ANALYZING NATIONAL POLICIES FOR GROWTH WITH EQUITY

International Institute for Applied Systems Analysis and Centre for World Food Studies[1]

Introduction

The Food and Agriculture Program (FAP) of the International Institute for Applied Systems Analysis (IIASA) has been engaged in the development of a set of linkable national models for agricultural policy analysis since 1976, with the help of a network of collaborating institutions around the world. The purpose of the FAP is to study the effect on the domestic food situation in given countries of alternative policy measures taken by their own governments, by the governments of other countries, and by international organizations.

National Models

The emphasis in the FAP is on national policy analysis, given that the major policy options are at the national level. Yet national food systems are highly interdependent, and one country's policy options are affected by other countries' policies. The national economies are linked through trade, aid, and capital flows. Thus for analysis of many national policies, the national models need to be linked.

The problem of persisting hunger is one of poverty and income distribution. One could argue that more agricultural production would trickle down and eliminate hunger, but policies that lead to more equitable income distribution, even at the cost of a reduced growth rate, may eliminate hunger faster. The objective is not distribution or growth, but distribution and growth, and to find an optimum combination of the two. Various policy options need to be evaluated in terms of their impacts on growth, income distribution, and the resulting distribution of food.

Policy Formulation

The emphasis has to be on policy analysis. For realistic policy analysis, one must consider policy instruments and actions which can be identified with specific decisionmakers. Thus government is an important actor in our system. Moreover, policies have to continue to be effective when various economic agents adjust their behaviour in response to policies. Thus we have to distinguish various economic agents and accurately describe their behavioural responses. This approach is followed at both the national and international levels. At the national level, the actors are farmers, nonfarmers, and the national government. At the international level, the national governments are the actors.

This basic approach permits a wide range of government policies. These include domestic price policies, rationing, trade restrictions, strategic reserve policies, normative consumption and income policies, planned target realization, self-sufficiency policies, and free market policies. The relative importance of each of these policies is determined by specifying a hierarchic order among them. For example, prices can be allowed to adjust to supply and demand, or may be set at desired levels and stocks allowed to adjust. Thus, depending on the particular set of policies, and the hierarchy of policy adjustment prescribed, one can characterize market, socialist, and mixed economies equally well, as the only constraints imposed are the accounting rules, which all economies have to respect.

To feel the full implications of these rules, which are similar in nature to the laws of conservation in that the system cannot provide more than is put into it, one needs to cover the whole system and not leave unaccounted any injections or leaks which can mask feedback and secondary (but not necessarily negligible) effects. Thus at the national level, we consider the whole economy, including the nonagricultural sector. Similarly, at the international level we cover the whole world by including an aggregated model for the countries outside our system.

The FAP system of linked models can be summarized as one that provides a quantitative tool for exploring alternative policy strategies applicable to various kinds of economies, planned and market, and which is realistic in the sense that it takes account of the behavioural response of its actors. To explore policies for growth for agriculture, one needs to quantify the supply responses of farmers to various policy instruments. To examine distribution policies, one needs to describe consumer behaviour under the influence of government policies. To analyze the interactions of growth and equity, one needs to define the income generation and distribution process, as well as recognize the limitations of government policies and constraints on their consistency. The typical national model of FAP does this, although the methodological approaches differ between models. The approaches used for each of these elements can be briefly described as follows:

Supply Responses

Four alternative approaches are used in various models:

1. Econometric estimations of acreage response and yield functions. In these, relative profitabilities and critical inputs and factors are included as explanatory variables. This is the approach followed in the India, Kenya, and USA models, and one version of the Canadian model.

2. A nonlinear programming model to allocate land, factors, and inputs to different crops, based on an estimated production function, is used in the model of our basic linked system.

3. A linear programming approach which integrates economic and institutional aspects with agronomic considerations is used in models of Thailand and Bangladesh.

4. A hierarchy of linear programs is used in our models of centrally planned economies (Hungary and Poland) to describe and coordinate the behaviour of planned and various agricultural subsectors.

Income Generation

In some of the models of developing countries, different classes are identified, based on the distribution of assets such as land, drought, animals, and equipment, and the product is distributed across these classes as income entitlements in the form of shares of labour, land, and capital. In other models, production itself is identified by different size classes. In the developed country models, as income distribution has no significant impact on food consumption, only two classes are distinguished, agriculture and nonagriculture.

Demand Behaviour

Demand behaviour is described through estimated linear expenditure systems. For developing countries, different expenditure classes are distinguished, and a separate demand system estimated for each class from time series of household expenditure surveys.

Government Policy

Government behaviour is described by a hierarchic set of adjustment rules for policy targets, such as domestic price targets, trade quotas, stock targets and bounds, and tax rate bounds.

The Thailand Model: An Application

The Thailand model is a dynamic system of equations describing supply, demand, and price formation. It operates with a time increment of one year. Two types of actors are distinguished, the government, and the consumers and producers.

The Exchange Component

This part of the model consists essentially of a system of simultaneous equations which is solved to derive the equilibrium price for 19 commodities. In equilibrium, each economic agent satisfies its budget constraint.

Demand behaviour for food is represented by a set of demand functions for each income group specifying relationships to income and prices. A share equation allocates available investment funds between the public and private sectors and between agriculture and nonagriculture.

Government policies are represented through tax rates (excise, income, and tariff). The exchange component takes supply of agricultural and nonagricultural commodities as given. This is reflected in a fixed endowment for each income group. Agricultural supply is determined in a detailed linear programming model. Nonagricultural production is determined by labour and capital using a CES production function. Labour supply is determined by an employment function. Capital supply depends on past investment and an exogenous depreciation rate. Full utilization of production capacity is assumed. When the equilibrium price is determined, the agents can carry out their expenditure plans and another round of supply and exchange can start.

The Supply Component

The supply model consists of two sets of information: (a) the agronomic synthetic crop production model, yielding production and input-yield relationships; and (b) the socioeconomic model specifying economic and behavioural relationships. Definition of a representative farm has been used as the basis for describing the supply behaviour of the agricultural sector as a whole. Similarities in farming structure, such as farm size, topography, and climate, are the selection criteria in determining the representative farm.

In Thailand we distinguish six agricultural regions: Northeast, Upper North, Lower North, Central Plain, Eastern and Western parts of the Central Region, and South. Within each region three farm sizes are distinguished--small, medium, and large. The recursive linear programming model consists of four elements:

1. Activity set: Six types of activities are distinguished: (a) production, (b) buying and selling, (c) hiring and renting, (d) subsistence, (e) migration, and (f) investment.

2. Constraints: The resource constraints comprise: (a) land classes, (b) monthly labour, (c) six types of livestock, (d) draught power, (e) fertilizer and manure, and (f) cash. The behavioural constraints are subsistence demand, and the flexibility constraint.

3. Objective function.

4. Dynamic resource adjustment.

The Agronomic Submodel—Crops

At the highest hierarchic level it is assumed that all removable constraints are effectively eliminated, leaving irradiance and physiological crop characteristics as the sole yield determinants. At the next lower hierarchic level, the influence of a subsequent factor is considered, with factors still lower in the hierarchy supposedly not constraining. Yield is being used as the independent variable which determines required yield-related material inputs and labour.

The gross dry matter production of a standard crop is calculated for all time intervals in the growing season of the crop. Summation of the production figures over the time intervals yields the standard production of the crop; i.e., the overall production of dry matter, limited only by physiological plant properties, and the prevailing conditions of temperature and irradiance.

Available water for crop use during each time interval is analyzed at the second hierarchic level. With the aid of the transpiration figures emerging from the water balance, the potential dry matter production is calculated, under the assumption that direct proportionality exists between water use and dry matter production if water is the limiting factor. Potential dry matter production is subsequently divided over the various plant organs. The harvested part constitutes the potential economic yield.

The availability of plant nutrients is analyzed at the third hierarchic level of the model. This information is fed into a generally applicable model to predict the yield response of crops on nutrients.

The Agronomic Submodel—Regional Aspects

There are regional differences in environmental conditions. Hence, roughly homogeneous tracts of land have to be identified so that the crop growth model can be run for combinations of sites. The following sections explain how data are aggregated and how representative numbers are established for use in the model.

Regions, land units, geographical aspects. First, to distinguish regions which are climatically homogeneous, data are prepared from information supplied by weather stations: (a) data necessary for the calculation of assimilation, (b) precipitation data, and (c) data necessary for the estimation of potential evapotranspiration. Then all relevant information on land, soils, and climate is transformed into numbers to be handled by computer programs.

Grid system. Thailand is divided into imaginary squares where each degree longitude has been divided into 12 equal parts and each degree latitude into 20. The location of each grid unit is indicated by its coordinates. The number of

grid units per region and per land unit is known, so therefore, the surface of each land unit can be computed. In the case of Thailand, one grid unit covers 3,030 ha.

Climate characteristics. Climatic data are used to calculate P_{st} in the submodel of dry matter assimilation. In the submodel of water availability, climatic information is required to calculate actual and maximum evapotranspiration.

Soil characteristics. Data on soil conditions are needed for the water balance to estimate P_{pot} and for the nutrient submodel to determine Y_{nut}. The main soil parameters used in the model are texture, organic matter content, nutrient stock, depth, and profile development.

The output of the crop model consists of sets of discrete yield-input and yield-resource relationships. The program which connects the crop model with the economic model is called "linkage interface."

The Agronomic Submodel—Livestock Production

Coefficients of livestock production have not been derived from a model of growth simulation, but are based on both Thai specific and general literature on feeds and animal nutrition. The livestock and crop production sectors have been linked via animal traction, crop production, the use of manure, and feed requirements.

Some Results of the Thailand Model

In order to illustrate the working of the model, some results of three runs that have been developed will be discussed: a base run and two alternative runs. In the base run, it is assumed that no policy changes will occur during the period under study. For this run only the model has been solved for the period 1973-1989. The two alternative policy runs are solved from 1980 until 1989. The new policies are assumed to be implemented in 1980.

In the first alternative run, the Thai government is assumed to impose a higher rate of direct tax. The increased direct taxes are levied on households and private corporations in the nonagricultural sector. Direct taxes levied on farmers remain very low. The effect of such an increase is that direct tax revenue increases, indirect taxes decrease, consumption of nonfarm households declines, and consumption as well as calorie intake of farmers increases. The second alternative policy assumes that the nonagricultural import duty decreases over time. This will cause a decrease in the domestic price of nonagricultural commodities. Consequently, the terms of trade change in favour of farm households. Consumption of farm households rises and consumption of nonfarm households declines. Total consumption of nonagricultural commodities increases in line with imports.

Under the base run, the average growth rate of real GDP reaches 5.9 percent, during both the 1973-1981 and 1981-1989 periods. The growth rate of population is exogenously estimated to be 2.5 percent per annum, resulting in a per capita growth rate of GDP of 3.4 percent. When direct tax rates are increased, the overall economic rate of growth is slightly lower at 5.6 percent. The lower rate of growth arises from the lower savings generated by the economy (these are taxed away) and therefore lower investment. In the import tariff alternative, the overall economic rate of growth is also slightly lower than in the base run, 5.8 rather than 5.9 percent.

Differences in rice export projections are quite remarkable. For the period 1980-1989, the base run predicts a decrease in rice exports of 0.5 percent per year, while the increase direct tax run shows an average decrease of 1 percent per year. In the import tariff alternative, on the other hand, a yearly increase in rice exports of 3.4 percent is expected. Exports are higher for all agricultural products in the import tariff run. Because of a lower price for nonagricultural products, use of inputs (fertilizer) becomes more attractive, which results in higher production and thus in higher exports. Farm exports also grow in order to pay for increased nonagricultural imports, given a fixed trade deficit.

In all three runs, income per capita grows faster in the Northeast than in the Central Plain. Because of the income disparity in the base year (in 1973, per capita incomes for the Northeast and Central Plain were 1,926 and 3,620 Baht respectively), relative income differences decline.

Per capita income grows in all cases except for the Central Plain farmers in the base run. Differences in growth among the policy runs are quite substantial. For the Northeast farmers, income increases of 17.6, 59.6 and 75.0 percent amount to -2.8, 35.1 and 29.8 percent in the respective runs. So if we take into account that incomes in agriculture are on average much lower than in nonagriculture, and that the Northeast is by far the poorest region, a policy directed at narrowing income differences will be more successful if import tariffs are decreased than if current policies or a policy of increasing direct taxes is applied.

The model generates for each income group a demand for food and nonfood commodities. To have an idea of the nutritional status, the food demand is translated in terms of calories and proteins. While the national average intake grows 30.1 percent to 2,975 calories, growth in the Northeast, for example, is only 6.6 percent, yielding 1,820 calories, which means that in the Northeast inadequate nutritional intake will occur frequently during the projection period.

Note

[1]This paper was written jointly by the staffs of the International Institute for Applied Systems Analysis, Laxenburg (Austria) and the Centre for World Food Studies, Free University, Amsterdam. It was read by K. S. Parikh and D. C. Faber.

OPENER'S REMARKS—G. J. Tyler

Andrews and de Janvry's Paper

An underlying weakness of much economic analysis is that it is completely divorced from politics. Often when political considerations are brought in, they are solely in the form of a wise and benevolent government manipulating various parameters or variables in the model in order to maximize social welfare of the country as a whole. It is the great strength of some writings, among which one can include the paper by Andrews and de Janvry, that they bring political considerations explicitly into the analysis and, moreover, view governments as being uneasy alliances of different power groups, each of whose interests sometimes conflict.

The authors first explore the conditions under which a terms of trade policy favouring agriculture is likely to stimulate demand for the nonagricultural sector's product; i.e., when dX_2/dp is positive. Depending on combinations of values of parameters and exogenous variables, it appears that the demand response can be positive or negative. They then use this information to estimate whether incomes of different social groups will be favourably or unfavourably affected by a policy of increasing agricultural prices. Finally, this information is used to see whether such a policy is likely to be supported by the various groups.

There seems to me to be an element of circularity or, if not circularity, certainly of inevitability in these models. For instance, taking the "disarticulated structure with functional dualism," the authors conclude that there is likely to be a negative demand response, that landlords and capitalists would lose from a positive price policy, and as a consequence there will be an alliance between them to impose a policy of depressed agricultural prices on peasants and workers. Why then cannot the peasants and workers, who might in certain circumstances gain from increased agricultural prices, and who presumably far outnumber the landlords and capitalists, unite in a political alliance and impose a positive price policy? They cannot, because by assumption only landlords and capitalists can form the government. The problem is that if the model allowed peasants and workers to compose the government, one cannot conceive that they would continue to accept being exploited, as the parameters of the model dictate. Thus with a different political grouping, the parameters of the model would have to change. Could this be modelled as evolution rather than revolution?

I found this paper a difficult one, partly because it was couched in terminology with which I am not too familiar, but I was not helped by the inclusion of exogenous variables, such as investment, under the heading "Parameters" in table 1.

In any extension of these models, I think it important to remove some of the simplistic and restrictive assumptions underlying the mechanism of income determination. I think it would also be fascinating to estimate empirically the parameters of these models with data drawn from a particular country and, rather than explaining past historical developments, to predict likely changes in the political structure of that country.

IIASA and CWFS Paper

Whereas government in Andrews' and de Janvry's paper is an uneasy alliance of power groups, in the paper from the IIASA and CWFS, government enters as an actor with a range of policy instruments at its command, able to manipulate the system, presumably in order to reach some particular goals and affected in turn by past actions of its own and the other actors in the model, such as farmers,

consumers, and so on. The authors give an example of the model's working in the Thai economy. I should like to ask two questions in this connection. Firstly, we are told what the policy instruments are (e.g., increased rates of direct taxes), but what were the objectives of the government? Does it have, in fact, any objectives? Secondly, we are told about the changes in regional income, but what happened to the incomes and the nutritional status of the various classes of the population based on ownership of land and other resources? This has obvious implications for the growth-equity tradeoff debate.

Lastly, whereas in other papers at this Conference growth and equity have been discussed in terms of incomes, this paper explicitly brings in nutrition. It appears, however, that nutrition is thought of as purely dependent on income, and hinges on being solved at the same time as poverty is solved. Two points arise in my mind. Firstly, there is plenty of evidence that there are a number of factors involved in undernutrition other than income. Secondly, governments may be better able to implement policies that address the nutrition problem directly, than the longer-term solution through improved incomes of the poor.

OPENER'S REMARKS—K. S. Howe

Andrews and de Janvry's Paper

The paper's three particularly important contributions are that it (a) explicitly embodies political structure, (b) shifts attention to effective demand, and (c), within a simple model, demonstrates via the reduced form equations that the nature of the relationship between parameters in determining any outcome gets quite complicated. It provokes the question of whether growth can take place without political change. The three models answer the question, which is that the greater the degree of disarticulation, the less chance of induced change.

Disarticulation is reduced where certain basic prerequisities are satisfied, including: (a) dominance of a commodity exchange economy, in the sense that most people are directly or indirectly engaged in production with the objective of exchange; (b) a money system which maximizes the ability to exercise choice in the market; and (c) appropriation of a significant proportion of their surplus value of labour by labour such that the desire to consume above subsistence needs is accompanied by the means to consume (i.e., there is effective demand). This implies existence of wage labour.

Mention of Keynesian-type models invites reflection as to the origins of Keynes' analysis and the sociopolitical conditions of the day. Two significant points occur: (a) the General Theory emerged in response to problems of economies in advanced stages of development; and (b) characteristic of the socio-political structure of the time, despite marked disparities in the distribution of power and wealth throughout the community, the economic system was sufficiently integrated to satisfy the prerequisities mentioned above.

The imposition of Keynesian-type models on predominantly less developed (agricultural, and therefore disarticulated) economies may not really be justified. Perhaps we should turn our attention to the potential contributions of rural sociology and economic anthropology, to observe and be guided by the experience of societies undergoing sociopolitical transformation. The consumption and investment behaviour of individuals and groups within the overall class structure, and between regions and localities within national frameworks, should give more clues about the specific conditions necessary to trigger growth.

The paper's fourth important contribution is, therefore, that it provides the stimulus to economists to look beyond the boundaries of their own discipline, appraise the relevance of traditional economic models to developing countries, and therefore to evolve more appropriate models set explicitly in sociopolitical contexts undergoing change.

The importance attached to such holistic models is undeniable, and this is an impressive example. A number of specific questions arise, as follows:

1. Although parts of the model use LPs for representative farms, there is no mention of how the problem of aggregation bias is countered. What approach, if any, was used?

2. The results which are quoted for Thailand include simulations for the 1970s. How do these results compare with what actually happened? The validation procedure is particularly important for models which explicitly incorporate optimizing criteria.

3. What was the contribution of the East European literature to the East European models?

4. What is the full extent of resources devoted to the project? In truth, it appears that there are a number of models devoted to a single objective.

5. How confident are the authors about the reliability of their data systems? Does the variability at least partly explain the mixture of econometric programming models adopted?

Experiences in even well documented countries emphasize the need for caution with sophisticated models.

RAPPORTEUR'S REPORT—Brian D'Silva

The discussion from the floor centred on the IIASA model. The thrust of the questions was the methodological issues concerning the construction of the IIASA family of models. There was general consensus that the researchers should be congratulated on their efforts in the construction of these models.

Discussion on the aggregation problem focused on the fact that the IIASA models are very detailed on the physical production aspects, (i.e. agronomic) and more aggregated on the economic aspects. The authors felt that these were not particularly serious problems because of the manner in which the activities for the model were generated, and also because characteristic farms were constructed for different farm size classes. Problems in data availability were acknowledged, but this was inevitable in construction of these models.

Other points of discussion on the IIASA models focused on the incorporation of nonfarm labour allocation into the model, and modelling of governmental policy objectives. Nonfarm labour allocation was incorporated through the use of migration (both seasonal and permanent). The authors acknowledged that this was elementary and hoped to improve on it. While it was acknowledged that there were different actors involved in governmental policymaking, and each with different priorities, the authors felt that there were sufficient policy instruments in the model to capture the objectives of government policymakers.

Participants in the discussion included R. O. Adegboye (Session Chairman), Csaba Csaki, Richard Meyer, Prasarn Trairatvorakir, and Adolf Weber.