KEY PROBLEMS IN THE THEORY OF CENTRALIZED INTERACTION OF ECONOMIC SYSTEMS

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The national economy of the USSR is a good example of a centralized hierarchical system. The main peculiarity of the system of planning and management in the USSR is the combination of productive and territorial principles.

The latter means that the development of plans and managing effects is carried out in two directions.

In terms of production these operations are carried out according to the hierarchy of governing bodies: the top bodies of planning and control - all-union (union-republic) ministries and departments - productive amalgamations and enterprises.

In terms of territory, plans and decisions are agreed upon with regional planning and control bodies (republic ministries and planning commissions of republics, regions and provinces).

Both directions are reflected in the system of models of territorial-production planning, that is being developed at the Institute of Economics of the Siberian Department of the USSR Academy of Sciences.

In the aspect of production, the system of planning the national economy of the USSR is a three-link one, and each link is associated with a certain problem stemming from the interaction of subsystems of different levels.

The aim of planning and control at the top level is to obtain

consistent planned decisions in separate industries and in agriculture for a certain period of time. Each decision at the level of an industry should be stated so as to provide all related industries for material resources produced by this industry, as well as to meet the demands of the social sphere.

The production of fund-forming industries (machine-building, construction and others) should be sufficient to provide for the planned rates of growth in the national economy. Apart from this, the balance relations regulating the use of non-reproducible natural resources and, which is even more important, the utilization and reproduction of labour force must be satisfied. This problem of production consistency in decisions made at industrial level allows various model interpretations, some of which will be discussed later; but in each model essential are relations indicating what labour, financial and main productive funds and in what quantities are needed by a given industry to fulfil a given planned task. These relations are called sectoral cost functions and are formed during solving the problem of the next link, i.e. the problem of working out a sectoral decision.

In the process of solving this problem one should bring into agreement planned tasks developed for the sector on the whole during the period of solving the previous problem and planned-productive activity of units that are run on a self-supporting basis (productive amalgamations and enterprises). An aggregated planned task for an industry is transformed into a concrete plan of the development of the existing enterprises and of the creation of new enterprises and amalgamations. To fulfil successfully this task, various mathematical models are used, but it is always helpful to have the largest possible number of plan fulfilment versions for each economic unit. This need is met by solving the problem of forming versions of the development of a certain unit.

The solution of each problem mentioned above is carried out in the direct connection with the solution of the nearest link problem; the adjacent levels of economic control are exchanging certain portions of information. This exchange of information and the accepted suquence of procedures to transfer it constitute the process of "big iteration" whose successful realization is to lead to a plan agreed upon at all the levels of economic management.

The process of "big iteration" begins with the solution of the problem of productive reconcilement under some hypothesis about

the functions of sectoral costs. The task given to an industry and the initial set of versions of the productive unit growth are the initial data for a sectoral problem. The solution of this problem is as follows: planned tasks for amalgamations are inputs in working out the versions of their development, and the estimated sectoral costs serve for the recalculation of planned tasks in the top planning link.

In the self-supporting link the set of versions is formed and the iteration cycle is repeated again.

As was mentioned above, the solution of each of the listed main problems is performed with the help of one or several mathematical models. The economic systems themselves being interconnected, the problems also appear interconnected, which entails special requirements also to models having to provide the "big iteration" process.

These models should be interconnected informationally so that the provision of reasonable inputs to each model would give a possibility to obtain a reasonable solution. For example, in a model for the problem of production reconcilement positive planned tasks for all the industries of the national economy should be guaranteed. The interconnections of models and sequences of procedures should be built up so as to provide for the convergence of the "big iteration" process. Any mathematical model which is used in solving the problem of production reconcilement is based on a balance system of equations that expresses the fact that the production output should be sufficient to cover all the material and capital costs of the national economy industries and to meet the demands of the social sphere, providing it with the necessary volume of non-productive (personal and public) consumption.

In the simplest case the basic balance system is as follows:

$$x_t = P(x_t) + Q(x_t, x_{t-1}) + u_t \qquad (1)$$

Here x_t vector whose components are amounts of the production output by industries,

$P(x_t)$ vector of material costs whose components are summary material costs of industries,

Q a similar vector of capital costs,

u vector of non-productive consumption.

For this system the problem of the existence of non-negative

solutions ($x_t \geq 0$) and of constructing a method for finding these solutions is considered. The economic contents of the problem allow to use only monotony of operators P and Q.

At present for system (1) a number of conditions for existence of non-negative solution have been determined and iteration methods for obtaining solutions worked out.

A number of problems for more complicated versions of models have been solved as well.

Typical models for working out sectoral decisions are those in which a sought for decision is found by a procedure (a rule) of choice on a given set of versions.

Optimization problems of choice, that are well adjusted and used in practice, play here an essential role.

In the case of optimization by minimum cost criterion, functions of sectoral costs are simply determined in the process of developing the industry plan with the help of cost structure coefficients.

In this case a problem of choice for an industry is stated as follows:

$$\sum_{\kappa} A_{\kappa j} z_{\kappa j} \geq x_{jt} \qquad (2)$$

$$\sum_{\kappa} R_{\kappa j} z_{\kappa j} \leq R_j , \quad z_{\kappa j} \geq 0 . \qquad (3)$$

Then the sought $\min (c, z) = g_j (x_j)$

and sectoral costs are:

$$p_{ij} (\kappa_j) = \alpha_{ij} g_j (x_j) \qquad (4)$$

where α_{ij} cost structure coefficients.

It is obvious, that functions of sectoral costs thus obtained will lead to a special type of operators P and Q of the previous problem. According to this, one should investigate into the relationship between the solutions of both problems and into an inverse problem about the properties of the solutions to sectoral problems.

To solve the problem of forming versions of the development of an economic unit, models describing the operation of the economic mechanism, including the mechanism of the motivation of workers, are used.

A typical model of this class has the following form:

$$y_l = \mu (x_l , \eta_l , \xi_l), \qquad (5)$$

Here y_l is vector whose components are characteristics of the state of a self-supporting unit with number l (the cost of basic productive funds, cost coefficients, the funds of economic incentives, etc.), η_l - vector of the parameters controlled by ministries (departments), ξ_l - vector of the parameters controlled by the management of the given amalgamation (enterprise), x - planned task for a given self-supporting unit, obtained as a result of solving the sectoral problem. By selecting different values of η_l and ξ_l with the same y_l different versions of state are obtained which are used to form the set $G(x_j)$ of the previous problem. The development of this type of models which are in general of simulation character is given.

The main line in solving the problem of territorial reconcilement of planned decisions is the use of inter-regional intersectoral optimization model. This model like that of intersectoral ties is a model of the top level. The problem of coordinating the solutions of both models have been examined and the conditions, on satisfying which certain aggregated values coincide, obtained. The problems of territorial reconcilement of sectoral plans down to the location of plants under construction are analyzed with the help of models of all-round growth of economic regions.

The appropriate problems are as a rule of multi-extremal nature and their solution is very difficult.