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ON SOME ELEMENTS AND PROBLEMS OF DECOMPOSITION ANALYSIS OF OPTIMAL PLANNING OF AN ECONOMIC COMPLEX

The paper attempts to show the advisability of working out economic fundamentals of the systems of polycentral planning and decomposed central planning models on the basis of analyses and interpretations of the decomposition methods of optimal problems (decomposition analysis). The most essential elements of decomposition analysis, such as decomposition principles, coordination means, etc. are presented. With their help the treated decomposition methods are systematized, and their economically prospective development trends described. Special attention is paid to investigations of multicoordination of stochastic problems and to the cultivation of decomposition by goals and questions.

1. Introduction

The dividing of management problems of large systems into simpler than the theoretical ones attracted already Aristotle's attention. In practice this problem has been solved by the evolution of the corresponding management systems, as a result of which complicated systems of decomposed management and decision-making models have been formed.

Mathematical theories of management and decision-making have so far developed mainly on the basis of "small systems". Here we might mention the theory of automatic control and operations research. Although the latter is essentially meant for studying large systems, it treats them aggregately, describing the whole system in one composed optimization problem.

For a formalized treatment of large systems the so-called general mathematical theory of large systems has been used in recent years. It seems that one aspect of the theory of decomposition methods for solving optimal problems is becoming one of the basic elements of this theory. Obtaining numerical solutions for optimal problems by decomposition methods has been regarded as the object of the former theory. However, several such methods can be interpreted as mathematical models of the rational systems of management or decision-making models. Thus, the theory can be developed and the obtained methods analyzed in the direction of creating a mathematical theory of the structure and functioning of a decomposed management system or decision-making models, in the main, of the structure and functioning of the interrelations between the elements of systems. In short we might call the above-described trend decomposition analysis, and state that it is the modelling of large decision-making systems by decomposition methods.

Decomposition analysis could be considered to be particularly fruitful for studying socialist economy, and especially now when automatic systems of management and planning of national economy are being created. For these systems strict coordination principles are needed.

Socialist economy is theoretically a large system aspiring to an objective dependent upon numerous indices. In practice a complicated hierarchical system which applies both vertical and horizontal coordination means with a varied structure has been formed to manage and plan it. Here every submanager applies a system of decomposed decision-making models. Such complexity is in accordance with the diversity of the object managed and its environment, and enables to solve management problems with surprising ease. Thus, a satisfactory plan is obtained already by one or two iterations. Rules for the functioning of this system have been created inductively on experiential basis, and they lack such a description in the basis of which algorithms could be formed for treatment by a computer system. Such coordination instructions have to be derived deductively, and one way for this is to use decomposition analysis of optimization problems of the national economy. Unfortunately, this method is not as yet capable of providing general coordination principles for economy since decomposition methods of optimal economic problems treated until now are still special cases of more general methods, the treatment of which has not yet been feasible. Evidently, a description and analysis of the principles of such more general methods might be part of decomposition analysis. Certainly, it must be added that in the field of mathematical planning much has been done to construct and apply models of central planning for management units belonging to several levels of socialist economy. These works will form a basis for constructing planning systems and systems of decomposed planning models or integration. However, as it has been already mentioned, integration rules have to be derived deductively by means of decomposition analysis.

As an introduction, we shall briefly discuss the principle of profitability of applying decomposition. Whether to use decomposition or not, is a separate optimum problem, the contents of which, in brief, are as follows: we must find an optimal proportion between the expenditures on management (resp. solving a planning problem) and the negentropic effect of the result. To put it more precisely, we mark the object managed (or the problem to be solved) by the symbol O. To control it, managers can be chosen out of the set $J=\{1,\ldots,Z\}$. The employment of the manager $I\in J$ brings about expenditures k_I and a negentropic effect h_I. The latter denotes the expectation of an economic loss due to the inexactness of management. Economically the manager with whom k_I+h_I is minimal is the best for object O.

Below it becomes clear that, on the basis of this criterion, the application of decomposition has apparent advantages in creating a structure of management systems of complicated economic complexes. But a more specific treatment of this problem is out of the bounds of the present paper.

The present paper describes some basic elements of decomposition analysis, such as decomposition techniques and coordination means and schemes. By the help of these terms, the methods already treated are classified, and some of their interpretations proposed; further, attention is also called to principles, possibilities and interpretations of new, more general methods.

The article considers an n-unit (element) economic system, where the plan for unit j is described by the vector $x_j\in X_j$, X_j being the constraint on the plan of unit j. This economy handles m resources (either material of informational), and the volume of the input-output (state) of resource i is limited by variable b_i. Technological characteristics of the units for m resources are described by technological functions $g_{ij}(x_j)$. Thus, the system of the constraints on the state of the whole economy is $\sum_{j=1}^{n} g_{ij}(x_j)=y_i(x)\geqslant b_i$, where $x=(x_j), j=1,\ldots,n$, and $y_i(x)$ describes the state of the system for resource i.

The arguments for the objective function of the economy is the vector of the state $y=(y_i), i=1,\ldots,m$, thus $f=f(y)$. But, as $y_i=y_i(x)$, the objective function can be considered as a function of x, and here we assume that this function is essentially separable by units; $f=\Sigma f_j(x_j)$. As to the shape of the functions of the problem, and also their determinateness or uncertainty, remarks are made in the context.

2. Decomposition and coordination

The solution of an optimal problem by means of a decomposition method implies that the problem is substituted by a system of informationally interrelated subproblems. The construction of a system of subproblems or decomposition, and the informational interrelating of the subproblems or coordination, may, in case of an economic problem, be carried out according to several essentially different principles which will be considered below.

2.1. We enumerate at least five essential decomposition principles: 1) by units (elements), 2) by temporal principles, 3) by goals, 4) by questions, and 5) by limits.

By the application of all these principles we can speak of pure decomposition and impure or overlapping decomposition. In case of the former, subproblems do not constitute common decision variables, and in case of the latter they do.

2.1.1. In case of decomposition by units, the structural or functional elements of the economic system to be optimized, such as branches of activity, regions, enterprises, departments, etc., serve as the basis for the decomposition of the initial problem. This decomposition principle is the main one in the practice of economic activities as well as in solving optimum problems of economy, and, depending upon the choice of a coordination principle, the process will lead either to a scheme of central coordination or to a decentralized management.

2.1.2. In case of temporal decomposition, a temporally uniform planning problem (from the current moment to the plan horizon) is divided into temporally different subproblems, such as the problem of short-term planning, that of an average period, and of long-term planning. This principle is widely applied in the practice of planning.

2.1.3. The idea of decomposition by goals consists in the following. Several economic indices serve actually as arguments for the objective function of the system. Such an initial problem can be decomposed in such a way that either one or a few indices of the initial problem occur as the argument of the objective function of every subproblem. For example, when consumption and accumulation serve as arguments for the objective function of the initial problem, we can construct two subproblems: those of maximizing consumption and accumulation.

2.1.4. Decomposition by questions in its turn can be divided into two, depending on whether we have to deal with essential questions of the object, or those of modelling planning problems.

Essential questions of the planning of economy are in the main the following: what, where, how much and in which way to produce and consume. Consequently, a complex problem can be decomposed by questions, for example, into the following subproblems: the problem of the choice of technology, the location problem, the problem of the structure of production and consumption, the specialization problem, etc.

The so-called modelling consist in the following. A complexly adequate model of economy should be a stochastic one, having nonlinear relations which are of a high rank, and the arguments of which can often acquire only discrete values. For the evaluation of the solution of this problem we can construct a system consisting of simpler problems, in which every subproblem is meant for studying the object from a certain aspect, only. For example, one problem may be non-linear, but determined and continuous; another problem may be stochastic, but linear and continuous; another one, however, discrete, but linear and determined.

2.1.5. Decomposition by limits is to be understood as follows. The initial problem comprises systems of constraints on the state of the object as well as on its management. Consequently, it is possible to form subproblems which comprise only part of the constraints.

In conclusion we should note that in order to construct a decomposition method, one may combine several decomposition principles. For example, one may apply in succesion temporal decomposition, and decomposition by units, or the same ones in the opposite succession. In this sense we can speak of a decomposition scheme.

2.2. Coordination possibilities and means, schemes and correction principles.

2.2.1. By the application of a decomposition scheme, the subproblems $k=1,\dots,p$ of the object are again optimum problems. As known, every optimum problem k contains four essentially different elements: 1) an objective function $c_k(x_k)$, 2) a state constraints vector d_k, 3) a vector function of the state $g_k(x_k)$, and 4) constraints on management x_k, which are described by the set X_k.

The optimal solution x_k^* of the subproblem k depends upon these four elements, and upon them only. Consequently, for the composition $x^*=(x_k^*)$, $k=1,\dots,p$ of the solutions to the subproblems $k=1,\dots,p$ to form the solution of the initial problem, it is possible to affect subproblems only by modifying these four elements. Thus, we can speak of four coordination possibilities and coordination means corresponding to them, which are the following.

Stimulation, which consists in correcting the parameters of the objective function of the subproblems. Parameters of the objective functions of economic problems can often be interpreted as value estimates, and in such a case we can say that prices (in a wide sense, as they include also rent rates, or loans, etc.) serve as coordination means. In other words, in case of stimulation, coordination takes place on the basis of the so-called law of value, and this principle is fundamental in economics.

Limitation consists in effecting subproblems by the help of the state constraints vector. In essence, this means the limiting of resources, especially the so-called global ones, and giving obligations.

Consultation is in other words correction of the parameters of the technological relations of the subproblems.

Direct commands or imposing constraints on the domain of the definition of the decision-making variables of the subproblems in essence means that the plan is fixed to a greater or smaller extent to some or all of the variables. Although direct commands seem to belong to the categories of central planning, they are also meaningful in coordination schemes.

By applying the above-described coordination means, either all or some of them, in parallel, multi-coordinations are obtained. Among them, the bicoordination variant, including stimulation and limitation, appears to be of special economic importance.

2.2.2. Another important element in coordination is the scheme (graph) of information flows. Here one must first distinguish between two basically different principles: 1) horizontal, and 2) vertical. In case of horizontal or decentralized coordination any subproblem k has direct informational relations with other subproblems (at least one), only. In case of vertical or central coordination, there does not exist any direct relations with other subproblems, and coordinative information is obtained from a special, so-called center's problem, which has informational relations with all subproblems.

In case of one center we speak of two-level coordination. If the center's problem is decomposed, the coordination is hierarchical. The latter scheme has several centers.

The following schemes are of interest in economics. First, combinations of horizontal and vertical coordination and parallel coordination. The latter is feasible in a hierarchical scheme, only, and this means that one subproblem is coordinated by several centers which can be located on several levels of the hierarchy.

2.2.3. The output of a coordination problem is the value of the coordinative indices, in other words, the plan of the coordination means. From the standpoint of the coordinator we can call it instrumental information. Applying this information, the units solve their problems. For the evaluation of their conformity with the global optimum, the units must send to the coordinating center certain information which we call indicative (again from the standpoint of the center). Naturally, the system of indicative indices must be in accordance with the system of coordinative indices. For the present we assume that the former are determined by coordinative indices, and we shall not make any classification on that basis.

On the basis of indicative information, numerical values of the coordinative indices are corrected. At correction two principles may be applied: we can either solve an optimal problem of correction or move toward the gradient (balance). The same principles are also valid at the correction of the plans of the subproblems, due to receiving additional corrective information.

3. A survey of the decomposition methods treated

As we can see, on the basis of economic contents it is possible to create, by the help of the above-given terms, a classification for describing decomposition methods including dozens of indices. The present brief survey deals with some aggregated indices, only. At that we keep in mind that, since an economic classification also comprises characteristics inherent in the object, it is larger than a classification based on the mathematical contents of these methods. In case of the latter, differences concerning the principles of coordination seem to occur chiefly between stimulation and limitation, while direct commands as well as consultation can be described as special cases of the former. As to decomposition principles, elemental (by units and temporal) and non-elemental (by resource and goals) are of mathematical importance. The following survey proceeds from the latter remarks.

3.1. Out of the combinations of stimulation and decomposition principles, stimulation by units and temporal stimulation have been treated in detail, mathematically.

3.1.1. Stimulation by units or coordination of economic units by prices found episodic mathematical treatment in terms of classical mathematics (differential calculus) already at the beginning of the present century (D. Pigou, A. Marshall), but those are only decomposition methods based on the duality theory of optimization that give the principle of coordination by prices (the classical doctrine of equilibrium prices) a mathematically consistent explanation, and algorithms for calculating these prices. It should be noted that a mathematical foundation for such an approach has already existed since the 18th century, by way of the method of the so-called indeterminate multipliers proposed by J. Lagrange. Most likely, its application was hindered by the fact that in a linear case an analysis of the Lagrangean function with the classical mathematical apparatus caused considerable difficulties. Thus the works by L. Kantorovich in the field of linear programming with shadow prices or "objectively determined valuations" being analogues to Lagrangean indeterminate multipliers are a new step forward. The work by Kuhn-Tucker on saddle point in 1950 and its actual application by Arrow, Hurwicz and Uzawa in 1958 were further great achievements. The next concrete milestone was achieved by Dantzig and Wolf in 1960, their work being succeeded by a number of similar ones, among them by works by E. Golshtein and V. Volkonsky. A number of investigations have been published on working out methods for solving various linear and non-linear classes of problems and on developing the mathematical theory of stimulation.

The mathematical contents of the method of stimulation by units are in general lines as follows. From a problem containing global inter-unit constraints, they go over to an equivalent Lagrangean problem where an indeterminate multiplier has the contents of price. For a further analysis of the Lagrangean function, concepts of duality and saddle plane are used. E. Golshtein has shown that, for analyzing the Lagrangean function, there exists another, a more general line of reasoning based on the game theory. Namely, the pair of dual problems corresponding to the Lagrangean function can be regarded as a game.

As already mentioned, the economic interpretation of this method is a classical theory of equilibrium prices. The task of the center is to correct prices according to the corresponding demand-supply relations of the units. Since the demand-supply balance represents the gradient of the center's problem, the correction of prices on its basis leads, in the presence of the corresponding preconditions, to the plans of the units, the composition of which forms the solution of the global problem.

The scope of the method is limited by the fact that the problems of units must have unique solutions, or to put it differently, the problems of units must comprise sufficient convexity. The Dantzig-Wolfe method overcomes this difficulty in such a way that, at the last step, the center uses direct commands instead of stimulation.

As to coordination levels, a multi-level scheme corresponds generally to this principle. Usually a two-level vertical scheme is used; however, hierarchical vertical schemes have been treated as well. One-level schemes are suitable in case of a successive connexion of the units.

3.1.2. Temporal stimulation can be regarded mathematically as an interpretation of the latter method, where the whole system serves as units, but does so at different intervals of the plan period. Here, due to temporal succession, the units are connected successively, and thus temporal stimulation can be considered as a separate mathematical method with the Hamiltonian function instead of the Lagrangean one. This method can be considered either as a one- or two-level method.

3.2. The principle of limitation has been applied to the decomposition of units, but. as already mentioned, it can be also interpreted as temporal decomposition. The idea of limitation originates from J. Kornai and Th. Liptak, 1961. Later on, it has been treated by V. Volkonsky and elaborated by A. Geoffrion et al.

The mathematical idea of limitation consists in distributing global constraints between units which will find local optimums within these bounds. The task of coordination is to distribute constraints so as to obtain a global optimum. The solutions to dual problems of the units serve as indicative information.

As for economic contents of the methods, we might add that the solutions to dual problems of the units describe the efficiencies of the resources limited for the units, and on their basis the resources are redistributed until the efficiencies have been evened out.

Though this method is applicable to linear as well as non-linear problems, it has some drawbacks. Namely there arise difficulties in connexion with securing non-contradiction of the problems of the units (meeting the Slater conditions), and the value of a global objective function changes unmonotonously in the course of iteration.

3.3. Some "less treated" methods which seem to be economically promising have been left out of the present section, and will be dealt with in the next one.

The above-given methods can, in general, be regarded as polycentral planning models. The only exceptions are problems based on temporal decomposition, which are applied in the field of decomposed central planning.

4. Some principles of economically potential methods

From the standpoint of economic interpretations, it seems to be promising to develop decomposition methods in the following directions: 1) multi-coordination, 2) decomposition by goals, and 3) by questions.

4.1. As compared to unicoordination, the volume of a coordination problem increases considerably in case of multi-coordination; however, we can assume that the methods based on the latter principle are 1) more general, and 2) with a better convergence. Economic interpretations of the methods of multicoordination by units should be of special interest, and particularly in case of stochastic problems. Namely, economic problems are in essence stochastic ones, and hence the question arises whether this circumstance brings about an increase in the volume of coordination, or *vice versa*.

The most general method of multi-coordination by units should, in an economic interpretation, simultaneously apply stimulation, limitation, direct commands and consultation. Up to now only bicoordination methods have been treated; below they will be dealt with, first in a deterministic, and next in a stochastic case.

4.1.1. The idea of bicoordination with stimulation and direct commands employed was partially made use of already by the Dantzig-Wolfe method, by which the center applies direct commands at the last step of iteration. It seems to be economically the most interesting variant of bicoordination, combining the flexibility of coordination by prices and the stability achieved by limitation. In socialist economy the simultaneous use of stimulation and limitation has become firmly rooted since limitation ensures not only a greater stability, but also enables to compensate, to a certain extent, for the drawbacks arising in case of stimulation (due to relatively stable prices). As we can see, extensions of this method are of interest both as solution methods and means of analysis for decomposed planning and polycentral planning of socialist economy.

4.1.2. Decomposition methods for stochastic economic problems are at present limited to observing rather narrow models. More general treatments have developed in the field of the so-called theory of economic equilibrium, which does not comprise the idea of hierarchical management.

As the first approximation, the randomness of the parameters of an economic problem can be described by the help of mean values and dispersions. In case of such a model all the parameters (coefficients) of a composed problem are random variables which are described by mean values and dispersions. Now we can bound the balance relations of the problem.

$$E\Big[\sum_j g_{ij}(x_j) - b_i\Big] \geqslant 0$$

$$D\Big[\sum_j g_{ij}(x_j) - b_i\Big] \leqslant d_i,$$

where the first constraint says that the balance expectation has to satisfy certain conditions, and the second one says that the realization of the balance must not have deviations exceeding a certain limit fixed by parameters d_i. Evidently, possible deviations are to a certain extent the smaller the more information is available for the planning period. Thus it is feasible to describe, in the problem, the optimal choice of informationally alternative activities in branch j. The alternatives are the following: whether to include, in the plan, a potential activity which requires less information (research work) and is connected with more risk (a greater probable deviation of results), or *vice versa*. The choice of the alternative containing more information increases the mean value of the branch's need for information. In the latter case, those branches of activity which prepare the corresponding technological information should be operated more intensively. A more intensive activity of the latter requires, in turn, greater material expenditures. Consequently, we can see that by taking into consideration dispersions it becomes also possible to find out the optimal amount of the research work applied. Since information can also be understood as a resource, it should be feasible to find out its shadow price, or in other words, the marginal value of information.

In the above treatment the factor causing deviation was the planner's subjective ignorance. However, in principle it is impossible to fully preclude ignorance. In this context we can conventionally speak of factors, the influence of which is objectively random. The deviation of the balance result of the economy brought about by both kinds of randomness can be reduced with the help of material means, first and foremost by accumulating stocks. Consequently, we can describe, in the problem, the accumulation of stocks as a branch which produces negative dispersion and requires means for this purpose. The sizes of both of them depend upon the branch's operation intensity (another possibility for reducing risk would be the description of such alternatives in the branches of activity, which are more risk-proof, though connected with greater expenditures). When stimulating the units, the center establishes prices both for mean values and dispersions. The latter can be interpreted as a certain insurance rate which every unit has to pay in order to be allowed to operate with a certain randomness. Thus the problems of the units would be the following:

$$f_j(x_j) - \sum_i \lambda_i E[g_{ij}(x_j)] - \sum_i \eta_i D[g_{ij}(x_j)] \to \max_{x_j}, \quad j = 1, \ldots, n,$$

where η_i is the price of risk for resource i.

When imposing limits on the units. the center establishes limits to mean values as well as to dispersions The latter indicate to the units the limits of risk allowed in their plans.

Finally it becomes clear that, in connexion with a stochastic calculation, the volume of the coordination problem increases, though, on the other hand, it may be accompanied by a quicker convergence. The feasibility of coordinating informational activities using the price of risk and limits to dispersions will also become clear.

4.2. Decomposition by goals with limitation is of economic interest, first and foremost, with its inverse problem. Below we shall observe both.

4.2.1. The meaning of the direct problem consists in the following. Let the problem be

$$\left.\max_x \sum_{k=1}^{p} a_k y_k(x)\right\} g(x) \geqslant b, \quad x \in X.$$

On its basis we form p subproblems

$$\left.\max_x a_k y_k(x)\right\} g(x) \geqslant b, \; y_e(x) \geqslant y^l_{ek}, \quad e=1, \ldots, p, \quad e \neq k, \quad x \in X,$$

where $y^l_{ek}, e=1, \ldots, p, e \neq k$ are given for problem k at every step l by the coordinating problem. The solutions of the dual problem γ^l_{ek}, $e=1, \ldots, p$, $e \neq k$, corresponding to the second constraint of problem k, are made known to the coordinating problem where they are used to find the values of y^{l+1}_{ek}, etc.

4.2.2. The meaning of the inverse problem or of the composing of the goal consists in the following. In general, great difficulties occur in evaluating the values of the weighting or substitute coefficients a_k, $k=1, \ldots, p$ in the objective function $f = \sum_{k=1}^{p} a_k y_k(x)$. We can even state that therefore it is not possible to construct directly such concrete objective functions in practice. There the solution of the problems takes place according to the principles of decomposition by goals, though without any mutual coordination of subproblems. At the solution of every subproblem k, other goals occur among constraints, the numerical values of which can be determined traditionally or intuitively. Thus, at solving every subproblem, one effective point (plan) which we call a satisfactory one, is found. If we conform subproblems (again on the basis of traditional or intuitive information), we shall get an effective point which we call a good one, regarding it as a suboptimal plan. Let a good problem for goal k be the following

$$\left.\max_x y_k(x)\right\} g(x) \geqslant b, \; g_{ek}(x) \geqslant \overset{*}{y}_{ek}, \quad e=1, \ldots, p, \quad e \neq k, \quad x \in X.$$

Let the solutions to the dual problem, corresponding to the second constraint of this problem, be $\overset{*}{\eta}_{ek}, e=1, \ldots, p, \; e \neq k$. Now (with certain preconditions) the problem equivalent to this one is the following:

$$\left.\max_x \left[y_k(x) - \sum_{\substack{e=1 \\ e \neq k}}^{p} \overset{*}{\eta}_{ek} g_{ek}(x)\right]\right\} g(x) \geqslant b, \quad x \in X.$$

We can see that here the estimate of a_e is $\overset{*}{\eta}_{ek}$, $e=1, \ldots, p$, $e \neq k$, and $a_k = 1$. Such estimates are of interest for analysis and give possibilities for composing an objective function.

To sum up, it might be added that, by applying decomposition by goals, a hierarchy of the subgoals of the complex is formed, the general goal being the top. At that a hierarchy having more than two levels can be developed. From top to bottom the subgoals are of the same direction, but in case of effective plans, they are horizontally of opposite directions, or conflictive: an increase in the value of one subgoal can take place only at the expense of some other subgoal of the same level. Besides, it might be of interest to know that similarly to the pair of dual problems of an optimum problem, dual pairs of the hierarchies of goals take form here. In order to better understand this, we shall discuss a linear model max $cy\}Ax=y\geqslant b$. Goal cy can be decomposed into a hierarchic structure according to the coordinates of vector y. But $cy=cAx=px$, where px is a dual goal. The latter can be put into a hierarchic structure either on the basis of the coordinates of x or by decomposing the elements of p. In the former case, decomposition by units is formed. In the latter case, however, we get a dual hierarchy of the goals of the complex. This can easily be explained with the help of an input-output table. The primal hierarchy of goals is obtained with the help of the elements of the second quadrant of the table, the dual one with the help of the elements of the third quadrant.

4.3. Decomposition by questions, as already said, is of interest in two meanings: in terms of economic questions and abstraction problems of the model. Here we shall make remarks only about the former. In case of these questions it seems to be advisable to apply principles of consultation by coordination, and thus the principles of the algorithm would be as follows. For each subproblem (location, choice of technology, composition of production, etc.) an optimum problem is constructed, in which we proceed from the availability of some approximate solutions of other subproblems. The solution of this problem will, in turn, be used in other subproblems as an approximate solution, etc. The application of the described principle would yield a method of consultation by questions.

4.4. Several problems connected with decomposition analysis, e.g. problems of aggregation by the aggregation of coordinative information in a hierarchical structure as well as aggregation as a solution method which could be considered as special cases of direct commands and limitation, have not been dealt with.

Other problems of economic importance, namely the inter-industry and territorial aspects of planning have not been treated since the methods presented did not deal with cases of overlapping decomposition.

At the same time it is evident that it will be of immense economic interest to develop decomposition methods in the following directions. Firstly, for analyzing polycentral systems, methods with a relatively large volume of the coordination problem, are of great significance. Secondly, from the viewpoint of central decomposed planning, the cultivation of the methods of decomposition by goals and questions is of prime importance.

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MAJANDUSE OPTIMUMÜLESANNETE DEKOMPOSITSIOONANALÜÜSI ELEMENTE JA PROBLEEME

Resümee

Artiklis püütakse näidata, et polütsentrilise planeerimise ning tsentraalse dekomponeeritud planeerimise mudelite süsteemide majandusteaduslikke aluseid on otstarbekas välja töötada optimumülesannete dekompositsioonimeetodite analüüsi ja interpreteeringute tulemuste alusel (dekompositsioonanalüüs). Esitatakse dekompositsioonanalüüsi olulisemad elemendid, nagu dekompositsiooni põhimõtted, koordineerimisvahendid jne. Nende abil süstematiseeritakse dekompositsioonimeetodeid ja kirjeldatakse nende majandusteaduslikult perspektiivseid arendamissuundi. Juhitakse tähelepanu vajadusele uurida stohhastiliste ülesannete multikoordinatsiooni ning viljelda eesmärgilist ja probleemset dekompositsiooni.

Eesti NSV Teaduste Akadeemia
Majanduse Instituut

Toimetusse saabunud
28. IV 1972

Ю. ЭННУСТЕ

ЭЛЕМЕНТЫ И ПРИНЦИПЫ ДЕКОМПОЗИЦИОННОГО АНАЛИЗА ОПТИМАЛЬНОГО ПЛАНИРОВАНИЯ ЭКОНОМИКИ

Резюме

Разработка систем оптимального планирования народного хозяйства требует определения более строгих принципов координации как между отдельными центрами системы управления и планирования, так и между моделями в каждом центре. Можно утверждать, что для дедуктивного выведения этих принципов целесообразно исходить из экономической интерпретации методов разложения (декомпозиционный анализ). В статье сделаны некоторые попытки интерпретировать методы разложения как модели систем планирования экономических комплексов.

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