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On Regional and Interregional Models of Planning for Agriculture

The spatial aspect of economic activity has been a topic of discussion and studies for a long time. Agriculture has always been an attractive field for such studies. Starting with Thünen a long list of authors dealing with problems of space in agriculture or other sectors of the economy could be enumerated. For brevity, I draw attention in the reference list to a paper by Weinschenck, Henrichsmeyer and Aldinger [1].

1. NATIONAL AND REGIONAL PLANNING

In many non-socialist countries there is a regular activity of national planning. Local and regional plans are also prepared but not always in connection with the national plans. There are efforts in various countries to elaborate national plans in a regional setting. As an example refer to the recent French REGINA model [2].

In the Soviet Union Lenin stressed already in 1918, i.e., at the start of the economic planning activity, the need to develop national plans in a regional setting, as we read in [3]. He emphasized the importance of a rational distribution over the country of the productive forces, the importance of a rational spatial division of social labor.

The Soviet experience, gained in the course of the steps toward the realization of these goals, was helpful for the other socialist countries where the need for consideration in national planning emerged soon after taking the first steps in building up a planned economy. This was true with Hungarian planning too.†

Important principles in the traditional methodology have been comprehensiveness and consistency. The very detailed system of balances required correspondence between figures for different sectors in the national economy as a whole and in various regions. Of course, due to weaknesses in planning –

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† The present author has good memories of the book entitled *Territorialnoe planirovanie*, by L. Volodarsky, from which he learned about the methodology of regional planning in 1949–50, and he still feels that his mathematical model building activity profited greatly from that traditional regional planning methodology.

or rather of the planners – these basic requirements have often been only partially met. However, mathematical model builders have still much to do in developing a system superior in every respect to traditional methodology.

1.1. *Types of problems in planning over space*

The spatial aspect of decision-making in economic activity, or of decision-making in the planning process, touches a number of problems. A few of them, characteristic ones, will be listed here.

(a) Finding a correct location for a unit of economic activity (e.g., a plant or a complex).

(b) Finding correct distribution over a space of a type of economic activity, along with resources and flows (i.e., sectoral location).

(c) Finding correct structure of economic activity within a region under, or without influence of, national plans or results from solutions of problems of type (b).

(d) Finding a correct distribution over space of economic and other activities and resources, in the form of activity structures (comprehensive plans) held appropriate for units on different levels of the hierarchy, and the flows between them.

Policies of a financial character (pricing, taxation, subventions etc.) often appear in problems (a)–(c). Problem (d) involves policies not only of financial character but also policies of social–cultural and environmental conditions, population movements, etc.

Various mathematical models and procedures have been developed for handling these problems. The mathematical apparatus used most frequently involves different types of functions and linear algebra (in the form of Leontief analysis and mathematical programming).

I note that the important task of establishing industrial (or agro-industrial) complexes touches points (a)–(d). As to treatment in relation to problems (a)–(c), I refer to several Soviet and American studies [3–6]. An excellent treatment of pricing and allocation over space can be found in Takayama and Judge [7].

1.2. *The choice of regions*

Depending on the geographical picture, its size and on the social system of a country, the considerations for marking out the regions may be different. Let us refer to only three items from a rich literature: Fox and Kumar [8], Kostetsky [9] and Alexandrov [10]. Difficulties with the number and size – to which there may be related also a problem of the degree of non-homogeneity – can be reduced by the application of a multi-level planning procedure which may reconcile the advantages and disadvantages of a micro-regional and of a macroregional approach in model building.

I would like to stress that the boundaries of regions should encircle complete administrative units. One reason for it is that the data basis, or at least an important part of it, is generally available for administrative units. Another reason is that the leaders of these units have to represent the interests of

the population of entire communities and are often responsible for important decisions concerning the respective units as entities.

1.3. *Planning downwards or upwards?*

No doubt serious regional planning cannot be imagined irrespective of central (government) decisions and information. On the other hand, the government also must be informed about needs and possibilities in their distribution over the country. Thus, a continuous exchange of informations between government and units on lower levels of the hierarchy is necessary for any type of planning.

We can speak of a centralistic type of planning if every important decision in the course of planning, particularly those concerning targets and resource allocations, comes downwards to a unit from the next higher level of hierarchy. Given official omniscience, it would be very efficient. In its very rigid form it already belongs to the past. As practised at present we see it in a looser form – as certain segments of the planning procedure in socialist countries and, for example, as the procedure corresponding to Tinbergen's concept [11, 12] of "planning in stages".

"Planning upwards" means that the units belonging to each level of the hierarchy make most decisions for themselves in the process of planning and the next higher level of hierarchy has to respect these decisions in setting up its own plan. Of course, the decisions which are necessarily made at appropriate higher levels are respected. This type also can be found in the practice of socialist countries, in a looser form. In the present author's view [13], regional and national plans can be built up in this way as will be discussed later.

2. TYPES OF MODELS AND THEIR USE FOR PLANNING

Section 1 has a rather general character although our efforts are directed to improving agricultural planning. But we can help agriculture more efficiently if we deal with its problems set in a general socio-economic planning process. Thus purely agricultural models should be considered as specific elements of a broader framework, or as precursors of such elements.

Now we shall review four types of models as means of analysis for planning purposes or as tools of planning.

2.1. *Single functions and systems of functions*

(a) *Production functions.* Production functions by regions or sub-regions appear very often in the literature, particularly if we also count here the crop response functions for different soil types. Crop and livestock response functions can help in studying possibilities of shaping yields and technologies for regions with different conditions. The result of such calculations may be useful in constructing the system of coefficients for Leontief analyses, for optimizing and simulation models.

Functions describing the dependence of total farm output on various types of inputs also offer productivity, substitution, etc., comparisons between

regions for considerations about policies to be included in planning models. By integrating regional production functions into a system, effects of different policies can be studied in each region and on the national level.

Interregional and international comparisons of resource efficiency in agriculture derived from production functions can be found, e.g., in Heady and Dillon [14]. From the Soviet Union I mention Zakumbayev [15] who estimated Cobb–Douglas functions for sectors, including agriculture, in a regional setting, for republics, and within Kazakhstan for macro and micro-regions, to analyze development.

The present author has also made calculations based on production functions in the preparatory stages of both the 4th and the 5th Five-Year Plan, with functions computed on the sector and on the regional level.

(b) *Demand functions.* The models known to me include demand either in fixed quantities – eventually in variants or in values changing according to a parameter – or in the form of demand functions. Some interregional models consider national demand only, others calculate regional demand figures from total national demand proportionally to population. Pant and Takayama [16] derived regional demand functions by substituting regional per capita income in the national per capita demand function and multiplying this formula by regional population. Kottke [17] estimated regional demand functions from data by states.

(c) *Supply functions.* As elements of a model, e.g., of a simulation model, they are generally estimated by variables like prices, area and inputs as well as proxies for technical change and eventually for natural conditions. Often we see them derived from results of optimization as normative supply functions.

2.2 *Leontief analysis*

The interindustry analysis has become not only a tool of national planning but has also found a wide application in spatial planning. We find input-output tables for cities, and for smaller and larger regions throughout the world, in countries having quite different social systems. These regional Leontief analyses have generally been of a static nature. As a new development in this field should be mentioned the elaboration of dynamic regional interindustry models for the Baltic Republics of the USSR [18].

Another important type of interindustry model is that reflecting spatial interdependence. Riefler [19] gives a good survey, with a long reference list, so citing examples here seems unnecessary. A specific type of these interindustry–interregional models is that emphasizing agriculture, with a disaggregation by commodity groups of the agricultural sector in a regional setting. The spatial-sectoral interdependence has generally been the focus of the studies, including projections. A further step is represented by primary factor commitment projections like the study by Schluter and Heady [20] presenting agricultural employment projections on the basis of an interindustry–interregional model emphasizing agriculture.

If we focus our attention on the interdependence within agriculture, the

connection between local, or regional, and national tables has to be organised. Of the present author's multipurpose studies the one to be mentioned is that which, based upon the tables calculated for each large-scale farm in a 2·5% sample, furnished distributions by regions of direct and cumulative, inverse, coefficients, also [21].

2.3. *Mathematical programming*

Spatial location of agricultural production had been mentioned among the fields of application by the very first paper [22] on the procedure which later became widely known under the name linear programming. Optimizing models are abundant and show a great diversity in relation to time and to coverage. The majority have aimed at finding an optimal final state for the spatial distribution of production. The simplest ones optimize only the location in space of an activity or groups of activities. Others include meeting demand, not only on the national level but in a regional setting too. The production–transportation models for agriculture often serve a multiplicity of purposes. As examples, I mention recent studies which consider, among others, policies for pricing, water use and pollution restriction [23, 24].

Another type of model deals explicitly with time. One of them, described in [5], is fully applicable to agriculture, although it was originally constructed for purposes of industrial development and location in Siberia. Here the variables and constraints have a yearly timing within the planning period. The interregional recursive programming models elaborated at the USDA as aids to agricultural policy-making have a cobweb character. (See, e.g., Miller [25] and Schaller [26]). For an application to a single region I refer to a paper by Singh [27].

The programming models also differ heavily in coverage. The variables may cover the whole agriculture or only part of it, may specify types of farming from technical as well as a social point of view, and may include links to non-agricultural activities. The constraints are also detailed in varying degrees. Some models include mainly commodity balances and technical constraints like a Polish model with high activity coverage [28], others include financial and behavioral equations along with detailed technical constraints over a deep spatial disaggregation like CHAC, having a much smaller coverage of Mexican agriculture [29].

The models of partial coverage, either in terms of activities or of constraints or both, may throw light on special problems. They may help in building more correct and more comprehensive models and may also furnish considerations for traditional, and more comprehensive, planning.

2.4 *Simulation*

This procedure may use different mathematical tools. For a single region, Singh [27] applied recursive programming while Miernyk *et al.* [30] the dynamic input–output analysis. The USDA models [25, 26] are based on the interaction of demand functions and optimizations through linear programming by regions. Systems of equations or functions characterize the simulation models constructed for Nigeria [31] and South Korea [32]. Both of

them include macroregions and connections with other sectors of the national economy. With a broad coverage and an appropriate choice of coefficients, such simulation models may contribute much to a more realistic planning. Running policy alternatives by using such models may help the decision-makers to construct strategies for development and policies serving the realization of the strategic goals.

3. THE PLANNING PROCESS

The success of plans depends to a great extent on how seriously planning has been taken by a government of a country first of all, by the leaders of the planning units and, last but not least, by the planners themselves. Development in many countries would require changes in the economic, social and political structure. To carry out these changes in a relatively short time, or even abruptly if necessary, needs a firm resolution of the government and its agencies, not only at the start but in the process of realization, also, when difficulties have to be faced day by day.

3.1 *The planners*

In any stage of the planning process, the planners must take stands and their preferences and dis-preferences may strengthen or weaken the intentions and efforts of the government. This is true for mathematical planning too: in model building and interpretation of results, attitudes play a role which should not be under-estimated. For example, in respect of the relation of regional development to national economic growth, Courbis [2] stressed that the conception of the REGINA model shows an explicit acknowledgement of the non-neutrality of spatial factors and regional policy to national development. And this occurred not independently of the attitudes of the planners and model-builders. Let us bear in mind, even a purely technocratic attitude in modelling can work against a development conceived on the basis of social justice and the result finally touches not only certain regions or groups of population but, also, the sound growth of the whole national economy.

In many cases, regional–national planning has been assigned to a central group – at least, many publications do not mention planners on lower levels of the hierarchy. Thus, the role, if any, left to the lower levels, might by that of consultants. At a very early stage, e.g., in a stage of developing models by researchers, it may be accepted. However, if we assume that planning means a set of decisions with a multiplicity of consequences, those who are interested should participate, at least through their representatives. Thus, planning agencies should include regional and local authorities, representatives of social groups and experts in various fields available in a certain region. The planning agencies at various levels of hierachy may have keen discussions with each other but they should respect the right to make certain decisions which have necessarily to be made at a higher or lower level.

3.2 *Goal setting*

Government intentions concerning the socio-economic development of the country necessarily involve a spatial aspect even at the stage where the plan

is taking shape, the natural resources to be used, problem spots to be eliminated, etc. In order to improve this first crude goal setting, a series of partial studies should be carried out.

These partial studies, focusing problems of agriculture, should cover at least the following areas at the national as well as at regional level.

(a) Population and labour force projections, by social and professional groups. Needs and possibilities for mobility (interregional and interprofessional) should also be studied under the present and possible future situations characterized by social system, educational and economic opportunities.

(b) Development of sectors other than agriculture, including various types or services. Projections, estimates and decisions have to be investigated from the point of view of demand and supply, employment opportunities and effect upon living conditions, with special regard to relations with agriculture.

(c) The formation of agrarian structure – a realistic picture assessing needs and possible directions of change, the forces in favor and against, the time span of realization, the factors and measures needed to make the change a success. Estimates about the effects on shorter and longer term.

(d) Agricultural production and technology should be surveyed. The balance of demand for products and the production potentials should be investigated, considering efficiency with changes in the agrarian structure, supply of inputs, general and professional education, diffusion of new farming techniques, incentives for increasing and modernizing production, financial sources of development.

(e) Income distribution should be studied by groups of population, according to the levels needed, the sources of income and the feedback to production.

(f) Government intervention with direct and indirect effects of policy variants should be surveyed in the field of legislation, finances, a state sector of production as a moving force, social-cultural development, population and employment policies.

An evaluation of such studies would show, how ambitious goals might and should be thought of as feasible, in the qualitative and quantitative sense, serving for starting points for the second stage of planning.

(a) *Mathematical models in the preliminary studies.* Mathematical models can be widely used in the course of these preliminary studies. Their application is helpful not only because of the information furnished by the solutions but at least as much through their effect upon thinking. The keen discussions in this stage about model-building, evaluation and assessment of results, can bring benefits for the later stages.

Demographic models may be used for studying and forecasting movements of population and labor force.

Production functions and Leontief tables offer good possibilities. A special form of the latter is an intra-sectoral table in a heavy disaggregation, the input coming from other sectors being linked as a premultiplying matrix. It must be

noted that intra-sectoral intermediate demand must justify the construction of such tables well suited to different types of organization, levels of technology, and connectable to more aggregative national Leontief models.

The behavior in connection with technical progress in practice should be studied, in its dependence on time and other factors, to evaluate coefficients for Leontief tables, MP matrices and equations in simulation models.

The simulation models used for the evaluation of the effects of different policies characterized quantitatively for future periods can cover either more narrowly a sector, as in an investigation made by Reynolds, Heady and Mitchell [33] or include to a certain extent the behavior of the economic environment of the sector in question as reflected by the above-mentioned studies of the Michigan team [31, 32].

The optimizing models should be used on both regional and interregional levels, for single sectors and for the ensemble of several sectors of the national economy, since computer time and cost would hardly allow running models of complete comprehensiveness in so detailed a form as is necessary in this stage.

As a result of the solution of a considerable number of such models, the spatial structure of economic activity offers information about employment, income distribution, living conditions, demand and supply, resource use, investment for different purposes etc., depending on the policies and socio-economic conditions reflected by the models.

(b) *The evaluation of the results.* The different models offer, of course, because of their character, different figures for the same categories. Comparisons of the results furnished may lead to acceptance or rejection of certain assumptions of the model-builders.

In the course of an assessment of results from various models, one can set up systems of balances on the regional and national level, for separate sectors and for the whole economy. We can see which policy, with how much effort, would lead to attainment of certain goals, which goals would be overfulfilled and which ones not attained. A projected population structure would need a certain food supply, an income structure: how do the food production and the income distribution meet these requirements according to solutions received from the models? How do the results of models of manufacturing industries correspond to the demand in input goals derived from models for other sectors? Does capital formation keep pace with the investment activity as it is distributed over time?

A long series of such questions must be asked and the staff of planners and their consultants, going through the results, item by item, must identify disproportions, find promising policies and change (replace) assumptions, coefficients, relationships in models in the course of this analysis. After this the important national and regional goals may be fixed for the second stage of planning.

3.3 *Planning over space and time*

Starting from the preliminary studies, aided by mathematical models as mentioned above, the national goals should be tested by Leontief analysis,

accompanied by projects involving policies touching the socio-economic sphere. It is preferable to set up several variants of the goal system, representing strategies of development, to allow the legislators to choose the path to be followed.

In the case of setting up the regional–national plan by using mathematical methods, one should first decide upon the direction of the planning procedure: going downwards or upwards.

(a) *Planning downwards.* In the first case, one might use an interregional Leontief analysis but this choice might give rise to questions touching serious problems. Even in the case of a static model, the spatial nomenclature of sectors should be fixed over the whole period and one should decide about interregional flows by fixing the coefficients and their eventual changes over time. More problematic would be an interregional dynamic Leontief model.

Choosing a normative approach for downward planning, a simultaneous solution for all regions should be considered. Here we have to deal with the case mentioned under 1.1(d) and we must consider, because of indivisibilities a mixed integer programming approach (with general integer and continuous variables). The objective function may represent different economic categories. The system of variables and constraints should be chosen in such a way that they would not eliminate possibilities important for the next step, the optimization for subregions. I stress that lower bounds of income for different social strata should be fixed for each region, along with requirements for social–cultural and infrastructural development. Foreign trade, balance of payments, financial balances, migration, and eventually transportation, should also be explicitly treated.

As far as optimization for the subregional level is concerned, the solutions for the respective regions would serve as components of the constraint systems.

Planning downwards is an efficient procedure but it does not allow much freedom of decision for lower levels as either responsible leaders or owners.

(b) *Planning upwards: building up a national plan from below.* With the exception of managing the economy in a rigid centralistic manner, decisions in planning for future action should be made by the representatives (leaders) of the respective units (firms, municipalities, regions, etc.). These units on various levels of hierarchy are assured of an economic independence by the legal framework prevailing in the country which not only allows, but also requires, their self-contained decision-making.

Under such circumstances, building up the national plan from plans of units belonging to different levels of hierarchy seems to be preferable. This would also correspond to the principle of an active and wide participation in the planning process. A basic requirement of such planning is that the totality of plans prepared by the units on a level of hierarchy must be compatible with the plan of the unit they belong to on the next higher level of hierarchy.

Since the aspirations and the response to the socio-economic environment, including incentives and other types of government intervention, of the

individual planning units may be different, compatibility with the plan of the unit on the next higher level can be more easily reached if there are variants of plans from which the higher unit can choose, one for each lower unit, in such a way that the higher unit can also develop its plan in a number of variants.

As was mentioned in 3.1 and 3.2, the preliminary studies, including investigations by partial mathematical models, and the discussions in the course of the evaluation of them, furnish rich material for the planners at all levels. Based on them and on the information received from higher levels, variants of plans can be developed by each unit, by using either traditional or mathematical methods. A system of goals with more modest or more ambitious aspiration levels elaborated according to different rates of change over time, considering the occurrence of more or less favourable situations with response to possible government actions, may lead to a useful number of variants which can be submitted to the unit (authority) on the next higher level.

The choice from the variants received from the units at the next lower level occurs according to the specific tasks and goals of the respective unit on the higher level (e.g., of a regional authority), in relation to a criterion. The same procedure can be followed in setting up the national plan – also in variants.

This procedure can easily be formalized as a mixed integer programming approach for several levels of hierarchy. The structure of the models had been described in [13], along with results from testing their workability. For the test, a problem of location of agricultural production had been chosen, with price response, the minimum necessary levels of subventions by regions as influenced by increasing requirements in earning foreign currency. (The results from running the extended more complex problem with new computer facilities confirmed the earlier judgment about the workability of such type of planning).

A main characteristic of this multi-level planning over space is the assumption that the plans of any unit on any level of hierarchy are organic entities representing strategies relative to a structure, an interdependent system, thus the variants cannot be mixed. Linear combination being excluded by the acceptance of political indivisibility, the higher level must choose in a zero – or one – manner. With technical indivisibility also appearing in the plans, the optimization problem has 0–1 integer, general integer and continuous variables. The variables which can assume a value equal to either one or zero represent the plans of the units on the next lower level as indivisible entities.

Comprehensiveness and consistency are enforced by the nature of this approach, in a degree obtainable at the respective level, from both social and economic points of view. Consistency of ends and means on a level of hierarchy can be assured by a proper formulation of the models for lower levels. Only that information can be included into the model of a unit on a higher level which can be derived from the solutions for the units on lower levels. I would like to stress that not only production but other categories too (e.g., income distribution, employment, migration, housing, transport

facilities, capital formation, credit, investment, etc.) should be also investigated in their timeliness, in their intra-unit (intraregional) and interunit (interregional) relations, too, not only on the national level.

3.4 *Planning at the international level*

In the present world, the usual international trade alone can less and less satisfy the requirements for international economic relations. The great differences in resource endowments, in conditions of rational use of national recources stemming from the degree of socio-economic development, the population pressure and the prospects of food production etc. press for a change in attitude. The idea of international planning has also emerged – let us refer here only to one book [11]. Mathematical economists have made efforts to set up models covering to a certain extent several countries [34] and an international effort for linking national models has emerged [35].

The procedure formalized in [13] and verbally treated in Section 3.3(b) of the present paper may also be one of the means helping to make a step forward. If we consider that countries can develop medium – and long-term – plans in several variants representing different strategies for socio-economic development, one might try to select those variants which can be connected with a common benefit from coordination. The procedure proposed by the present author would assure, as with the case of interregional planning within a country, that even the weaker nations should not accept, as a result of international coordination, plans which were less advantageous than the most modest of the variants elaborated (possibly optimized) by themselves. Any type of pressure for the sake of non-mutual benefits is regarded as a topic beyond the scope of this paper.

Since even models constructed in highly developed countries display considerable differences, much effort would be needed for the introduction of requirements in model building to get a data system for a model of international choice.

4. SUMMARY

This paper has tried to show how a wide variety of mathematical models has been used for regional–interregional analysis and planning of separate sectors or of the national economy. Of course, only a small fraction of the literature could be cited, mainly recent publications characteristic of types of problem treatment. This abundance of models also made it possible to avoid formal presentations. The paper has been aimed at insisting on a treatment of agricultural planning, not separately, but as an organic element of national planning. By making use of the already existing partial models, the possibilities of planning in a multi-level system were shown, alluding to the advantages of the upward procedure with emphasis upon the rights to independent decision-making on the lower levels of hierarchy and upon the reconcilability of interests and goals of the different levels of a hierarchy.

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DISCUSSION OPENING – E. A. Attwood, *Ireland*

We must congratulate Dr Sebestyen on the breadth of his knowledge of the literature and for the way in which this knowledge has been summarised into an integrated assessment of the subject.

There are two major issues which arise from the paper. The first is that most of the work has been of a basically theoretical nature and some further examination of the problems in the day-to-day application of this work would be useful. Let me illustrate this by reference to the discussion on "Planning downward" in which the use of an inter-regional dynamic Leontief model is considered. This discussion is in terms of what should be done, rather than in terms of what actually happens in practice. There is a need for a further and more detailed examination of the subsequent outcomes of the many regional models specifically referred to in this paper. Many of these studies are of a predicitive character and these predictions should be considered in relation to the developments which took place after the models had been completed. There are, of course, many valid reasons why the real world does not evolve in the way predicted in economic models but, even so, it is a useful discipline for model-builders to have their models checked against the subsequent out-

comes. Perhaps some additional consideration of this aspect would have been useful, though clearly time was limited.

The second point is that in the paper there is an implied, rather than explicit, discussion of the entirely different situation in planned and in market economies. In practice there could be a valid distinction in a horizontal and a vertical plane – between market and planned economies (with various degrees of combination of these two different economic systems within a spectrum covering the whole range of actual economic systems in different countries). At the same time it would be desirable to distinguish according to the sheer size – mainly in terms of area – of different countries. Regional and inter-regional models in very large countries, such as the U.S.A. and USSR, are of a very different character from those which would apply in small countries – such as, for example, in Ireland. If a common methodology and uniform data were available it would be possible to consider regional and inter-regional planning models for a number of countries – and perhaps for a whole continent – but in practice attention is focused primarily on models applying within national frontiers, and these cover countries of very widely differing size.

Finally, a more general comment; the problems of the inter-relationship between regional and national models of the development of agriculture and of the economy as a whole are of critical importance, and these are generally not considered in the same detail as the models for the individual sectors. This is certainly true for my own country and my impression from this paper is that this is true in many other countries as well. Yet if we are to see the maximum impact of the work of agricultural economists in the decision-making process this aspect needs to be given very full attention.

DISCUSSION OPENING – Claude Baillet, *Offices EEC Commission*

In opening the discussion on Dr. Sebestyen's paper I shall confine myself to a few general comments on certain aspects connected with the novelty, diversity, limitations and usefulness of regional models for agriculture.

(a) Judging from the literature to which the speaker referred, drawing-up regional and inter-regional models for agriculture would seem to be a relatively new departure by agricultural economists. The approaches and methods are many and various; even the objectives are different and in course of evolution from one country to another and even from one region to another; that is a feature of developing disciplines.

(b) These regional models all have one thing in common, however; they constitute the inevitable link and an essential correlating factor between the micro-economic models conceived at farm level and the macro-economic models constructed at the national level. In this respect, they are an indispensable complement to the planner's set of tools, whatever the type of planning envisaged.

(c) Regional and inter-regional agricultural models are becoming more

important both in planned economies in which they constitute a privileged instrument and in market economies in which they represent an essential basis for forecasting. They are also a valuable tool to the regional authorities, especially where the latter are seeking more far-reaching responsibility. In this connection they could be a significant factor in greater regional independence in a system of inter-dependent regions which have a greater awareness and are better organised. They could in this way play a decisive role in achieving more democratic management of the economy and thus help to reinforce the feeling of solidarity between the various economic sectors of a nation.

(d) The development of regional agricultural models encounters one basic problem, however – the frequent absence of adequate statistical data. Despite the considerable efforts made in many countires, there are large gaps in most cases; these gaps discourage, or even thwart, attempts to construct such models.

The complexity and troublesomeness of the calculations which was formerly a major obstacle to the construction of models in general, and agricultural models in particular, has been solved by the prodigious, universal development of data processing. It is now the lack of statistical base which is the main limiting factor.

(e) Regional agricultural models also presuppose an explicit and quantified formulation of the general and specific agricultural policies and an accurate knowledge of agricultural prices at the regional level. This is probably one of the reasons why they are more highly developed in countries with planned economies than in those with free market economies.

(f) The conditions required for the correct operation of regional agricultural models still apply, of course, when the notion of region is taken beyond national frontiers. At the international level, however, these conditions are even more difficult to create than within one country. None of the existing international economic unions, even the advanced ones, seems to have produced any real agricultural development models so far or even to have attempted or managed to integrate models produced for the individual member countries. At the most they have produced very general forecasts. This is due to the fact that the practical use of such models depends on the unity of purpose and policy within the regional group of countries concerned. Such models are fully viable only when the States concerned belong to a federation. Any other form of association or community with looser political ties makes for regional agricultural models of a purely academic significance.

The above considerations show that it is difficult to assess the effectiveness of a regional agricultural model except in the general context in which it was drawn up and specific objectives laid down for it. The general context and the objectives vary from one model to another even if the economic function of such models is similar as a rule (minimization of costs and maximization of profits).

The close reasoning which regional agricultural models imply, the internal consistency which they presuppose, the co-ordination of information they

require, the retrospective factual verifications to which they lend themselves are factors which make regional agricultural model-making an interesting exercise for agricultural economists and one which is likely to be developed in the future in all economic systems. Agriculture would thereby become better integrated in the economy, the management of agricultural policy better balanced and the work of agricultural economists more effective. Although there may be no doubt as to the merit and usefulness of such models, the fact that more use is not made of them would seem to be due to lack of information and to the constraints involved in establishing and exploiting them. It would be interesting to hear Dr Sebestyen's opinion on the matter.

RAPPORTEUR'S REPORT – T. Matzugi, *Japan*

The discussion began by focusing on a further examination of the practical results of model-building, involving the question of their effectiveness and validity, whereas the paper deals more with the technical aspects of model-building. The need to create a framework of interregional models with horizontal and vertical differentiation with respect to different conditions in planned and market economies, small and large countries, etc., was explored. In response to the call for more participation of lower stages an example was given from Ireland, where no satisfactory solution had been found so far to the question whether top-down or bottom-up planning is to be preferred.

The view was expressed that the plurality of models built so far is not the result of theoretical exercises but corresponds to the variety of situations such as, for example, state of development, different political systems, different availability of statistics on regional levels. The lack of regional statistics, which also trace the interregional flow of factors and goods, and data on prices, are, so far, the main bottlenecks to achieving validity and efficacy of regional models.

The principles of socialist planning were explained in further discussion. The core of this explanation was that, in socialist planning, science and computer technology are applied to build a unified, integrated, management system in the field of food in order to transform inputs (that is, regional resources) into outputs in line with regional and national demand functions.

Further discussion developed the range of issues further. It seemed to be generally agreed that the high cost of collecting data, and its specialised manpower needs, call for a less sophisticated approach in regional model-building; that so far there has been an unnecessarily theoretical approach to the question due to the intellectual fascination of models; the different chances of participation by different levels of the population in goal determination under conditions of disaggregation and devolution of the society in question; the existence of different criteria for determination of regions; the role and the influence of the model-builder in the process. He is often requested to introduce other than profit maximisation functions, and preferably multiple objective functions related to the structure of the economy and its level of development, in his regional planning models.

In his final comment on the issues raised during the whole session the author extensively dealt with the practicability of existing models, which he thinks is a *sine qua non* of the success of socialist planning. This is the reason why much emphasis has been placed on the further adaptation of models to reality, for example, by the incorporation of several variables into the system and the development of both systematic and partial models. However, the possibility of utilizing the models developed for socialist planning are not restricted to that political environment, but rather depend on the objective functions and the content of variables involved. Consequently different planning targets – for example, even distribution of labour, meeting the demand of food in all regions equally, etc., – which determine the allocation of activities within the country, as well as different levels of planning, determine the structure of the model to be applied.

In order to overcome the lack of data needed to feed the models which imply new systems of planning, the author recommended carrying out sample surveys in order to limit the cost of providing new sets of data. While determining the size of such samples one should keep in mind that a substantial degree of aggregation precludes the tracing of micro phenomena.

One crucial factor in planning is the difficulty of price forecasting. Many price reaction models have been developed, such as the Cobweb theorem and simulation models, but their application is still unsatisfactory. Price forecasts are equally relevant for socialist planning; however, the price determinants are different, since prices have to be fixed centrally. Such price fixation has to anticipate price reactions and the cost of subsequent transformation. As such, the projection of price-induced changes is limited by the scarcity of funds available for computation. Moreover, in a politically indivisible plan all consequences of substitution have to be forecast and weighed in a system of multiple objectives represented by individuals and political bodies, which involves a maximization problem.

As to the incorporation of agriculture in an overall plan, there are possibilities of taking regional balances as a link – for example, balances of the labour force, financial requirements of industries, social and cultural facilities – and integrating them into national balances. However, in spite of the relevance of finding solutions for such technical problems, it remains a fact that social and political aspects deserve much more attention if planning is to be successful.