | 4.15 | 4.15 | 4.15 | 4.15 | 4.15 |
| Rural informal market price for beans | 2.16 | 2.16 | 2.16 | 2.16 | 2.16 |
| Urban informal market price for beans | 2.76 | 2.76 | 2.76 | 2.76 | 2.76 |
| Domestic price of tea | 3.40 | 3.40 | 3.40 | 3.40 | 3.40 |

**DEMAND AND SUPPLY (1,000 MT/yr)**

| Maize supply from smallholders | 1099.2 | 1099.2 | 1099.2 | 1099.2 | 1099.2 |
| Maize demand by smallholders | 1099.3 | 1099.3 | 1099.3 | 1099.3 | 1099.3 |
| Maize supply from large farms | 177.5 | 203.8 | 229.5 | 255.3 | 281.1 |
| Maize demand by large farms | 85.1 | 85.1 | 85.1 | 85.1 | 85.1 |
| Maize demand in urban areas | 94.9 | 116.1 | 137.3 | 158.5 | 179.7 |
| Beans supply from smallholders | 226.5 | 226.7 | 226.9 | 227.1 | 227.3 |
| Beans demand by smallholders | 171.6 | 171.6 | 171.6 | 171.6 | 171.6 |
| Beans supply from large farms | 222.0 | 222.0 | 222.0 | 222.0 | 222.0 |
| Beans demand by large farms | 222.0 | 222.0 | 222.0 | 222.0 | 222.0 |
| Beans demand in urban areas | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 |
| Wheat supply from large farms | 129.9 | 129.9 | 129.9 | 129.9 | 129.9 |
| Wheat demand by smallholders | 19.0 | 19.0 | 19.0 | 19.0 | 19.0 |
| Wheat demand in urban areas | 94.6 | 94.6 | 94.6 | 94.6 | 94.6 |
| Tea supply from smallholders | 109.9 | 109.9 | 109.9 | 109.9 | 109.9 |
| Tea supply from large farms | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 |
| Coffee supply from large farms | 172.0 | 172.0 | 172.0 | 172.0 | 172.0 |
| Coffee supply from large farms | 25.7 | 25.7 | 25.7 | 25.7 | 25.7 |

**IMPORTS AND EXPORTS**

| Wheat imports (1,000 MT/yr) | 158.4 | 202.9 | 247.4 | 291.9 | 336.4 |
| Wheat exports (1,000 MT/yr) | 136.9 | 136.9 | 136.9 | 136.9 | 136.9 |
| Coffee exports (1,000 MT/yr) | 205.8 | 205.8 | 205.8 | 205.8 | 205.8 |
| Fertilizer imports (1,000 MT/yr) | 202.7 | 202.7 | 202.7 | 202.7 | 202.7 |
| Agricultural Commodity Balance of Payments (1,000,000 MT/yr) | 4555.6 | 4555.6 | 4555.6 | 4555.6 | 4555.6 |

**GOVERNMENT AGRICULTURAL COMMODITY REVENUES (1,000,000 sh/kg)**

| Maize revenues | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 |
| Wheat revenues | -46.0 | -46.0 | -46.0 | -46.0 | -46.0 |
| Tea revenues | 67.3 | 67.3 | 67.3 | 67.3 | 67.3 |
| Coffee revenues | 264.0 | 264.0 | 264.0 | 264.0 | 264.0 |
| Total agricultural commodity revenues | 88.4 | 88.4 | 88.4 | 88.4 | 88.4 |

**FACTOR DEMAND (1,000,000 sh/kg)**

| Demand for fertilizers for maize | 49.0 | 49.0 | 49.0 | 49.0 | 49.0 |
| Demand for fertilizers for wheat | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 |
| Demand for fertilizers for beans | 9.1 | 9.1 | 9.1 | 9.1 | 9.1 |
| Demand for fertilizers for coffee | 11.4 | 11.4 | 11.4 | 11.4 | 11.4 |

**FARM INCOMES AND PROFITS (sh/per-person-yr)**

| Full income of smallholders | 3185.6 | 3185.6 | 3185.6 | 3185.6 | 3185.6 |
| Cast income from smallholder farm profits | 233.2 | 233.2 | 233.2 | 233.2 | 233.2 |
| Smallholder profits from maize | 35.4 | 35.4 | 35.4 | 35.4 | 35.4 |
| Smallholder profits from beans | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Smallholder profits from coffee | 24.5 | 24.5 | 24.5 | 24.5 | 24.5 |
| Smallholder profits from crops | 131.8 | 131.8 | 131.8 | 131.8 | 131.8 |
| Full income of large farms | 9027.5 | 9027.5 | 9027.5 | 9027.5 | 9027.5 |
| Cast income from large farm profits | 1081.9 | 1081.9 | 1081.9 | 1081.9 | 1081.9 |
| Large profits from maize | 88.4 | 88.4 | 88.4 | 88.4 | 88.4 |
| Large profits from beans | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 |
| Large profits from coffee | 179.0 | 179.0 | 179.0 | 179.0 | 179.0 |
| Large coffee farm profits | 766.9 | 766.9 | 766.9 | 766.9 | 766.9 |
### Table 6-4: WHEAT VOLUME IMPLICATIONS AND COMMODITY TAX POLICIES

<table>
<thead>
<tr>
<th>POLICY VARIABLES</th>
<th>BASE YEAR</th>
<th>POLICY TEST #9: IMPORT RATES W/ HIGHER FORMAL MARKET VOLUME</th>
<th>POLICY TEST #10: EXPORT RATES W/ HIGHER FORMAL MARKET VOLUME</th>
<th>POLICY TEST #11: INCREASE EXPORT TAX FROM 12 TO 15</th>
<th>POLICY TEST #12: INCREASE COFFEE EXPORT TAX FROM 12 TO 15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government buying price for wheat</strong></td>
<td>1.11</td>
<td>1.11</td>
<td>1.11</td>
<td>1.11</td>
<td>1.11</td>
</tr>
<tr>
<td><strong>Government selling price for wheat</strong></td>
<td>2.73</td>
<td>2.73</td>
<td>2.73</td>
<td>2.73</td>
<td>2.73</td>
</tr>
<tr>
<td><strong>Government buying price for coffee</strong></td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
</tr>
<tr>
<td><strong>Government selling price for coffee</strong></td>
<td>2.68</td>
<td>2.68</td>
<td>2.68</td>
<td>2.68</td>
<td>2.68</td>
</tr>
<tr>
<td><strong>Maize imported (1,000 MT/yr)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Government maize surplus exported (1,000 MT/yr)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Export tax on tea ($/1200 MT)</strong></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Export tax on coffee ($/1200 MT)</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Devolution of currency ($)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**PRICES ($/MT)**

- **Basal informal market price for wheat**: 1.85
- **Urban black market price for maize**: 5.10
- **Urban informal market price for beans**: 2.16
- **Urban informal market price for maize**: 2.76
- **Domestic price of tea**: 3.40
- **Domestic price of coffee**: 16.40

**DEMAND AND SUPPLY (1,000 MT/yr)**

- **Maize supply from smallholders**: 1082.2
- **Maize supply from large farms**: 177.5
- **Maize demand for large farms**: 85.5
- **Maize demand in urban areas**: 94.9
- **Maize leakage from smallholders to formal market**: 0.2
- **Maize leakage from smallholders to black market**: 2.7
- **Basis supply from smallholders**: 226.6
- **Basis demand for smallholders**: 52.5
- **Basis demand for large farms**: 125.1
- **Wheat demand in urban areas**: 84.6
- **Wheat supply from small farms**: 34.6
- **Wheat supply from large farms**: 129.3
- **Tax supply from smallholders**: 109.9
- **Coffee supply from large farms**: 172.7
- **Evolution of currency ($)**: 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**IMPORTS AND EXPORTS**

- **Wheat imports (1,000 MT)**: 198.4
- **Cheese exports (1,000 MT)**: 136.9
- **Coffee exports (1,000 MT)**: 283.8
- **Fertilizer imports (1,000 MT)**: 285.7
- **Agricultural Commodity Balance of Payments (1,000 shs)**: 4552.6

**GOVERNMENT AGRICULTURAL COMMODITY REVENUES (1,000,000 shs)**

- **Maize revenues**: 3.7
- **Sugar revenues**: -95.6
- **Taxes revenues**: 67.3
- **Coffee revenues**: 91.5
- **Net agricultural commodity revenues**: 66.8

**FACTOR DEMAND (1,000 MT/yr)**

- **Demand for fertilizer for maize**: 49.0
- **Demand for fertilizer for wheat**: 2.9
- **Demand for fertilizer for beans**: 2.7
- **Demand for fertilizer for tea**: 213.3
- **Demand for fertilizer for coffee**: 11.4

**FARM INCOMES AND PROFITS ($/person-yr)**

- **Full income of smallholders**: 3105.4
- **Cash income from smallholder farm profits**: 253.3
- **Smallerholder profits from smallholder**: 65.6
- **Smallerholder profits from coffee**: 24.4
- **Smallerholder profit per head from coffee**: 150.2
- **Full income of large farms**: 9017.5
- **Cash income from large farm profits**: 1081.9
- **Large farm profits from sugar**: 90.6
- **Large farm profits from wheat**: 26.9
- **Large farm profits from coffee**: 760.3

**ECONOMIC GROWTH AND COMMODITY TAX POLICIES**

- **Government buying price for wheat**: 1.11
- **Government selling price for wheat**: 2.73
- **Government buying price for coffee**: 1.64
- **Government selling price for coffee**: 2.68
- **Maize imported (1,000 MT/yr)**: 0
- **Government maize surplus exported (1,000 MT/yr)**: 0
- **Export tax on tea ($/1200 MT)**: 5
- **Export tax on coffee ($/1200 MT)**: 2
- **Devolution of currency ($)**: 0

**RESOURCES AND INCOME**

- **Wheat imports (1,000 MT)**: 198.4
- **Cheese exports (1,000 MT)**: 136.9
- **Coffee exports (1,000 MT)**: 283.8
- **Fertilizer imports (1,000 MT)**: 285.7
- **Agricultural Commodity Balance of Payments (1,000 shs)**: 4552.6
- **Government agricultural commodity revenues (1,000,000 shs)**: 3105.4
- **Income per person**: 3105.4
- **Cash income from smallholder farm profits**: 253.3
- **Smallerholder profits from smallholder**: 65.6
- **Smallerholder profits from coffee**: 24.4
- **Smallerholder profit per head from coffee**: 150.2
- **Full income of large farms**: 9017.5
- **Cash income from large farm profits**: 1081.9
- **Large farm profits from sugar**: 90.6
- **Large farm profits from wheat**: 26.9
- **Large farm profits from coffee**: 760.3

**ECONOMIC GROWTH AND COMMODITY TAX POLICIES**

- **Government buying price for wheat**: 1.11
- **Government selling price for wheat**: 2.73
- **Government buying price for coffee**: 1.64
- **Government selling price for coffee**: 2.68
- **Maize imported (1,000 MT/yr)**: 0
- **Government maize surplus exported (1,000 MT/yr)**: 0
- **Export tax on tea ($/1200 MT)**: 5
- **Export tax on coffee ($/1200 MT)**: 2
- **Devolution of currency ($)**: 0
### Table 4-6: Export and Domestic Prices Policies

<table>
<thead>
<tr>
<th>Policy Variables</th>
<th>Base Run</th>
<th>Policy Test #1: Devalue Domestic Currency</th>
<th>Policy Test #2: Export Government Prices to Conform with Domestic Currency</th>
<th>Policy Test #3: Border Prices</th>
<th>(1)</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SE</td>
<td>10E</td>
<td>20E</td>
<td>SE</td>
<td>10E</td>
<td>20E</td>
</tr>
<tr>
<td><strong>Prices (¥/kg)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural informal market price for maize</td>
<td>1.85</td>
<td>1.87</td>
<td>1.90</td>
<td>1.94</td>
<td>1.86</td>
<td>1.88</td>
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<tr>
<td>Urban black market price for maize</td>
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<td>3.37</td>
<td>6.14</td>
<td>4.61</td>
<td>3.76</td>
<td>3.36</td>
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<tr>
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<td>1.30</td>
<td>1.40</td>
<td>1.22</td>
<td>1.32</td>
<td>1.29</td>
<td>1.29</td>
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<tr>
<td>Urban informal market price for beans</td>
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<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
</tr>
<tr>
<td>Domestic price of tea</td>
<td>3.40</td>
<td>4.40</td>
<td>4.44</td>
<td>5.73</td>
<td>3.39</td>
<td>4.44</td>
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<tr>
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<td>16.40</td>
<td>17.55</td>
<td>18.95</td>
<td>21.87</td>
<td>17.55</td>
<td>18.93</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government buying price for maize (¥/kg)</td>
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<td>1.20</td>
<td>1.40</td>
<td>1.60</td>
<td>1.20</td>
<td>1.40</td>
</tr>
<tr>
<td>Government selling price for maize (¥/kg)</td>
<td>1.20</td>
<td>1.40</td>
<td>1.60</td>
<td>1.80</td>
<td>1.40</td>
<td>1.60</td>
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<tr>
<td>Government buying price for wheat (¥/kg)</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.63</td>
<td>1.62</td>
</tr>
<tr>
<td>Government selling price for wheat (¥/kg)</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
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<tr>
<td><strong>Imports</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Maize imports (1,000 MT/yr)</td>
<td>1,200</td>
<td>1,350</td>
<td>1,500</td>
<td>1,650</td>
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<td><strong>Exports</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat exports (1,000 MT/yr)</td>
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<td>550</td>
<td>600</td>
<td>650</td>
<td>550</td>
<td>600</td>
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<tr>
<td>Coffee exports (1,000 MT/yr)</td>
<td>1,000</td>
<td>1,100</td>
<td>1,200</td>
<td>1,300</td>
<td>1,100</td>
<td>1,200</td>
</tr>
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<td>Agricultural Commodity Balance of Payments (1,000,000 Yen)</td>
<td>3,500</td>
<td>4,000</td>
<td>4,500</td>
<td>5,000</td>
<td>4,000</td>
<td>4,500</td>
</tr>
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<td><strong>Government Agricultural Commodity Expenses (1,000,000 Yen)</strong></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Maize subsidies</td>
<td>3.7</td>
<td>4.1</td>
<td>4.4</td>
<td>4.7</td>
<td>4.1</td>
<td>4.4</td>
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<tr>
<td>Wheat subsidies</td>
<td>-6.0</td>
<td>-6.4</td>
<td>-6.8</td>
<td>-7.2</td>
<td>-6.4</td>
<td>-6.8</td>
</tr>
<tr>
<td>Coffee subsidies</td>
<td>9.1</td>
<td>9.6</td>
<td>10.0</td>
<td>10.4</td>
<td>9.6</td>
<td>10.0</td>
</tr>
<tr>
<td>Export subsidies</td>
<td>46.8</td>
<td>52.7</td>
<td>58.4</td>
<td>64.1</td>
<td>52.7</td>
<td>58.4</td>
</tr>
</tbody>
</table>

### AGRICULTURAL PRICING MODEL SIMULATION RESULTS

- **Prices (¥/kg):**
  - Rural informal market price for maize: 1.85
  - Urban black market price for maize: 4.10
  - Rural informal market price for beans: 1.30
  - Urban informal market price for beans: 2.73
  - Domestic price of tea: 3.40
  - Domestic price of coffee: 16.40

- **Governmental Policies:**
  - Government buying price for maize: 1.00
  - Government selling price for maize: 1.20

- **Imports:**
  - Maize imports: 1,200

- **Exports:**
  - Wheat exports: 500

- **Government Agricultural Commodity Expenses:**
  - Maize subsidies: 3.7
  - Wheat subsidies: -6.0
  - Coffee subsidies: 9.1
  - Export subsidies: 46.8

- **Agricultural Commodity Balance of Payments:**
  - Value: 3,500

- **Government Agricultural Commodity Expenses:**
  - Value: 3,500

- **Policy Tests:**
  - Policy Test #1: Devalue Domestic Currency
  - Policy Test #2: Export Government Prices to Conform with Domestic Currency
  - Policy Test #3: Border Prices

- **Factors:**
  - Demand for fertilizer for maize: 49.0
  - Demand for fertilizer for beans: 2.0
  - Demand for fertilizer for coffee: 15.0

- **Income and Savings:**
  - Full income of smallholders: 3,105
  - Gross income from large farmers: 3,200
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105

- **Gross Surplus:**
  - Gross surplus for smallholders: 83.4
  - Gross surplus for beans: 86.4
  - Gross surplus for coffee: 84.6

- **Agricultural Surplus:**
  - Agricultural surplus for smallholders: 21.0
  - Agricultural surplus for beans: 23.0
  - Agricultural surplus for coffee: 21.0

- **Government Agricultural Surplus:**
  - Value: 210

- **Net Agricultural Commodity Revenues:**
  - Value: 50.0

- **Agricultural Surplus:**
  - Value: 50.0

- **Gross Surplus:**
  - Value: 50.0

- **Factor Demand:**
  - Value: 50.0

- **Agricultural Commodity Expenditures:**
  - Value: 50.0

- **Gross Surplus:**
  - Value: 50.0

- **Net Agricultural Commodity Revenues:**
  - Value: 50.0

- **Agricultural Surplus:**
  - Value: 50.0

- **Farms, Income and Savings:**
  - Full income of smallholders: 3,105
  - Gross income from large farmers: 3,200
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105

- **Government Agricultural Surplus:**
  - Value: 210

- **Net Agricultural Commodity Revenues:**
  - Value: 50.0

- **Agricultural Surplus:**
  - Value: 50.0

- **Farms, Income and Savings:**
  - Full income of smallholders: 3,105
  - Gross income from large farmers: 3,200
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105

- **Government Agricultural Surplus:**
  - Value: 210

- **Net Agricultural Commodity Revenues:**
  - Value: 50.0

- **Agricultural Surplus:**
  - Value: 50.0

- **Farms, Income and Savings:**
  - Full income of smallholders: 3,105
  - Gross income from large farmers: 3,200
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105

- **Government Agricultural Surplus:**
  - Value: 210

- **Net Agricultural Commodity Revenues:**
  - Value: 50.0

- **Agricultural Surplus:**
  - Value: 50.0

- **Farms, Income and Savings:**
  - Full income of smallholders: 3,105
  - Gross income from large farmers: 3,200
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105
  - Gross income from large farmers: 3,105

- **Government Agricultural Surplus:**
  - Value: 210

- **Net Agricultural Commodity Revenues:**
  - Value: 50.0

- **Agricultural Surplus:**
  - Value: 50.0
ANNEX 1

MODEL EQUATIONS

Land Allocation Conditions

\[ A^n_{i=1} = A^n_{i=1,2}, \quad k^n_{i=1} \]

\[ k^n_{i=1} = \frac{p^n_{i=1} \Pi^n_{i=1}}{p^n_{i=1} \Pi^n_{i=1} + p^n_{i=2} \Pi^n_{i=2}} \]

- \( i \) crop subscript
- \( n \) farm type subscript
- \( A^n_{i=1} \) Area of land allocated to crop \( i=1 \) on each farm of the \( n \)th type
- \( A^n_{i=1,2} \) Area of land available for either crop \( i=1 \) or \( i=2 \) on each farm of the \( n \)th type
- \( k^n_{i=1} \) Fraction of land on farms of the \( n \)th type available for crop \( i=1 \) or \( i=2 \) allocated to crop \( i=1 \)
- \( p^n_i \) Farm price of the \( i \)th crop on farms on the \( n \)th type
- \( \Pi^n_i \) Profit per hectare, normalized by price, for the \( i \)th crop on farms of the \( n \)th type
Profit Functions

\[ \Pi_i^n = \exp \left[ \alpha_{oi} + \alpha_{il} \ln \left( \frac{\Pi_i^n}{\Pi_i^{p_n}} \right) + \alpha_{il} \ln \left( \frac{\Pi_i^{p_n}}{\Pi_i^{fert}} \right) + \alpha_{il} \ln \left( \frac{\Pi_i^{fert}}{\Pi_i^{p_n}} \right) + \alpha_{il} \ln \left( \frac{\Pi_i^{p_n}}{\Pi_i^{seeds}} \right) + \alpha_{il} \ln \left( \frac{\Pi_i^{seeds}}{\Pi_i^{p_n}} \right) \right] \]

i = crop subscript

n = farm type subscript

\( \Pi_i^n = \) Profit per hectare, normalized by price, for the i^th crop on farms of the n^th type

\( \Pi_i^{p_n} = \) Farm price of the i^th crop on farms of the n^th type

\( \Pi_i^{fert} = \) Wage rate for laborers working on the i^th crop on the n th farm type

\( \Pi_i^{seeds} = \) Cost of fertilizer for the i^th crop on the n th farm type

\( \Pi_i^{p_n} = \) Cost of seeds for the i^th crop on the n th farm type

\( \Pi_i^{mech} = \) Cost of machinery for the i^th crop on the n th farm type

\( \alpha_{oi} - \alpha_{il} \) = Production function coefficients
Supply Functions

\[ S^n_i = \Pi^n_i A^n_i (1 - a^n_{1i} - a^n_{2i} - a^n_{3i} - a^n_{4i}) \text{ HH}^n \]

- \( i \): crop subscript
- \( n \): farm type subscript
- \( S^n_i \): Total production of the \( i^{th} \) crop on the \( n^{th} \) farm type
- \( H^n_i \): Profit per hectare, normalised by price for the \( i^{th} \) crop on farms of the \( n^{th} \) type
- \( A^n_i \): Area of land allocated to the \( i^{th} \) crop on each farm of the \( n^{th} \) type
- \( a^n_{1i} - a^n_{4i} \): Production function coefficients
- \( \text{HH}^n \): Number of farms of the \( n^{th} \) type

Income Functions, Rural

\[ Y^n = (W^n \text{ NE}^n 8760 + Y^n + P^n_0 \frac{P^n_i \Pi^n_i A^n_i}{N^n})/N^n \]

Note: for landless households, \( n=0 \), \( A^n_i = 0 \)

- \( i \): crop subscript
- \( n \): farm type subscript
- \( Y^n \): full income per capita of members of farm households of the \( n^{th} \) type
- \( W^n \): Wage paid to working members of the \( n^{th} \) type of farm households.
- \( \text{NE}^n \): Number of members of each farm household of the \( n^{th} \) type employed
8760 Number of hours per year
$Y^n$ Non-farm income of households of the $n^{th}$ type
$P^n_i$ Farm price of the $i^{th}$ crop on farms of the $n^{th}$ type

Note: For small farms, the price received for maize is the average of the rural price, the formal market buying price, and the black market price, weighted according to the share of production sold on each market.

$\Pi^n_i$ Profit per hectare, normalized by price, for the $i^{th}$ crop on farms on the $n^{th}$ type
$A^n_i$ Area of land allocated to the $i^{th}$ crop on each farm of the $n^{th}$ type
$N^n$ Number of members in each household of the $n^{th}$ type

**Income Functions, Urban**

$$y^m = (W^m NE^m 8760 + Y_o^m) + s^{formal} _{maize} (P^{black market} _{maize} - P^{formal urban} _{maize}) \frac{Prop^{m}_{HH^m}}{N^m}$$

if $P^{black market} _{maize} > P^{formal urban} _{maize}$

$$+(D^{urban} - s^{formal} _{maize}) (P^{formal urban} _{maize} - P^{black market} _{maize}) \frac{Prop^{m}_{HH^m}}{N^m}$$

if $P^{formal urban} _{maize} > P^{black market} _{maize}$

$y^m$ Full income per capita of members of urban households of the $m^{th}$ type
$W^m$ Wage paid to working members of the $m^{th}$ type of urban households
$N^m$ Number of members of each urban household of the $m^{th}$ type employed

8760 Number of hours per year

$y^m_o$ Non-wage income of households of the $m^{th}$ type

$\text{Prop}^m$ Proportion of urban market maize consumed by households of the $m^{th}$ type

$HH^m$ Number of farms of the $m^{th}$ type

$n^m$ Number of members in each household of the $m^{th}$ type

$S_{\text{maize}}^\text{formal}$ Supply of maize available in the formal urban markets

$D_{\text{maize}}^\text{urban}$ Urban demand for maize

$P_{\text{maize}}^\text{formal urban}$ Government selling price for maize on the formal urban market

$P_{\text{maize}}^\text{black market}$ Selling price for maize on the urban black market

**Price Index Functions**

$$P_{I}^n = e^{\beta^o_n \ln (W^n) + \sum_i \beta^i_n \ln (P^n_i)}$$

$$P_{I}^m = e^{\beta^o_m \ln (W^m) + \sum_i \beta^i_m \ln (P^m_i)}$$

$P_{I}^n$ and $P_{I}^m$ Price index for $n^{th}$ and $m^{th}$ households

$\beta^o_n$ and $\beta^o_m$ Share of full income expended on leisure by the $n^{th}$ and $m^{th}$ households

$W^n$ and $W^m$ Wages paid to members of $n^{th}$ and $m^{th}$ households.
\[ \beta_i^n \text{ and } \beta_i^m \] Share of full income spent on the \( i^{th} \) commodity by the \( n^{th} \) and \( m^{th} \) households

\[ p_i^n \text{ and } p_i^m \] Price paid for the \( i^{th} \) commodity by the \( n^{th} \) and \( m^{th} \) households

Demand Functions

\[ D_i^n = N^n \frac{Y^n}{P_i^n} \left( Y_o^n + \gamma_1^n \ln \left( \frac{Y^n}{P_i^n} \right) + \sum_{i} \gamma_i^n \ln (P_i^n) \right) \]

\[ D_i^m = N^m \frac{Y^m}{P_i^m} \left( Y_o^m + \gamma_1^m \ln \left( \frac{Y^m}{P_i^m} \right) + \sum_{i} \gamma_i^m \ln (P_i^m) \right) \]

\[ D_{urban}^i = \sum_{m} D_i^m \]

\( i \) crop subscript

\( m \) urban household type subscript

\( n \) rural household type subscript

\( D_i^n \text{ and } D_i^m \) Demand for the \( i^{th} \) commodity by the \( n^{th} \) and \( m^{th} \) household groups

\( N^n \text{ and } N^m \) Number of members in each household of the \( m^{th} \) type

\( HH^n \text{ and } HH^m \) Number of households of the \( n^{th} \) type and \( m^{th} \) type

\( Y^n \text{ and } Y^m \) full income per capita of members of households of the \( n^{th} \) type and \( m^{th} \) type

\( P_i^n \text{ and } P_i^m \) Price index for \( n^{th} \) and \( m^{th} \) household groups
\[ \gamma_i^m \text{ and } \gamma_i^n \]

Demand coefficient of the \(i^{th}\) commodity and the \(n^{th}\) or \(m^{th}\) household group

\[ D_{\text{urban}} \]

Urban demand for the \(i^{th}\) commodity

**Market Clearing Conditions**

\[ S_{\text{smallholders}} = D_{\text{smallholders}} + D_{\text{landless}} + D_{\text{formal market}} + D_{\text{black market}} \]

\[ S_{\text{maize}} = D_{\text{maize}} + D_{\text{maize}} + D_{\text{maize}} + D_{\text{maize}} \]

\[ S_{\text{large farms + I}} + D_{\text{large farms}} + D_{\text{urban}} + D_{\text{government surplus}} \]

\[ = D_{\text{maize}} + D_{\text{maize}} + D_{\text{maize}} + D_{\text{maize}} \]

\[ S_{\text{smallholders}} = D_{\text{smallholders}} + D_{\text{landless}} + D_{\text{urban}} \]

\[ S_{\text{beans}} = D_{\text{beans}} + D_{\text{beans}} + D_{\text{beans}} + D_{\text{beans}} \]

\[ I_{\text{wheat}} = D_{\text{urban}} + D_{\text{large farms}} + D_{\text{smallholders}} + D_{\text{landless}} + D_{\text{large farms}} + D_{\text{wheat}} \]

\[ S_{\text{wheat}} = D_{\text{wheat}} + D_{\text{wheat}} + D_{\text{wheat}} + D_{\text{wheat}} + D_{\text{wheat}} \]

**Imports**

\[ I_{\text{maize}} \]

Imports of maize

\[ I_{\text{wheat}} \]

Imports of wheat
Export of wheat

Surplus government maize

Maize surplus withheld by government from formal market for export or storage

Linkage Equations

\[ p_{\text{formal market buying}} = \frac{\text{smallholders maize}}{\text{maize}} \times \left[ 1 + \exp \left( \frac{4.6}{\eta_2 - \eta_1} \right) \right] \]

\[ p_{\text{black market}} = \frac{\text{smallholders maize}}{\text{maize}} \times \left[ 1 + \exp \left( \frac{4.6}{\eta_4 - \eta_3} \right) \right] \]

\[ p_{\text{formal market buying}} = s_{\text{large farms maize}} - d_{\text{large farms maize}} + i_{\text{maize}} + l_{\text{maize}} = \text{Surplus government maize} \]

\[ p_{\text{urban beans}} = p_{\text{rural beans}} + t_{\text{beans}} \]

\[ p_{\text{formal urban market wheat}} = p_{\text{formal market buying wheat}} + m_{\text{wheat}} \]

\[ p_{\text{formal urban market wheat}} = p_{\text{formal market buying maize}} + m_{\text{maize}} \]

\[ p_{\text{rural smallholder selling maize}} = p_{\text{smallholder buying maize}} = p_{\text{landless buying maize}} \]

\[ p_{\text{large farm selling maize}} = p_{\text{formal market buying maize}} \]
large farm buying = p \text{ formal market buying maize} \\
\text{if } D_{\text{large farms}} < S_{\text{maize}} \\

large farm buying = p \text{ formal market selling maize} \\
\text{if } D_{\text{large farms}} > S_{\text{maize}} \\

large farm buying = p \text{ formal market buying wheat} \\
\text{if } D_{\text{large farms}} < S_{\text{wheat}} \\

large farm buying = p \text{ formal market selling wheat} \\
\text{if } D_{\text{large farms}} > S_{\text{wheat}} \\

large farm selling = p \text{ formal market buying wheat} \\

urban = p \text{ formal market selling maize} \\
\text{if } p \text{ formal market selling } > p_{\text{maize}} \\

urban = p \text{ black market maize} \\
\text{if } p_{\text{black market}} > p_{\text{maize}} \\

p_{\text{domestic}} = p_{\text{world}} \cdot (1 - \text{Tax}_\text{export}) - \text{Admin}_\text{tea} \\

p_{\text{domestic}} = p_{\text{world}} \cdot (1 - \text{Tax}_\text{export}) - \text{Admin}_\text{coffee} \\

\text{formal market maize} \\
\text{Leakage of maize from smallholders to formal urban market} \\

black market maize \\
\text{Leakage of maize from smallholders to urban black market}
Imports of maize
Imports of wheat
Maize surplus withheld by government from formal market for export or storage
Cost of transporting maize from rural to urban areas
Cost of transporting beans from rural to urban areas
Markup of wheat price by government
Markup of maize price by government
Export tax rate for tea
Export tax rate for coffee
Administrative costs of tea marketing program
Administrative costs of coffee marketing program

Accounting Functions

\[
D_{\text{fert}} = -1 \sum_{i=1}^{n} \frac{p^n_i}{p^n_{\text{fert}}} - A^n_i \cdot H^n \]

Net = Rev\text{maize} + Rev\text{wheat} + Rev\text{tea} + Rev\text{coffee} + Rev\text{fertilizer}

Rev\text{maize} = (\text{f}\text{ormal market selling} - p_{\text{world}} - T_{\text{maize}})

\text{government}\quad (p_{\text{world}} \text{ export} - \text{f}\text{ormal market buying} - M_{\text{maize}})

+ (S_{\text{large farms}} - D_{\text{large farms}}) (M_{\text{maize}} - T_{\text{maize}})
if \( S_{\text{large farms}} > D_{\text{large farms}} \)

\[
\text{Rev}_{\text{wheat}} = I_{\text{wheat}} (P_{\text{formal market selling}} - P_{\text{world wheat}} - T_{\text{wheat}}) + E_{\text{wheat}} (P_{\text{world export wheat}} - P_{\text{formal market buying wheat}} - M_{\text{wheat}}) + (S_{\text{large farms wheat}} - D_{\text{large farms wheat}}) (M_{\text{wheat}} - T_{\text{wheat}})
\]

if \( S_{\text{large farms}} > D_{\text{large farms}} \)

\[
\text{Rev}_{\text{wheat}} = \sum_{i} (P_{\text{formal market selling wheat}} - P_{\text{world wheat}} - T_{\text{wheat}}) + \sum_{i} (P_{\text{world export wheat}} - P_{\text{formal market buying wheat}} - M_{\text{wheat}}) + (S_{\text{large farms wheat}} - D_{\text{large farms wheat}}) (M_{\text{wheat}} - T_{\text{wheat}})
\]

Balance of Payments = \( P_{\text{world export tea}} I_{\text{tea}} S_{\text{tea}} + P_{\text{world export coffee}} I_{\text{coffee}} S_{\text{coffee}} + P_{\text{world export wheat}} I_{\text{wheat}} S_{\text{wheat}} + P_{\text{world export maize}} I_{\text{maize}} S_{\text{maize}} + E_{\text{wheat}} P_{\text{surplus wheat}} + E_{\text{maize}} P_{\text{surplus maize}}
\]

Balance of Payments = \( P_{\text{world export tea}} I_{\text{tea}} S_{\text{tea}} + P_{\text{world export coffee}} I_{\text{coffee}} S_{\text{coffee}} + P_{\text{world export wheat}} I_{\text{wheat}} S_{\text{wheat}} + P_{\text{world export maize}} I_{\text{maize}} S_{\text{maize}} + E_{\text{wheat}} P_{\text{surplus wheat}} + E_{\text{maize}} P_{\text{surplus maize}}
\]

\[
\text{Rev}_{\text{fertilizer}} = \sum_{i} (P_{\text{formal market selling fertilizer}} - P_{\text{world fertilizer}} - T_{\text{fertilizer}})
\]

\[
\text{Balance of Payments} = P_{\text{world export tea}} I_{\text{tea}} S_{\text{tea}} + P_{\text{world export coffee}} I_{\text{coffee}} S_{\text{coffee}} + P_{\text{world export wheat}} I_{\text{wheat}} S_{\text{wheat}} + P_{\text{world export maize}} I_{\text{maize}} S_{\text{maize}} + E_{\text{wheat}} P_{\text{surplus wheat}} + E_{\text{maize}} P_{\text{surplus maize}}
\]

where \( D_{\text{maize}} \) evaluated at \( P_{\text{formal market selling maize}} \)

\[
\bar{Y}^{m} = \frac{Y^{m}}{N^{m}} \left( \delta + \sum_{i} \delta_{i} \ln (P_{i}^{m}) \right) / N^{n}
\]

\[
\bar{Y}^{n} = \frac{Y^{n}}{N^{n}} \left( \delta + \sum_{i} \delta_{i} \ln (P_{i}^{n}) \right) / N^{n}
\]
Efficiency index = Net + \sum_{n} D_{i}^{n} Y_{i}^{n} \cdot HH_{i}^{n} + \sum_{m} Y_{i}^{m} \cdot HH_{i}^{m}

\begin{align*}
D_{i}^{n} & \quad \text{Demand for fertilizer for the } i^{th} \text{ crop by the } n^{th} \text{ farm type} \\
\Pi_{i}^{n} & \quad \text{Profit per hectare, normalized by price, for the } i^{th} \text{ crop on farms of the } n^{th} \text{ type} \\
\alpha_{2i}^{n} & \quad \text{Production function coefficient} \\
\rho_{i}^{n} & \quad \text{Farm price of the } i^{th} \text{ crop on farms of the } n^{th} \text{ type} \\
A_{i}^{n} & \quad \text{Area of land allocated to crop on each farm of the } n^{th} \text{ type} \\
HH_{i}^{n} & \quad \text{Number of farms of the } n^{th} \text{ type} \\
Net & \quad \text{Net government revenues from agricultural commodities} \\
Rev_{\text{maize}} & \quad \text{Government revenues from maize marketing} \\
Rev_{\text{wheat}} & \quad \text{Government revenues from wheat marketing} \\
Rev_{\text{tea}} & \quad \text{Government revenues from tea marketing} \\
Rev_{\text{coffee}} & \quad \text{Government revenues from coffee marketing} \\
Rev_{\text{fertilizer}} & \quad \text{Government revenues from fertilizer marketing} \\
I_{\text{maize}} & \quad \text{Imports of maize} \\
T_{\text{maize}} & \quad \text{Cost of transporting maize from rural to urban areas} \\
M_{\text{maize}} & \quad \text{Markup of maize price by government} \\
\text{Surplus}_{\text{government}}^{\text{maize}} & \quad \text{Maize surplus withheld by government from formal market for export or storage} \\
E_{\text{maize}} & \quad \text{Maize exported, from government surplus} \\
I_{\text{wheat}} & \quad \text{Imports of wheat}
\end{align*}
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T\textsubscript{wheat}</td>
<td>Cost of transporting wheat from rural to urban areas</td>
</tr>
<tr>
<td>M\textsubscript{wheat}</td>
<td>Markup of wheat price by government</td>
</tr>
<tr>
<td>E\textsubscript{wheat}</td>
<td>Exports of wheat</td>
</tr>
<tr>
<td>Tax\textsubscript{tea}</td>
<td>Export tax rate for tea</td>
</tr>
<tr>
<td>Tax\textsubscript{coffee}</td>
<td>Export tax rate for coffee</td>
</tr>
</tbody>
</table>

**Balance of Payments**

Net contribution of agricultural commodities to balance of payments

- \( S\textsubscript{m} \) Maize self sufficiency index
- \( S_{\text{maize}} \) Supply of maize in the formal market
- \( Y\textsubscript{m} \) Real cash income, per capita, for urban households
- \( Y\textsubscript{n} \) Real cash income, per capita, for rural households
- \( Y^{*}\textsubscript{m} \) Cash income of urban households

**Efficiency Index**

Measure of net economic efficiency
ANNEX 2
DATA REQUIREMENTS

In this Annex, we describe the data necessary for the construction of the model discussed in the text. We emphasize, however, that the model provides a framework in which the analyst can use the existing data, whatever their reliability, to best possible effect. We also note that the structure of the model is as important as the particular numerical values assigned to the parameters. That is, the analyst must investigate the institutional arrangements influencing the markets to be modelled.

QUANTITY RELATIONS

The model requires information on commodity balances. Information on production, consumption, imports or exports and inventories (if any) are required for each of the major crops and fertilizer (or other inputs) for a selection of years. In some cases, consumption may have to be measured as a residual. Where possible, this information should be disaggregated by region and by type of producer (e.g. smallholder or estate). The quantity purchased by the marketing board (if any) should also be reported. Table 1 illustrates the type of information required for each crop in the model. In the case of some export crops, domestic consumption may be negligible and export data instead of import data would be required.
Table 1
Food Crop Commodity Balance ('000 tons)

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>Imports</th>
<th>Change in Inventories</th>
<th>Consumption</th>
<th>Official Procurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>153</td>
<td>26</td>
<td>-20</td>
<td>199</td>
<td>30</td>
</tr>
<tr>
<td>1976</td>
<td>196</td>
<td>10</td>
<td>-</td>
<td>206</td>
<td>63</td>
</tr>
<tr>
<td>1977</td>
<td>230</td>
<td>-</td>
<td>+10</td>
<td>220</td>
<td>80</td>
</tr>
<tr>
<td>1978</td>
<td>202</td>
<td>10</td>
<td>-</td>
<td>212</td>
<td>55</td>
</tr>
<tr>
<td>1979</td>
<td>200</td>
<td>15</td>
<td>-5</td>
<td>220</td>
<td>50</td>
</tr>
</tbody>
</table>

Information of this kind is usually presented in official agricultural and trade statistics and is generally reproduced in Bank agricultural sector reports. Where this information is not immediately available in published sources, it will be necessary to rely on semi-official and private estimates. For the major crops in most countries, it should not be too difficult to arrive at reasonable commodity balances. 1/

PRICE RELATIONS

The manner in which prices are determined is critical. For some crops, prices may be controlled at virtually every stage of the market chain. For other crops, prices may be subject to the forces of supply and demand. The operation of the market should be described in as much detail as possible for every output and input included in the

1/ This is not always the case because official statistics sometimes fail to "match up". This may not be totally due to statistical errors but due to efforts on the part of authorities to hide losses or leakages.
analysis. In addition, the elements in the price "chain" from final consumer to producer should be recorded. Tables 2 and 3 illustrate the type of calculation involved for maize produced in Malawi.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Lilongwe (Central Region)</th>
<th>Karonga (Northern Region)</th>
<th>Ngebru (Southern Region)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price f.o.r. Liwonde</td>
<td>60.45</td>
<td>60.45</td>
<td>60.45</td>
</tr>
<tr>
<td>less Buying Expenses</td>
<td>13.00</td>
<td>13.00</td>
<td>13.00</td>
</tr>
<tr>
<td>Overhead</td>
<td>4.30</td>
<td>4.30</td>
<td>4.30</td>
</tr>
<tr>
<td>Transport from Local Markets</td>
<td>14.70</td>
<td>64.10</td>
<td>16.30</td>
</tr>
<tr>
<td>Export Parity Price at</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Market</td>
<td>28.45</td>
<td>-20.95</td>
<td>26.85</td>
</tr>
<tr>
<td>Average Local Price</td>
<td>54.00</td>
<td>74.00</td>
<td>86.00</td>
</tr>
<tr>
<td>ADMARC Purchase Price</td>
<td>46.00</td>
<td>46.00</td>
<td>46.00</td>
</tr>
</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Lilongwe (Central Region)</th>
<th>Karonga (Northern Region)</th>
<th>Ngebru (Southern Region)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price Liwonde</td>
<td>139.00</td>
<td>139.00</td>
<td>139.00</td>
</tr>
<tr>
<td>Add Overhead</td>
<td>6.00</td>
<td>6.00</td>
<td>6.00</td>
</tr>
<tr>
<td>Transport to Local Markets</td>
<td>14.70</td>
<td>64.10</td>
<td>16.30</td>
</tr>
<tr>
<td>Import Parity Price at</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Markets</td>
<td>159.70</td>
<td>209.10</td>
<td>161.30</td>
</tr>
<tr>
<td>ADMARC Selling Price</td>
<td>66.00</td>
<td>66.00</td>
<td>66.00</td>
</tr>
</tbody>
</table>

In Malawi, maize is neither exported nor imported on a regular basis. This is revealed clearly in Tables 2 and 3 where the export and import parity prices at local markets bracket the local price. In the event that maize is exported (say, after a good harvest), Table 2 would allow the calculation of the loss incurred by ADMARC, the state procurement agency. Similarly, in the event of a bad maize harvest, Table 3 shows the cost incurred if ADMARC has to resort to imports. To complete the picture, it is also necessary to know the price "chain" from domestic producers to domestic consumers. This chain would allow the analyst to compute the gain or loss incurred by ADMARC on its purchase of domestic maize for sale at home. This information can often be reduced from the accounts of the marketing agency. Table 4, for example, shows the losses incurred by ADMARC in recent years. This table suggests that on average the loss (−h in equation 4b) per short ton procured in 1976 was 40 Kwacha. Given ADMARC's policy of maintaining a constant buying and selling price throughout the country (see Tables 2 and 3), an analysis of ADMARC's activities (and hence production and demand) by region would be of potential policy interest.

Finally, time series information on price trends, although not absolutely necessary, is useful in placing current events in their historical context. Trends in the relation of domestic to border prices, in the relation of output to input prices, in the relation of

1/ Where such data are totally unavailable then the marketing costs and margins have to be assumed. The model can still be run in a "parametric mode" to see what is likely to happen under varying assumptions on marketing costs, margins and prices.
output prices among substitutes, in the relation between official buying and selling prices, and in the relation of output prices to the prices of consumer goods are all of interest and provide substantial information to supplement model results.

Table 4
ADMARC Maize Accounts (Kwacha)

<table>
<thead>
<tr>
<th></th>
<th>1976</th>
<th>1977</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>4,223,778</td>
<td>3,884,777</td>
</tr>
<tr>
<td>Selling Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>21,048</td>
<td>-</td>
</tr>
<tr>
<td>Railage, Freight and Charges</td>
<td>142,065</td>
<td>12,793</td>
</tr>
<tr>
<td>Bags, Twine and Hession</td>
<td>117,551</td>
<td>91,269</td>
</tr>
<tr>
<td>Inventory Build-up</td>
<td>5,748,114</td>
<td>735,489</td>
</tr>
<tr>
<td>Purchases</td>
<td>5,748,114</td>
<td>3,590,536</td>
</tr>
<tr>
<td>Buying and Direct Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing</td>
<td>186,792</td>
<td>457,404</td>
</tr>
<tr>
<td>Depot and Storage</td>
<td>449,962</td>
<td>548,973</td>
</tr>
<tr>
<td>Bags, Twine and Hession</td>
<td>113,595</td>
<td>241,201</td>
</tr>
<tr>
<td>Transport of Crops</td>
<td>336,569</td>
<td>723,221</td>
</tr>
<tr>
<td>Fumigation</td>
<td>68,626</td>
<td>48,620</td>
</tr>
<tr>
<td>Insurance - cash and crops</td>
<td>3,752</td>
<td>9,007</td>
</tr>
<tr>
<td>Seed Distribution</td>
<td>7,602</td>
<td>8,661</td>
</tr>
<tr>
<td>Net Administrative Expenses</td>
<td>458,179</td>
<td>501,376</td>
</tr>
<tr>
<td>Net Loss</td>
<td>2,868,673</td>
<td>1,612,795</td>
</tr>
<tr>
<td>Net Loss per Short Ton Purchased</td>
<td>40</td>
<td>16</td>
</tr>
</tbody>
</table>

The price information described in this section is usually provided in agricultural sector reports. More specialized studies, such as exercises to measure nominal or effective protection, domestic resource costs, and analyses of marketing chains, also contain price information of this kind. In the absence of published information, reasonable data on prices, margins, and marketing costs can be obtained during field work. This is a worthwhile exercise regardless of the availability of published material because it increases the analyst's familiarity with market structure.

**Links to the Model**

The data requirements described in the sections on Quantity Relations and Price Relations allow the analyst to construct the systematic set of accounting equations depicted in Section 2.3 of the main text. In particular, this information should be sufficient to construct the quantity equations (equations 3a, 4a, 5a, 6a and 7a) and the price equations (3b, 4b, 4c, 6b, 6c, and 7b). The variables measures include exports (E), supply (S), demand (D) and imports (M) for the quantity equations, and procurement prices (\(\bar{p}\)), export prices (\(p^e\)), export taxes (t), administrative costs (a), marketing board surpluses (h), controlled consumer prices (\(p_u\)), import prices (\(p^m\)), and free market prices (\(p_r\)). Information on urban black market prices (\(p_b\)) would also be of value.
BEHAVIORAL RELATIONS

Equations 1 and 2 of the main text describe the behavioral relations of the model. On the supply side, we are interested in the profit function (equation 1a), land allocation (equation 1b), supply (equation 1e) and input demand (equation 1g). And on the demand side, we need information on demand (equation 2a) and utility (equation 2b). The basic sources of information are farm management studies for the supply side and consumer budget studies for the demand side. If detailed farm management and expenditure surveys are available, these behavioral relationships can be estimated directly. More often than not such data are unavailable or the analysis proves to be cumbersome. Preferred and short-cut methods of estimation are described below.

(i) Supply Side (equation 1)

In some countries, farm management studies can be used to estimate a profit function (equation 1a) directly. This is the preferred approach. For this exercise, one needs observations on profits, factor shares, output prices, input prices for variable factors (e.g. fertilizer), and quantities for fixed factors (e.g. land). The unit of observation is the farm and there must be sufficient variation in prices among farms to allow econometric estimation. Unfortunately, cross-sectional data do not usually exhibit substantial price variation.

In the event that econometric estimation proves infeasible, farm management data (of the type often available in project feasibility studies) can be used as follows. First, if we assume that technology is characterized by a Cobb-Douglas production function and that there are
two variable inputs, labor and fertilizer, and one fixed factor, land, then the corresponding profit function is:

\[
\ln \Pi = \gamma + \sum \alpha_j \ln \left( \frac{p_j}{p} \right) + \ln \Lambda
\]  (1)

where the log of profits (\(\Pi\)) is shown to be a function of the price of the variable inputs (\(p_j\)) relative to the price of output (\(p\)) and the quantity of land (\(\Lambda\)). The supply curve consistent with this profit function is:

\[
Q = \Pi (1 - \sum \alpha_j)
\]  (2)

and the demand functions for the variable inputs are:

\[
Q_j = \frac{-\alpha_j \Pi}{p_j} \quad j = 1,2
\]  (3)

Assume that the analyst has information on farm output (\(Q\)), inputs used (\(Q_j\)) and prices (\(p, p_j\)). The system of equations 1-3 thus comprises four equations and four unknowns -- \(\gamma, \alpha_j\) and \(\Pi\). The system can be solved, therefore, to obtain the unobserved parameters and profits.

There are two flaws with this approach. First, there may be errors in the data. Second, the true relations may not be adequately captured by a Cobb-Douglas specification of technology. These flaws can be partially overcome by taking advantage of other data sources and
allowing some flexibility when solving the system. For example, from
the above equations, it can be shown that the short-run elasticity of
supply with respect to own-price equals \(- (a_1 + a_2)\). Independent
estimates of supply response can be used, therefore, to check the
plausibility of estimates derived from the analysis of the profit
function.

Assume that we have a good independent estimate of short-run
supply response which differs substantially from the derived estimate
(that is, \(- (a_1 + a_2)\)). This may be because the data underlying the
profit function are unreliable. We may wish to resolve the system of
equations but in such a way that \(- (a_1 + a_2)\) is constrained to
approximate the independently estimated elasticity. One procedure is to
solve the system using nonlinear programming techniques and minimizing
an objective function of the form:

$$
\text{Min } L + \delta_1 \left[ \frac{1}{2} a_1^* - \frac{1}{2} a_i^* \right]^2 + \delta_2 \left[ \frac{1}{2} Q_j - Q_j^* \right]^2 \\
+ \delta_3 \left[ \frac{1}{2} Q - Q^* \right]^2 + \delta_4 \left[ \frac{A - A^*}{A} \right]^2 \\
+ \delta_5 \left[ \frac{\pi - \pi^*}{\pi} \right]^2
$$

(4)

where the asterisk indicates the value of the variable used in the
analysis of the profit function and \(a_1^*\) is the independently observed
elasticity. If we think that the independently observed elasticity is
more reliable that the other information then we should assign a higher
cost to any departure from that value. Therefore, we place a larger coefficient \( \delta \) on the term showing the percentage departure from the observed value for this elasticity than on the other terms. Minimization of this objective function will yield a set of values (those without the bars) that are consistent with the (assumed) Cobb-Douglas technology and which depart from observed variables in accordance with our prior assessment of the reliability of those variables. The model would then be based on this new set of derived parameters. In arriving at this set, we would have made maximum use of available data and, moreover, allowed for varying degrees of reliability. \(^1\)

If this procedure yields unacceptable departures from observed variables, it may be concluded that technology cannot be adequately captured by a Cobb-Douglas representation. In this event, it would be appropriate to experiment with alternative functional forms.

This example of a short-cut method illustrates the basic idea in a simple case. The same principle applies, however, for more complicated cases. For example, if two crops are substitutes in production, it would be necessary to treat them jointly and also to allow for the possibility of reallocating land between them. Nevertheless, the basic information needs are the same. The analyst requires information on inputs, outputs, areas, and prices. This sort

\(^{1}\) Since the present exercise is based on hypothetical data, this approach was not used. In has, however, been used by Messrs. Braverman and Hammer in their work in Senegal. This approach is also being used in our current work on Malawi.
of information is usually provided in farm management surveys and also in exercises to measure returns to labor or land by crop, an exercise often conducted in Bank sector and project reports. Table 5 illustrates the kind of information that is necessary to model the supply side.

Table 5
Comparative Gross Margins per Acre
(Farmgate prices, 1977)

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Groundnut</th>
<th>Tobacco</th>
<th>Cotton</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield (lb./acre)</strong></td>
<td>1,500</td>
<td>480</td>
<td>450</td>
<td>1,000</td>
<td>3,500</td>
</tr>
<tr>
<td><strong>ADMARC Price (t/lb)</strong></td>
<td>2.25</td>
<td>8.30</td>
<td>15.20</td>
<td>8.60</td>
<td>4.50</td>
</tr>
<tr>
<td><strong>Gross Value (Kwacha)</strong></td>
<td>6.83</td>
<td>9.20</td>
<td>6.33</td>
<td>35.75</td>
<td>21.85</td>
</tr>
<tr>
<td><strong>Fertilizer</strong></td>
<td>5.50</td>
<td>-</td>
<td>5.50</td>
<td>-</td>
<td>16.50</td>
</tr>
<tr>
<td><strong>Insecticide</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>25.00</td>
<td>-</td>
</tr>
<tr>
<td><strong>Seed</strong></td>
<td>0.50</td>
<td>8.00</td>
<td>-</td>
<td>-</td>
<td>2.50</td>
</tr>
<tr>
<td><strong>Sprayer</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7.00</td>
<td>-</td>
</tr>
<tr>
<td><strong>Credit</strong></td>
<td>0.83</td>
<td>1.20</td>
<td>0.83</td>
<td>3.75</td>
<td>2.85</td>
</tr>
<tr>
<td><strong>Gross Margin</strong></td>
<td>26.92</td>
<td>31.64</td>
<td>62.00</td>
<td>50.25</td>
<td>135.65</td>
</tr>
<tr>
<td><strong>Labor Mandays</strong></td>
<td>50.00</td>
<td>90.00</td>
<td>120.00</td>
<td>140.00</td>
<td>150.00</td>
</tr>
<tr>
<td><strong>Returns per Manday (t)</strong></td>
<td>54.00</td>
<td>35.00</td>
<td>52.00</td>
<td>36.00</td>
<td>90.00</td>
</tr>
</tbody>
</table>

Source: Malawi: The Development of the Agricultural Sector, May 1981 Table 38.

The data presented in Table 5 are drawn from several sources and in some cases are mission estimates.

(ii) **Demand Side (equation 2)**

The estimation/construction of the demand side of the model involves similar procedures. The basic equation for demand is of the form:
\[
\frac{E_i}{Y} = a_i + b_i \ln Y + \sum_j \gamma_{ij} \ln P_j
\]  

(5)

where \(E_i/Y\) is the share of expenditure on the \(i\)th food crop, \(Y\) is total income, and \(P_j\) is the price of the \(j\)th consumption good. Cross sectional household budget surveys allow the estimation of equation 5 provided the sample contains sufficient price variation. Alternatively, independent estimates of demand elasticities can be used to derive the parameters in equation 5. This can be done from the following relations:

\[
\varepsilon_y = 1 + b_i Y/E_i
\]  

(6)

\[
\varepsilon_{ii} = -1 + \gamma_{ij} Y/E_i
\]  

(7)

\[
\varepsilon_{ij} = \gamma_{ij} Y/E_i
\]  

(8)

where \(\varepsilon_y\), \(\varepsilon_{ii}\), and \(\varepsilon_{ij}\) are the income, own-price, and cross-price elasticities respectively.

For basic foodstuffs, international estimates of demand responses may be sufficiently accurate in the event that country-specific estimates are unavailable. In this case, however, it may be appropriate to apply the method described for the supply side so that greater reliance can be placed on the information considered most reliable. For Kenya, for example, estimates of income elasticities are
unavailable but not price elasticities, it would be appropriate to assign a lower weight in the objective function to departures from the parameters derived from these elasticities than to departures from the parameters derived from the income elasticities.

**ADDING-UP RELATIONS**

The analyst also requires information on number of households, number of farms, etc. so that the micro relationships describing supply and demand behavior can be aggregated. The output of, say, maize derived by scaling up the output produced on each of the representative farms must match the total output derived from the aggregate commodity balances. A similar point holds for the demand side. This matching cannot be expected to be exact. Further adjustments may be required, therefore, either in the micro supply and demand relations or in the aggregate commodity balances. Again it may be useful to assign weights to departures from observed values for the different variables and use the minimization procedure. At the end of this exercise, the analyst should have a consistent set of accounts for the agricultural sector at both the micro and the sectoral levels as well as between the micro and sectoral levels. Development of agricultural accounts is, of course, a useful exercise whether or not one wishes to undertake a modelling exercise.

The information requirements -- number of farms, size of households, etc. -- for the adding-up relations should be available in such sources as Population Census, Agricultural Census, Consumer Budget Surveys and National Employment Surveys.
Adding up relations are also required to derive the effects of policy on the five objectives discussed in the text. The information required for consideration of the equity objective is provided immediately by the estimates of compensating variation. For the revenue objective, however, the analyst needs to know the aggregate effect on all taxed and subsidized commodities as well as the levels of tax and subsidy. This latter, of course, is obtained from the price relations. Similarly, for the balance of payments objective, the analyst must add up the effects of any price change on all affected imports and exports. The self-sufficiency ratio for maize, on the other hand, is obtained immediately from a comparison of aggregate production and consumption whereas the measure of efficiency requires the summation of compensating variation for each representative household group and total revenue. None of these relations requires additional information, however. All the information required for their deviation is already contained in the model.

We can summarize the data requirements of the model as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Equations</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity Relations</td>
<td>3a, 4a, 4d</td>
<td>Official Agricultural Statistics</td>
</tr>
<tr>
<td></td>
<td>5a, 6a, 7a</td>
<td>Bank Sector Reports</td>
</tr>
<tr>
<td>Price Relations</td>
<td>3b, 4b, 4c</td>
<td>Marketing Studies</td>
</tr>
<tr>
<td></td>
<td>6b, 6c, 7b</td>
<td>Effective Protection Studies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accounts of Parastatals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bank Sector Reports</td>
</tr>
</tbody>
</table>
Behavioral Relations

i) Supply
  1e  Farm Management Studies
  Studies of Supply Response

ii) Demand
  2a  Consumer Budget Surveys
     Studies of Demand Response

Adding up Relations
  1f, 1g, 2c  Agricultural Census
  2e  Population Census
     National Employment Survey
     Consumer Budget Survey

The table shows likely sources of information. The analyst does not need all these sources. For example, Consumer Budget Surveys and Studies of Demand Response are alternative sources.

With one exception, all the equations in the text can be derived if numerical values are available for the equations cited in the table. The exception is the leakage equation (equations 4e and 4f). Information will not be directly available on leakages from the formal to the informal system. Nevertheless, leakages can be an important feature of agricultural commodity markets and should not be ignored. Some progress, however, can be made by a careful analysis of official procurement data since it is official procurement that will be most sensitive to the amount of leakage. An historical analysis of procurement should enable the analyst to put reasonable bounds on the parameters of the leakage functions.

Finally, it is worth noting the obvious point that a model allows maximum potential for sensitivity analysis. If the estimated leakage function or maize response function is thought to be unreliable the analyst can explore the consequences of alternative estimates in great detail. This is true of other demand, supply and market
parameters also. By means of this process, it should be possible to distinguish between relatively robust policy conclusions and those that are highly sensitive to particular parameter estimates.
REFERENCES


The Agricultural Development Experience of Algeria, Morocco, and Tunisia: A Comparison of Strategies for Growth
Kevin M. Cleaver
Compares agricultural experience of Algeria, Morocco, and Tunisia. Provides insights into the importance of food and agriculture for development, and determinants of agricultural growth.

The Agricultural Economy of Northeast Brazil
Gary P. Kutcher and Pasquale L. Scandizzo
This study, based on an agricultural survey of 8,000 farms, assesses the extent and root causes of pervasive rural poverty in northeast Brazil. The authors review a number of policy and project options; they conclude that courageous land reform is the only effective means of dealing with the problem.

Agrarian Reform as Unfinished Business—the Selected Papers of Wolf Ladejinsky
Louis J. Walinsky, editor

Agrarian Reforms in Developing Rural Economies Characterized by Interlinked Credit and Tenancy Markets
Avishay Braverman and T.N. Srinivasan
Stock No. WP-0433. $3.

Agricultural Credit
Outlines agricultural credit practices and problems, programs, and policies in developing countries and discusses their implications for World Bank operations.
Stock No. BK 9039 (English), BK 9052 (French), BK 9053 (Spanish). $5 paperback.

Agricultural Extension: The Training and Visit System
Daniel Benor, James Q. Harrison, and Michael Baxter
Contains guidelines for reform of agricultural extension services along the lines of the training and visit system. The central objective—making the most efficient use of resources available to governments and farmers—is achieved through encouraging and facilitating feedback from farmers to research workers through extension personnel who visit and advise farmers on a regular, fixed schedule, thus helping research to solve actual production constraints faced by the farmer.
Explains the complex relationships in training and visit extension and draws attention to the range of considerations that are important to implementing the system.
1984. 95 pages.

Agricultural Land Settlement
Theodore J. Goering, coordinating author
Examines selected issues related to the World Bank's lending for land settlement and gives estimates of the global rate of settlement and the world's ultimate potentially arable land.
Stock Nos. BK 9054 (English), BK 9055 (French), BK 9056 (Spanish). $5 paperback.

Agricultural Price Management in Egypt
William Cuddihy
Stock No. WP-0388. $5.
Agricultural Price Policies and the Developing Countries
George Tolley, Vinod Thomas, and Chung Ming Wong

This book first considers price policies in Korea, Bangladesh, Thailand, and Venezuela, bringing out the consequences for government cost and revenue, farm income, and producer and consumer welfare. Other effects, including those on agricultural diversification, inflation, economic growth, and the balance of payments are also discussed. The second part of the book provides a methodology for estimating these effects in any country. Operational tools for measuring the effects on producers, consumers, and government are developed and applied.

NEW

Agricultural Prices in China
Nicholas R. Lardy

Analyzes recent adjustments to China's agricultural pricing systems and its effects on urban consumers and overall production patterns. Defines price ratios from key inputs and outputs and examines price/cost relations in view of the institutional setting for price policy.

Agricultural Research

Points out that developing countries must invest more in agricultural research if they are to meet the needs of their growing populations. Notes that studies in Brazil, India, Japan, Mexico, and the United States show that agricultural research yields a rate of return that is more than two to three times greater than returns from most alternative investments and cites some of the successes of the high-yielding varieties of rice and wheat that were developed in the mid-1960s. Discusses the World Bank's plans to expand its lending for agricultural research and extension, particularly for the production of food and other commodities that are of importance to low-income consumers, small farmers, and resource poor areas.

Stock Nos. BK 9074 (English), BK 0160 (French), BK 0161 (Spanish). $5 paperback.

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Provides and illustrates a framework for analyzing and designing agroindustrial projects.


NEW

Alternative Agricultural Pricing Policies in the Republic of Korea: Their Implications for Government Deficits, Income Distribution, and Balance of Payments
Avishay Braverman, Choong Yong Ahn, Jeffrey S. Hammer

Develops a two-sector multimarket model to evaluate agricultural pricing policies, replacing insufficient standard operational methods. Measures the impact of alternative pricing policies on production and consumption of rice and barley, real income distribution, import levels of rice, self-sufficiency in rice, and public budget. Provides a valuable synthesis of the work that has been done to date on agricultural household models. Helps economists evaluate the impact of alternative pricing policies aimed at reducing deficits. Based on the experience of the Grain Management Fund and the Fertilizer Management Fund in Korea.

Argentina: Country Case Study of Agricultural Prices, Taxes, and Subsidies
Lucio G. Reca

Stock No. WP-0386. $3.

Appraising Poultry Enterprises for Profitability: A Manual for Potential Investors
International Finance Corp.

Decisionmaking tool for entrepreneurs and project managers considering investments in integrated poultry projects. Use this guide to conduct on-site investigation of proposed project. Figure production costs and determine fixed asset and working capital for broiler operations. Analyze market and accurately forecast market prices. This comprehensive guide tells how to manage integrated broiler operations, gives specifications for broiler and breeder houses and summarizes production costs.

The Book of CHAC: Programming Studies for Mexican Agricultural Policy
Edited by Roger D. Norton and Leopoldo Solis M.

The principal tool of analysis is the sector model CHAC, named after the Mayan rain god. This model can be used throughout the sector to cover short-cycle crops, their inputs, and their markets. It can also be broken down into submodels for particular localities if more detailed analysis is required. The model helps planners weigh the costs among policy goals, which can vary from region to region. This volume reports the experience of using the CHAC model and also presents purely methodological material.
The Johns Hopkins University Press. 1983. 624 pages (including maps, bibliographies, index).
Building National Capacity to Develop Water Users' Associations: Experience from the Philippines
Frances F. Korten
Staff Working Paper No. 528. 1982. v + 69 pages (including references).

Bureaucratic Politics and Incentives in the Management of Rural Development
Richard Heaver
Analyzes management problems in implementing rural development from a bureaucratic political standpoint. Emphasizes the need to take account of informal interests in managing programs. Suggests possible methods for assessing incentives.

The Common Agricultural Policy of the European Community: A Blessing or a Curse for Developing Countries?
Ulrich Koester and Malcolm D. Bale
Examines the importance of the European Community (EC) in global agricultural trade. Points out that the EC is the leading importer of agricultural goods and is the dominant exporter of a number of agricultural products. Emphasizes that policymakers in developing countries must understand the implications of the EC's common Agricultural Policy. Spells out how this policy operates and categorizes important commodities.
Stock No. WP 0630. $3.

The Design of Organizations for Rural Development Projects: A Progress Report
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Clarifies the relation between simple farm income analysis and the broader field of agricultural project analysis and emphasizes the more practical aspects of project preparation. Gives guidance to those responsible for planning in agriculture.

Fishery
Highlights the importance of fisheries to the economies of developing countries and recommends that the World Bank provide assistance to those countries that have the fishery resources and are willing to develop them further.

Forestry
Graham Donaldson, coordinating author
Examines the significance of forests in economic development and concludes that the World Bank should greatly increase its role in forestry development, both as a lender and adviser to governments.
Stock Nos. BK 9063 (English), BK 9064 (French), BKL 9065 (Spanish). $5 paperback.

Prices subject to change without notice and may vary by country.
NEW

Forestry Terms—Terminologie forestiere
English—French; Francais—Anglais.
Prents terminology related to forestry development and erosion control in arid and semiarid lands. Since fuel-wood problems and desertification have become serious, particularly in Western Africa, the World Bank has become increasingly involved in wood-based energy and erosion-control and in forest-management projects. Assists translators and researchers who work in this field.
A World Bank Glossary—Glossaire de la Banque mondiale
1984. 48 pages.

Improving Irrigated Agriculture: Institutional Reform and the Small Farmer
Daniel W. Bromley

India: Demand and Supply Prospects for Agriculture
James Q. Harrison, Jon A. Hitchings, and John W. Wall
Stock No. WP-0500. $5.

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Stock No. BK 0297. $3.

Managing Information for Rural Development: Lessons from Eastern Africa
Guido Deboeck and Bill Kinsey
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Measuring Project Impact: Monitoring and Evaluation in the PIDER Rural Development Project—Mexico
Michael M. Cernea
Stock No. WP-0332. $5.

Monitoring and Evaluation of Agriculture and Rural Development Projects
Dennis J. Casley and Denis A. Lury
This book provides a how-to tool for the design and implementation of monitoring and evaluation systems in rural development projects. Because rural development projects are complex, they seek to benefit large numbers of people in remote rural areas, and they involve a variety of investments. The need for monitoring and evaluating them during implementation has been accepted in principle, but effective systems have not heretofore been formulated. The concepts of monitoring and evaluation are differentiated and issues that need to be considered in designing systems to monitor and evaluate specific projects are outlined, emphasizing the timeliness of the monitoring functions for effective management. Elaborates on such technical issues as selection of indicators, selection of survey methodology, data analysis, and presentation. It is directed primarily to those working with specific projects and will be useful to project appraisal teams, to designers of monitoring and evaluation systems, and to project staff who work with these systems.

Monitoring Rural Development in East Asia
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