IASP TRANSLATIONS FROM ORIGINAL SOVIET SOURCES

problems of economics

NOVEMBER 1963/VOL. VI, NO. 7

Scientific Planning and a Rational System of Economic Information

Mathematical Methods and Electronic Computers in Economics and Planning

Mathematical-Economic Methods and Problems of the Organization of Production

The System of Price-Forming Factors and the Principles of Their Classification

Structure of Production in the USSR and Foreign Countries

iasp

Published monthly by INTERNATIONAL ARTS AND SCIENCES PRESS / 156 Fifth Avenue, New York

problems of economics

NOVEMBER 1963/VOL. VI, NO. 7
TABLE OF CONTENTS

MATHEMATICAL METHODS IN PLANNING

N. I. KOVALEV: Scientific Planning and a Rational System of Economic Information
(Voprosy ekonomiki, 1962, No. 12) 3

V. KOSSOV, Iu. FINKEL'SHTEIN, and A. MODIN: Mathematical Methods and Electronic Computers in Economics and Planning
(Planovoe khoziaistvo, 1963, No. 2) 18

G. PRUDENSKII: Mathematical-Economic Methods and Problems of the Organization of Production
(Voprosy ekonomiki, 1963, No. 4) 24

PRICE POLICY

V. DIACHENKO: The System of Price-Forming Factors and the Principles of Their Classification
(Voprosy ekonomiki, 1963, No. 2) 30

COMPARISON OF SOVIET AND OTHER ECONOMIES

L. BERRI and Iu. SHVYRKOV: Structure of Production in the USSR and Foreign Countries
(Voprosy ekonomiki, 1963, No. 1) 43

problems of economics

SELECTED ARTICLES FROM SOVIET ECONOMICS JOURNALS IN ENGLISH TRANSLATION

PROBLEMS OF ECONOMICS contains unabridged translations of articles from the following Soviet publications:

Voprosy ekonomiki (Problems of Economics)
Planovoe khoziaistvo (Planned Economy)
Mirovaia ekonomika i mezhdunarodnye otnosheniia (World Economy and International Relations)
Ekonomicheskaia gazeta (Economic Gazette)
Vestnik statistiki (Journal of Statistics)
Sotsialisticheskii trud (Socialist Labor)
Biulleten' nauchnoi informatsii. Trud i zarabotnaia plata (Bulletin of Scientific Information. Labor and Wages)
Vneshniaia torgovlia (Foreign Trade)
Vestnik Leningradskogo universiteta, seriia ekonomiki (Journal of Leningrad University, Economic Series)
Vestnik Moskovskogo universiteta, seriia ekonomiki (Journal of Moscow University, Economic Series)
Nauchnye doklady vysshei shkoly — ekonomicheskie nauki (Scientific Papers of Higher Educational Institutions — Economic Sciences)

Articles from other publications are included from time to time if they are considered of sufficient interest for translation.

PROBLEMS OF ECONOMICS is published as a service for purposes of information and education. Articles are selected which best reflect developments in Soviet economics and which are of most interest to those professionally concerned with this field. All views expressed are those of the authors.

Publisher: Myron E. Sharpe. Editor: Fred Ablin.

Twelve issues per year. Subscription rate: $50.00 per year.

INTERNATIONAL

ARTS

AND

SCIENCES

PRESS

156 Fifth Avenue
New York, N.Y. 10010

Mathematical Methods in Planning

Voprosy ekonomiki, 1962, No. 12

N. I. Kovalev

SCIENTIFIC PLANNING AND A RATIONAL SYSTEM OF ECONOMIC INFORMATION

The main economic task set forth by the Program of the CPSU is to create the material and technical base of communism within two decades. This task is being implemented by means of technological progress, by integrated mechanization and automation not only of the processes of material production but also of their control. We will shift to enterprises of communist society with increasingly complete automation of production processes and the introduction of automatic management and control. The rapid advance of production necessitates drastic changes in the methods and practice of planning and controlling the economy. Cybernetics, electronic computing and control devices will be widely used in industrial processes, construction, transportation, research, planning and designing calculations, accounting and management. These tasks received further specific elaboration in the decisions of the November 1962 Plenary Meeting of the CPSU Central Committee.

The application of cybernetics, mathematics and computing techniques promotes, first of all, the growth of labor productivity and the progress of social production. Their use is of major importance for creating higher forms of automation and intensification of production, the centralized control of numerous and scattered production and technological processes and enterprises, the elimination of unproductive outlays and losses in working time, and the accelerated development of new equipment and progressive technology on the basis of improving engineering calculations and the automation of designing processes.

Of major importance is the application of these means in management, where the economic effect is in some cases higher and quicker than in production, mainly due to better planning and the elaboration of methods of optimum development of the national economy. Besides, the elimination of inefficient manual calculations will lead to a considerable increase in the productivity of computing personnel. Thus, the use of calculating-analyzing machines with electronic computers increases labor

---

The author is a member of the Editorial Board of Voprosy ekonomiki.

productivity from 20 to 30 times in making calculations, and the use of high-speed electronic computers -- thousands of times, disregarding the fact that some problems cannot be solved at all by simpler means.

The role of economics, planning and management steadily rises in the realization of the targets of communist construction. The socialist economy develops successfully only on the basis of scientific planning, which implements the requirements of the economic laws of socialism and reveals the processes of expanded reproduction in specific quantitative definiteness. Therefore, the planned management of the economy must rely above all on Marxist-Leninist economic science to ensure a profound qualitative and quantitative economic analysis.

Some Problems of Planning and Cybernetics

Management of the optimum development of the economy requires a scientific organization of the processes of management and advanced means and methods of such management. The scientific organization of these processes is based on economic cybernetics, which is the application of the general theory of control to economic phenomena. Economic cybernetics establishes the most general principles and methods of the optimum control of the national economy and its links in accordance with the target set by society, as well as the algorithmization of economic processes and the construction and operation of a rational system of economic information. Economic cybernetics investigates economic processes and systems of controlling them by the methods of the exact sciences and furnishes a general basis for understanding and improving the diverse processes of management. Any process of management, regardless of its essence, is fundamentally based on the functioning and processing of information, the quantitative measurement of which makes it possible to apply modern mathematical apparatus and advanced computing techniques to investigations.

The application of cybernetics to the planned socialist economy holds out great prospects that are beyond comparison with the possibilities in the capitalist system. Management of the economy can be successful only under socialism. Any process of management requires, first of all, an aim for whose attainment the management is exercized; the establishment of major connections, and the quantitative definiteness of these connections for the mathematical description of the object managed, and a well-organized control system with direct and feedback channels, and scientific methods and means of producing, transmitting, transforming and utilizing information.

A major condition for the successful creation of the material and technical base of communism is the achievement, in the interests of society, of maximum results with the least outlays. The basic relationships in the socialist economy, determined by the objective laws of development, lend themselves to quantitative measurements and mathematical formalization; the state system of economic information contributes to scientific control of the national economy. In the socialist economy, whose planned and proportional development is an economic law, it is quite possible to predict economic trends and exercise purposeful optimum control, for all the complexity of the economic interdependencies.

But in the capitalist system, based on private ownership, with its unpredictable trends, anarchy and destructive operation of economic laws manifested through the ungovernable market-exchange mechanism, such control involves insurmountable difficulties.

Control of a planned economy is the most difficult and, unfortunately, the least studied problem of cybernetics. Different economic processes occur in strictly definite relations between the main factors of production. The quantitative description of this definiteness constitutes the content of economic information. Its qualitative and time parameters determine the different streams of information (planning, operative, statistical and other information) in accordance with the specialized functions of

control. The process of control is exercised by means of the totality of control commands and feedback signals, which are the major elements of economic information. Accordingly, one of the basic problems of the successful development of the theory and practice of national economic control is the organization of economic information on scientific bases with the aid of the latest computing techniques.

Planning requires comprehensive information describing the state and development of the economy, the different aspects and elements of the productive forces, and branch and general-economic targets in the plan period. Economic control can be regarded as a closed system of direct and feedback channels realized through the creative activity of individuals and collective bodies. No practical problem in the improvement of planning and management can be solved successfully without improving economic information, as well as the methods and means of its processing. This is especially true under the conditions of accelerated technological progress based on advances in the natural sciences, which is constantly changing the established economic and branch proportions.

The new organization of production involves achieving continuous and optimum planning and putting greater emphasis on technical-economic substantiation. Continuity in planning, which is manifested in the organic combination of operative and long-range plans and coordination of planning between the local and central links of the national economy, requires high reliability, constant renewal and processing of economic information in accordance with the changes at work in the economy. Optimum planning, which most fully reflects the main condition of socialist management -- the attainment of maximum results with the least outlays -- requires integrated study of interconnected economic problems or of the economy as a whole, corresponding economic information, and an advanced analytical apparatus, since it is impossible to find the optimum solution of a complicated economic problem with primitive means.

The development of economic information is also necessary for the further advance of economic theory. The generalization of practical experience that enriches theory is attained through profound quantitative as well as qualitative analysis. The analytical expression of a law is one of the best means of its demonstration. It is well-known that V. I. Lenin paid much attention even to the information of bourgeois statistics and drew scientific conclusions on the basis of quantitative analysis of certain processes at work in the social life of Russia. Using Zemstvo statistics, Lenin revealed the law-governed process of the class differentiation of the countryside and the inevitability of the capitalist path of development for Russia as he exploded the anti-scientific idealist concepts of the Narodniks. Lenin's famous work Imperialism as the Highest Stage of Capitalism [Imperializm, kak vysshaia stadiia kapitalizma] is also a model of the scientific approach to quantitative analysis. Lenin based important theoretical generalizations and conclusions on it.

It should be emphasized that a number of vital economic problems such as price formation, the effectiveness of capital investment, and others, have not received sufficient theoretical and practical treatment not only because our economics has fallen behind in this respect, but also because Soviet economists do not possess reliable and comprehensive information in this field. To sum up, the rational organization of economic information in the country with the help of the latest computing techniques is an important problem of economic cybernetics and a necessary condition for the improvement of the entire process of control. Improvement of planning and management, realization of new principles in planning, rationalization of economic information and automation of its processing are interlinked processes. They are the outcome of the objective needs of material production and the tasks involved in building communism.

Problems of Economic Information

Of special importance in the construction of an optimum control system is the determination of

the amuunt of information necessary for its functioning and of the effective methods of the transmission of this information with the smallest number of elementary signals. This is a major problem of economic cybernetics.

The amount of economic information necessary for planning and control can be correctly determined only on the basis of a thorough and detailed study of the process of expanded socialist reproduction, of the specific conditions and factors of economic development. It seems to us that the only correct criterion of the objectively necessary minimum of economic information is the volume of different data expressing quantitatively the most essential tees and dependencies (that is, those which must be taken into account in planning and guidance) within economic processes as well as between them. The primary aim of economic analysis is to determine these ties precisely and measure them quantitatively.

The problem of ascertaining the extent of determinateness, i.e., the rigidity of the limits of control of a system as a whole as well as of its components, is also very important. Obviously, the more narrow (rigid) these limits, the more often the state of the system must be recorded (measured) and the greater the number of parameters involved, and hence the larger the required amount of information functioning in the control system.

Research shows that at present, with highly reduced standards of useful economic information, there is much excessive, insignificant and overlapping information. The vast tracts of more labor-consuming primary information are used very inadequately. Thus, the investigation of the technical-industrial-financial plans of many enterprises performed by the Laboratory of Mathematical Economic Methods of the USSR Academy of Sciences under the guidance of Academician V. S. Nemchinov has shown that, given a rational construction of these plans in the form of matrix models, the volume of useful data can in some cases be expressed by a fraction of the information now used. In the local links, where the different streams of information feeding the numerous control agencies originate, a large amount of data is put together that is not required for control. Identical information reported by the different services of enterprises proves to be uncoordinated. For example, the data on material resource needs for the fulfillment of the production program provided by the supply department do not coincide with the estimates of the planning department when determining production costs. And, as a rule, they do not correspond to the actual needs. In some cases the operative report data do not tally with bookkeeping account data and statistics.

The total comparability of all streams of information presupposes a single source of information, unity of the methods and means of its production and processing, as well as an integrated scheme of technical-economic calculations similar to the matrix model of a technical-industrial-financial plan. Given such a calculation system, various indices are produced by different services, but only once. The results of one run of calculations are used as the initial data for the subsequent run. Thus, the corresponding data in any streams of information will be identical if the system is balanced. This coordinated system of calculation is most economical as regards the primary information and offers broad possibilities for producing derivative (secondary) information in accordance with the needs of various control agencies. However, such calculation systems are difficult to implement if the information is processed by manual methods.

The correct determination and evaluation of primary and derivative information make it possible to approach the problem of automating its production and processing.

Primary information reflects direct ties, or ties of the first order, existing in each specific production process. This information represents a quantitative evaluation of a certain quality or specific connection of a phenomenon and expresses the quantitative aspect of the elements involved in the material process. The variety of primary information reflects the variety of specific connections and dependencies in the process of production. For example, in the production of some

specific commodity there are direct dependencies between the output of a unit of finished product and the need for resources such as metal, electric power, fuel, insulation and other auxiliary materials, etc. These dependencies, described by coefficients of direct outlays, i.e., by standards, belong to the primary information.

A connection between two products which is not effected in a specific technological process but is mediated through other products belongs to secondary or derivative information since it can be calculated through primary information (all outside information can be conventionally referred to primary information only because of certain common methods of its formation and introduction into a system of automated treatment of information). Secondary information reflects a certain system of connections effected through a chain of primary links. This information comprises the connections of the second and higher orders. For example, the direct technological coefficients of material outlays reflect connections of the first order. Coefficients of total material outlays, reflecting the system of chain connections in material production mediated through other products, belong to the secondary information. The demarcation line between primary and secondary information is conditional and flexible. Thus, at enterprises where the part-by-part standardization of production outlays is made, the primary information characterizes the expenditure of materials for each part, while enlarged material standards per unit of final product are referred to the secondary information. At other enterprises, enlarged standards may belong to the primary information.

Primary information is the basis of secondary information. The methods for furnishing and processing the two types of information are very different. Primary information cannot be reduced arbitrarily, for certain channels of control would be lost and some of the actual connections would prove to be outside the control system. The connections that can and that cannot be neglected in the process of control are determined by the extent to which deviations (fluctuations) of the guided system from the optimum regulation are allowed. Here we have the problem of the correct relation between determined, i.e., regularly reproduced, and stochastic states.

The primary documents – technical, technological, standardizing, bookkeeping and operative – are the medium of primary information. Its collection can be automated, but much less so than secondary information and documentation. Different organizational and technical methods are now being worked out and used for automating the collection of primary information. Nevertheless, this process still consumes much labor and requires substantial outlays of manual labor. A large contingent of administrative personnel is engaged in this work. Therefore, a reduction of labor requirements for this process by means of its rationalization and mechanization is a major national economic task.

The control process requires a great variety of information, mainly secondary information, the consumption of which is much greater than that of primary information. Different combinations of the elements of primary information produce all the variety of economic information. The production of secondary information can and must be automated completely, while the records carrying this information must be sharply decreased within the limits stipulated by legal formalities.

To effectively fulfill its role, economic information must meet several requirements, the most important of which follow.

Information must be authentic, i.e., it must correctly reflect the actual processes at work in the economy. To ensure this, it is necessary to eliminate the effect of subjective factors on its production as much as possible. Experience has shown that these factors reduce the objectivity of information.

Information must be processed by rigorously scientific methods and advanced techniques which, while altering information in form, do not affect its content and authenticity. In many cases the planning agencies deal with enlarged indices in the aggregate form. To reflect

correctly the processes it describes, each index of this kind must take into account adequately and in due time all changes of the primary factors and structural shifts.

The timeliness of information is a prerequisite for its correspondence to planning and control aims. Optimum control of a complicated, highly diversified economy is the more successful the less time is lost in the production and transmission of planning and accounting information. The long experience of the planning and statistical agencies shows that it is impossible to improve the timeliness of economic information by the techniques now in existence. This lowers the level of operational planning and makes it more difficult, which affects the planning of the supply of materials and equipment. The delays between the development of the supply plans at the enterprises and reception of the documents for the funds allocated amount to six or seven months.

One of the basic properties of economic information is that it provides extensive possibilities for analysis. Modern methods of quantitative analysis cannot be used effectively unless the information is exhaustive, embracing the totality of major connections and factors of the phenomenon being studied. Economic information must be flexible and have large potentialities for the formation of new characteristics describing the national economy as a whole or its particular aspects. The primary elements of information must be capable of repeated use in different sets of information. Hence it is necessary to have a ramified and rigorously scientific organization of economic information from the formation of its primary elements up to the development of economic categories and abstractions.

An important index of the level of organization of information is the extent to which it is economical. It is impermissible to extend primary information infinitely and make it more laborious. Information must be rationalized to a maximum degree and reduced to what is actually necessary. The numerous and varied needs of planning, economic analysis and management must be met from derivative information obtained by the processing of primary data.

The modern theory and practice of planning and management require the unity and unambiguousness of information for all links involved in planning and managing the national economy. Planning and management are exercised in every link of social production, and hence each link requires economic information that is definite in form and content. As the democratic principles of the guidance of the national economy develop, the streams of economic information must meet fully the needs of both local and central agencies of planning and management.

All this requires a drastic reorganization of the system of economic information, improvement of its "language" methods of processing, technical facilities, organizational coordination, forms of expression and functioning. It is generally known that the present state of planning and statistical information does not correspond to the requirements set by the development of our economy. The existence of different streams of information (statistical, bookkeeping, planning and operational), isolated methodologically, organizationally and structurally, as well as great delays and the awkwardness of information make it more difficult to improve planning and management. Specialization of some functions of management isolates the different streams of information even more, disuniting them in time and space. The absence of a clearly defined system of indices, general units of measurement and nomenclature-branch specifications leads to the incomparability of the same economic indices produced in different channels of information and by different methods.

The state statistical agencies organize accounting and statistical information with inadequate technical facilities. The infinite variety and unwieldiness of records, the extensive exchange of records, and the backwardness of the means and methods of record-keeping lead to the repeated overlapping of the streams of information, thus diverting a large contingent of employees from material production. This being the state of documentation, the possibility of applying effective methods of coding and automating processing is practically ruled out. The attempt to apply,

even partially, the above methods would require double processing of all information because of the transfer of data onto automated media of information (punched cards, punch tapes, magnetic tapes, special forms, etc.) and, hence, an additional number of accounting personnel.

The coefficient of the utilization of economic information is very low. Large tracts of information collected by banks and other financial agencies, the Ministry of Communications and the statistical agencies by selective surveys are used insufficiently. The information materials of the Ministry of Communications contain valuable data on transportation-territorial ties in the national economy, but these are being processed for only nine items. The data on most products shipped are not processed at all and cannot be used by planning agencies when planning the territorial distribution of the productive forces and rational transport connections.

In some cases the planning and statistical information does not correspond to the requirements of the computing-machine solution of integrated economic problems. For example, the construction of interbranch balances and the investigation of structural changes in the economy require specifying pure branches of the national economy and the standardizing materials from branch to branch. Unfortunately, such information is not now furnished, and mass observations of enterprises and construction sites have to be resorted to. At the same time, much redundant primary information is collected which is not used for putting together the required derivative information. The production of primary records is based on outdated equipment and primitive techniques, and the selection of useful information for further treatment is done manually. The situation in the production and treatment of secondary information is even worse. Several examples can be given to illustrate this point. The data on the national economy's needs for separate material resources are formed by a method under which the streams of information are reprocessed manually many times, this growing like a snowball without any essential transformation. The central planning agencies are simply drowned in an avalanche of planning and calculation documents. A case in point is determining the national economy's need for ball-bearings: an enterprise compiles a statement of its need for each product and use norms for the specific types of ball-bearings. The branch administration of the economic council also calculates the branch's need for each type of manufactured product and specific type of ball-bearings, i.e., sums up the requests of the enterprises. This process was repeated by the economic council, the republic and the Chief Administration of Inter-Republic Deliveries under the State Planning Committee of the USSR. This system of producing and processing information is obviously irrational. But it lends itself to overall automation, with a considerably smaller volume of information processed as a result. The time required for plan estimates and the exchange of data in the system of planning for the supply of materials and equipment would thus be reduced considerably; roughly 50% of the data now furnished in drawing up plans for the national economy would prove excessive. There would be no need to indicate the source of issue, the plan indices for the current year, and constant standard indices since this information would be known and available on special information bearers. The calculations would require the introduction into the system of only the corrected part of the economic information and contemplated projects for the period under discussion. There is already practical experience in this respect. Thus, about 2,000 man-hours of preparatory work were initially needed by the Computing Center of the State Planning Committee of the USSR to calculate the basic indices of the draft national economic plan for 1963, broken down for large economic areas and 91 branches of the national economy and industry over the years of the Seven-Year Plan with per capita indices. The second variant of the calculation, with refined data of the draft plan (the changes affected about 30% of all indices of the year planned), took only 20 man-hours.

The expansion of production and accumulation,

the accelerated development of science, and the growing complexity of interbranch and interregion ties will lead to a multiple increase in the volume of economic information required for managing our country's economy. Calculations show that over the past seven years the volume of production has increased 2 times and the planning-controlling machinery 1.5 times. If the existing methods of processing information are preserved, the planning-controlling machinery will increase more than 4 times within 20 years and yet the national economy will have to subsist on a "starvation diet" of economic information.

Constructing a Rational System of Economic Information

It is clear from the above that a system of economic information corresponding to the targets of communist construction can be established in the country only through large-scale introduction of the latest achievements of science and technology, and above all, electronic computing techniques. The establishment of such a system will require the utilization of the most complicated means of modern computing technique, automation, and communications, the reorganization of planning, accounting and statistics, the improvement of primary documentation and methods of processing it, a strict classification of all elements and items of production, and a scientific method of codifying and processing economic information automatically. The solution of this problem requires comprehensive preparations and strenuous efforts on the part of various scientific and practical institutions of our country.

An automated system of economic information is a precisely coordinated set of technical means (electronic computers and automatic devices, channels of communication, and means of the transformation and transmission of data) connecting all links of planning and management and organized through specialized computing centers and computing machine stations. Modern calculation equipment can register, process and store vast amounts of digital and letter information, running into tens and hundreds of millions of words. Before long the entire process of the registration and introduction of this information directly from the primary documents will be automated with the aid of special reading devices. The electronic memory of computing machines, which permits a quick alteration and renewal of information, will ensure a timely recording of all changes in the economy.

Along with the production of new means of computing technique and automation corresponding to the requirements of an automated system of economic information, it is necessary to make effective use of the available computing equipment. Functioning at present in the national economy are about 800 computing machine stations and more than 2,400 computing offices (excluding the Central Statistical Administration network). They are used very inadequately, however, and mainly for the calculation of wages and bookkeeping. The equipment functions for less than one shift on the average. For example, the punch card calculators function about 6 hours a day at the enterprises of the Moscow City Economic Council and the Leningrad City Economic Council. The cybernetic devices now in production must be capable of synthesizing sets and systems of varying complexity and their interactions, so as to automate the entire process of producing and processing economic information from the local sources of information up to the central administrative agencies.

It should be emphasized that the construction of a rational system of economic information must correspond to the improved organizational structure that emerged after the reorganization of the management of the national economy. The basic feature of this structure is the combination of democratic and centralized principles of management. Accordingly, the automated system of economic information must have many levels and be ramified into several autonomous (local) subsystems. Such a system of information will make it possible to control the economy through a multitude of simultaneously

functioning subsystems at different levels with a comparatively small number of the simplest acts of management and local sources of information in each of them.

The ramification of management and of the production and processing of information is an essential factor for cybernetics since its methods can be used most effectively for the control of complicated ramified processes in which any local change affects many phenomena through the mechanism of chain connections. The stepped structure of the existing system of management can be effected through a network of computing centers, computing machine stations, and computing offices forming the different levels of the processing of information.

Thus, the accounting-computing departments at enterprises, construction sites, state farms and collective farms form the lowest level of information processing. Computing machinery of varying capacity and even computing centers equipped with electronic computers (at large enterprises) can be used at this level. Such centers are already being organized at several enterprises (the Likhachev Automobile Plant in Moscow, the First State Ball-Bearing Plant, the Magnitogorsk Metallurgical Combine, etc.). At smaller and medium-size enterprises it is expedient to have mechanized accounting factories or computing machine stations, and at small enterprises — computing offices equipped with the simplest equipment of the cheaper kind requiring no special personnel for maintenance. Computing centers and mechanized accounting factories equipped with calculating-analyzing machines and electronic computers are being set up under the economic councils and state planning committees of the republics. The system of these centers constitutes the area level of information processing. The computing centers of the economic councils must be connected, by means of automatic transmission and reception of information, with the enterprises and state planning committees of the republics, and the latter, in turn, with the chief computing center of the all-Union departments and ministries. The system of automatic processing of economic information must be continuous, i.e., it must not be interrupted by manual processing stages.

The result is a series of interacting levels producing and processing economic information, and corresponding to the reorganized management of the national economy. The transmission and reworking of controlling information from the central to the local management agencies proceed in a similar way.

The construction of an automated system of economic information presupposes a certain mode of operation of computing equipment. In particular, it necessitates the concentration of equipment and the establishment of unified computing centers for planning and management. Certain measures are being taken along these lines: for example, to establish a single computing center to service the central departments and ministries. The problem must be solved along similar lines in the union republics and large economic areas.

Experience has shown that the use of computing equipment at large machine computing stations and machanized accounting factories is much more efficient. Therefore, the utilization of computing equipment in consolidated computing machine stations is more economical and expedient. This is especially important for small enterprises, which cannot buy and run highly efficient computers.

The establishment of unified computing centers for management of the national economy ensures the most effective and productive utilization of all equipment at minimum cost, uniformity of the methods of processing information and programming (the problem of automating programming and unifying the mathematical apparatus can be effectively solved), and the accumulation of all information required by the central agencies, above all, the planning agencies, at a single center. The overlapping in producing and transmitting information is thus eliminated, and the complete coordination of different streams of information is attained.

However, the establishment of a single computing center for servicing the central departments and ministries does not mean that specialized centers and specialized systems cannot

be set up, along with a unified state system of economic information, in order to control the concrete processes involved in the technologies of separate branches of the national economy or the state machinery. Thus, it may be expedient to set up specialized systems for the operative control of various types of transport traffic in the system of the Ministry of Communications, as well as for operative accounting of the state cash plan in the system of the State Bank of the USSR. In addition, the operation of these centers and systems must be functionally coordinated with the unified system of economic information. The latter will regularly obtain from the former a portion of the information pertaining to branches or the national economy.

Recommendations have been worked out for the organization of the first section of this system for automating calculations in the planning of the supply of materials and equipment. Preliminary estimates show that such a system, as pertains to the planning of the supply of materials and equipment, may automate the entire process of producing and processing information, and systematize and reduce the exchange of documents in this sphere. The system will ensure determination of the needs of an enterprise, an area, a branch in materials and equipment, necessary transition stock, optimum transportation connections between consumers and suppliers, optimum work loads for unique and complicated equipment (rolling mills, automatic systems, etc.) and, what is most important, it will help to coordinate the production plans with the plans for the supply of materials and equipment. The following procedure is possible.

The summary plan for the supply of materials and equipment and initial data, entered into special media of information according to the established system of indices for the branch management of the economic council, are produced automatically at the machine calculating station of an enterprise. The processing of punch cards and punch tapes carrying the initial data of enterprises automatically yields the draft supply plan of the branch and prepares the initial data for the development of the supply plan of the economic area. This process is repeated at the state planning committees of the republics and is completed at the central planning agencies. The system of the automatic processing of information also makes it possible to obtain the necessary information directly from the enterprises, without reprocessing it at the subsequent levels of management.

The plans for the supply of materials and equipment and the plans for production and capital construction are coordinated through a system of interbranch and interarea material balances.

At the preliminary stage of development of the draft national economic plan, its main indices are coordinated by means of the interbranch balance for materials and the balance of interarea ties. Corresponding balances are drawn up in each republic and economic area. After local consideration of the draft plan, the balance ties are refined and completed in the final variant of interbranch and interarea balances for materials.

The coordination of the plans for the supply of materials and equipment with the production plans is based on iteration. Complete coordination of these plans in all links of the national economy can be attained by consecutive approximations. It goes without saying that complete automation of this stream of data and coordination of the supply plans with the production plans can be effected with the help of a precise automatic system of economic information using the latest means of computing equipment. According to preliminary estimates, this will require the establishment, within the next three or four years, of approximately 29 information-computing centers and 71 mechanized accounting factories, the addition of more advanced letter-number computing equipment to the calculating machine stations now in operation, and the doubling of the number of available machine calculating and computing offices. The cost of the equipment of the system will not exceed the remuneration of the additional employees whose services are enlisted from time to time in the field of supply.

Automated systems of economic information are being set up at some enterprises, economic areas, and republics. Thus, the Moscow City Economic Council has worked out a concrete program for the establishment of eight model enterprises, at which the production and processing of information for intra-enterprise planning and management, as well as management by the economic council, will be automated with the aid of computing equipment. It is also contemplated to establish an automated system for processing the data on the operation of the industry of an area, needed by the economic council for controlling the operation of the area's enterprises. The Computing Center of the Moscow City Economic Council is being set up for this purpose. The Moscow Region Economic Council has already begun the automation of the processing of current information on the operation of the area's industry. This will enable the heads of the economic council and its branch administrations to know, on the following day, the results of the operation of industry. The Leningrad Economic Council is engaged in interesting work on the automation of calculations in the sphere of intraplant planning and the processing of information in the enterprise-economic council link. Experimental work has begun on the automatic production of economic information between the Computing Center of the State Planning Committee of the USSR and the State Planning Committee of the Belorussian Republic.

Work along the same lines is in progress at the Magnitogorsk Metallurgical Combine. In cooperation with the Central Research Institute of Integrated Automation and the Computing-Design Office of the Vilnius Computing Machinery Plant, the enterprise is working on a system for automating the collection and processing of economic information necessary for management of the enterprise. It is planned to connect all the shops and services of the combine with its computing center by automatic data transmission channels. Through a special system of inquiry, the primary information of the shops will be automatically received, controlled and recorded on punch cards at the computing center. The processing of information will be mechanized throughout. The system will make it possible to have a detailed description of the enterprise's operation for the previous 24 hours on the following day.

Extensive work on automating the production and processing of information is in progress at the Likhachev Automobile Plant. A high-capacity electronic computer has been put into operation for this purpose. The Leningrad Economic Council contemplates the organization of such systems of information at several large enterprises, as well as the automation of the production and processing of information in the enterprise-economic council link. The valuable initiative of local organizations must, however, be coordinated and guided by the overall plan for the establishment of the automated system of economic information.

Foreign experience in the automatic processing of information pertaining to enterprises or industries should also be utilized. There have been several publications concerned with these questions in the foreign and Soviet press. Entire systems for the processing of data have been established in the USA, Britain, France, Italy and other capitalist countries (the "Bismac" and "Pert" systems, as well as others, in the USA, a system of the Lyons firm in Britain for studying demand and processing the information of several thousand commercial enterprises, etc.). The problem of automating production management and sales, as well as the processing of economic and commercial information, has been dealt with in interesting ways at the Olivetti firm and the enterprises and divisions of Fiat in Italy, and at Sylvania in the USA. IBM, in the USA, widely advertises its machines for accounting and management of individual enterprises and entire industrial branches.

Effective methods of ensuring completely reliable economic information must be worked out in connection with automation of the reception, transmission, and processing of information. This problem must be solved by a combination of different means: by increasing the stability and reliability of communication channels, by developing special protection codes and automatic

coding and decoding of information, and by utilizing computers for the logical and automatic verification of the reliability of information.

Effective protection codes and automatic logical verification are of special importance. Different codes are used at present. They all involve the transmission of redundant information. The efficiency of the protection code is determined by the ratio between redundant information and its increased reliability. The simplest code for the protection of information transmitted through the channels of communication is an additional transmission of signals which complements each code combination to the parity or non-parity of the elementary transmissions. The control sums method is more effective as protection. In the transmission of information, all significant elementary signals are summed. The control sum is transmitted after the main information. At the reception end, the information is summed as it comes in, and if the resultant sum and the control sum coincide the transmitting device is allowed to continue the transmission. If they do not coincide, the transmission is repeated. The method of combining control sums with complementing to the "even" or "odd" of each combination, as well as other methods of coding information, are used. If the rate of automatic transmission and processing of economic information is high, it is necessary to have a code protection system that not only checks the reliability of the information received but also restores the partially lost information.

Of great importance is the development of methods of employing electronic computers for the automatic control and correction of economic information. With the aid of these machines it is possible to have additional calculations, logical operations and comparisons for control purposes. It is a commonly known fact that, when processing information on punch card machines, use is made of the methods of comparing interconnected indices to detect incongruous, i.e., illogical, combinations. They are used especially in processing census data, sample surveys, etc. Measures of automatic control of the reliability of the computing process are used when solving problems on electronic computers. Utilization of these machines for the control and correction of automatically transmitted and processed streams of information is a new field. It has received little study and development.

The automatic production and processing of economic information requires a scientific classification of all elements, standards of technical-economic indices, and products of the material production sphere. Each elementary transmission in the automated system of economic information should have a single meaning in any stream of information and at any level of management. Without this, automation of the production and processing of economic information is out of the question. Yet the present classification of products of even the leading branches of the national economy does not correspond to this requirement. Thus the classification of products for some branches in the list of the State Planning Committee of the USSR differs from the classification of the USSR Central Statistical Administration; and it fails to coincide with the list of the chief administrations for inter-republic deliveries under the State Planning Committee of the USSR and the economic councils, as is shown by the table on page 15.

Hence, an important and basic premise for the automated processing of information is the development of an unambiguous classification of the products and standards of all branches of industry and agriculture, of technical and economic indices, of a system of indices differentiated for all links of the national economy. An all-Union classification of the national economy's output is now being worked out, and is scheduled to be completed in 1963 or 1964. The classification of several branches of industry, including machine building, metalworking, metallurgy, and construction will have been worked out in 1963. Research and designing institutions of industry and agriculture, as well as planning and management agencies, must take an active part in this work. Of considerable importance is the development of classification codes that will allow the coded

Number of Listed Products of Major Industries in the Planning, Statistical and Sales Documents

	List of the USSR State Planning Committee	List of the Central Statistical Administration of the USSR	List of the chief sales administrations of the USSR State Planning Committee	Of these there coincide:		
				Lists of the USSR State Planning Committee and the Central Statistical Administration of the USSR	Lists of the USSR State Planning Committee and chief sales administrations	Lists of the Central Statistical Administration of the USSR and chief sales administrations
Rolled ferrous metals (shaped)	70	131	55	39	48	27
Power machinery output	122	221	322	21	6	3
Metallurgical equipment	46	34	682	21	21	17
Mining equipment	439	95	444	45	278	69
Oil extracting and oil processing equipment	38	44	114	7	28	7

data to be sorted rapidly and unambiguously and processed efficiently.

Improvement of the system of economic information requires a drastic reorganization of the system of methods for producing and processing primary documents. The current system of documentation intended for the more primitive methods of producing and processing information, cannot be used rationally in the automatic processing of information. The time has come to reorganize the production of documents and to work out and introduce progressive record-media devices and scientific techniques for the production and treatment of documents. The problem has not yet been sufficiently worked out, but even now several major principles for its solution can be put forward.

The system of record-making corresponding to the different functions involved in managing the national economy (planning, accounting, operational control, etc.) should be set up in such a way that the records of two adjacent levels fully correspond, i.e., the aggregate or contour data of the lower level enter as the initial data into the elaboration of documents of the next higher record-making level. The same type of coordination between particular and overall indices and kinds of records is needed here as exists in engineering and designing documentation, where the drawings for parts are perfectly coordinated with those for the assembly of units, and the latter -- with the overall scheme and kinematics of the mechanism.

Progressive record media ensuring the automatic introduction of these data directly into electronic and other computers should also be applied. Several methods for the production of such media are known (use of symbolic entries on special forms in magnetic ink, filling in of a document and a punch card form, which can be torn off, etc.). However, work along these lines has been in the experimental stage for an intolerably long time.

Of special importance is the designing of equipment for automatic reading and data input into the electronic computer directly off the printed forms and primary documents. This would raise the effectiveness of computing techniques in economic planning and management by scores of times. Experience has shown that with the existing manual methods of preparing economic information for input into the electronic computer, from 50 to 100 hours of manual work are necessary to keep the machine going for 1 hour. Unfortunately, our people in mathematical machine building pay very little attention to this problem. Thus, the tendency of some designers to raise the speed of operation of the computing system proper without corresponding improvement of the outer devices of the computer and integrated treatment of the problem of raising the productivity of the computer does not yield the advances sought in computing techniques. Rapid action is important but it is by no means the all-embracing parameter of the computer.

It is also necessary to cut down the number of record-making channels and to eliminate unjustified overlapping in this field. All summary and unified data, in accordance with the specialization of management functions, must be produced automatically by agencies responsible for processing economic information: a computing office, machine calculating station, or computing center.

Improvement of the methods, means and modes of record-making and processing is an important and complicated problem. It requires scientific organization and advanced management techniques. Unfortunately, the measures envisaged in this field are being fulfilled inadequately. The state committees of the USSR Council of Ministers on labor and wages, automation and machine building, and radioelectronics have failed to fulfill their assignments for the development of new technical means and progressive reoord-making and record-processing methods. The Central Statistical Administration of the USSR is not sufficiently effective in controlling the implementation of these measures.

The creation and introduction of new record-making and record-processing means and techniques call for an integrated solution. Thus, the development of new media of information and methods of their processing must be coordinated with the production of the corresponding automatic reading devices that will permit the effective pick-up of information off these media. Automatic data input directly off the production line or unit requires the production of the corresponding information pick-ups and scanning systems. Without an integrated study of these problems it is impossible to carry out a correct technical policy in this field and rationally construct unified sets of computing equipment and automated installations. Analysis of isolated aspects of this problem, ignoring their interconnections, can lead to excessive expenses and to a lack of coordination in the work of different devices, which, incidentally, is confirmed by past practice.

The available, only slightly mechanized, computing means (keyboard machines) are not combined between themselves and with punch card techniques, while the latter are not combined with electronic computers. As a result, it is impossible to create a set out of the Soviet smaller computers that would ensure, simultaneously with the printing of a document, the production of punch card information and the automatic transmission (reception) of data through communication channels. To build such sets, additional devices are needed, and these are designed by each organization at its own discretion. For example, a set consisting of the ST-35 apparatus, an adding machine, and a specially designed device coordinating their operation has been made at the Moscow Region Economic Council to automate the production and processing of operative information. The Institute of Integrated Automation uses electric typewriters, a standard P1 puncher and a special device called a "contact coder" for automatic transmission to the channels of information. The invoice printer, which makes it possible to type a document and punch a card simultaneously, is a very convenient and cheap

instrument for the automation of economic calculations. The invoice printer, however, should be modernized to be suitable for an automatic transmission and processing unit.

Several new digital and logical machines and devices will have to be designed for the system of economic information. Hundreds of millions of computer-analyzer punch cards cannot be processed by the electronic computers since there are no corresponding devices for the automatic transformation of information entered on different media and in different codes. Without these devices it is impossible to process the information prepared for one electronic computer with the aid of another. At the same time, an integrated set of automated information means must be worked out taking into account the maximum use of the available computing equipment, which operates with different media of information and different codes.

Economists, planners and managerial personnel, along with computer specialists and mathematicians, must take an active part in the development of a system of rational document-making and document-processing, as well as of an automated system of economic information. The participation of economists will make it possible to determine correctly the parameters and conditions of the functioning of this system and its role and place in the management of the national economy.

Drastic improvement of economic information requires the appropriate training of specialized personnel. There must be extensive retraining of available personnel along with the preparation of new specialists at higher schools. Calculations show that about 15,000 engineers and technicians and roughly 30,000 operators will be required for the first stage of the establishment of such a system, more than half of whom will be needed at the lower links of the system. A considerable number of specialists are already working at the machine calculating stations and computing offices. Nevertheless, this personnel needs retraining to be able to operate the new electronic equipment. This work should not be left without direction. Courses should be organized at large machine calculating stations, computing centers, and enterprises manufacturing electronic equipment to retrain specialists for the operation of electronic equipment, and they should be supplied with textbooks, visual aids, and instructors. At the same time, we must increase the output of specialists in mathematical economic methods and computing equipment. It is therefore surprising that the RSFSR Ministry of Trade, in 1962, reduced to 75 the enrollment in the specialty "National Economic Planning with the Use of Mathematical Economic Methods" at the Plekhanov Institute of National Economy in Moscow (100 persons had been annually admitted to the Institute in this field for the last four years). The action of several Moscow schools with polytechnical education (Schools No. 2, 52, etc.) in initiating the training of programmers for electronic computers deserves every support and encouragement. We should bring their experience to other cities and areas.

Development of an automated system of economic information involves other problems, in particular, the problem of providing the system with means of remote reception-transmission of information. This problem merits special treatment, and the Ministry of Communications is now paying considerable attention to it.

The establishment of a perfect economic-cybernetic system for the country is a major national economic task. For this system to function adequately within five to seven years, we must draw up a precise program right now for work in this field and begin to implement it.

* * *

Planovoe khoziaistvo, 1963, No. 2

V. Kossov, Iu. Finkel'shtein, and A. Modin

MATHEMATICAL METHODS AND ELECTRONIC COMPUTERS IN ECONOMICS AND PLANNING

I

A conference devoted to an exchange of experience and perspectives on the use of mathematical methods and electronic computers in planning was held in Novosibirsk from October 12 to 16, 1962. More than 300 persons, 229 of them from other cities, participated in the work of the conference.

The participants discussed a wide range of questions relating not only to the statement and solution of individual problems, but also to the training of economists working in the field of mathematical-economic methods.

The papers presented can be divided into groups corresponding broadly to the three sections of the conference: location of production and fuel-power balance; production planning; mathematical methods for the solution of economic problems.

It is of significance that the conference devoted equally great attention to two main areas:

1. Discussion of practically resolved problems and new mathematical models.
2. Development of mathematical methods and elaboration of new algorithms for the numerical solution of problems.

The conference was opened by Academician S. Sobolev, who dealt with the general aspects of applying mathematical methods in economic research. He said that in the Siberian Branch of the USSR Academy of Sciences this problem was being studied by the Mathematical-Economics Section of the Institute of Mathematics, headed by L. Kantorovich, Corresponding Member of the USSR Academy of Sciences, and the Laboratory of Economic-Mathematical Research of the Institute of Economics and Production Organization, headed by A. Aganbegian. Besides, a cost-accounting laboratory had been set up at Novosibirsk University, which is also working in this field. The university is training economists and mathematicians specializing in economic-mathematical methods.

Corresponding Member of the USSR Academy of Sciences G. Prudenskii presented a paper entitled "Present-Day Problems of the Economics and Organization of Production," in which he discussed questions of the organization of labor, utilization of the means of production, management and planning. Mathematics is used in investigating each of these spheres.

L. Kantorovich's paper, "Mathematical Problems of Optimum Planning," dealt with the work in this sphere carried out by the Mathematical-Economics Section of the Institute of Mathematics. He outlined the basic fields of research in mathematical programming:

1. Linear programming.
2. Nonlinear programming.
3. Dynamic programming.
4. Whole-number programming (and combined [kombinatornye] problems).
5. Stochastic programming.

The authors of Section I of this article, V. Kossov and Iu. Finkel'shtein, are research workers at the Laboratory of Economic-Mathematical Methods of the USSR Academy of Sciences and the Academy's Council for the Study of the Productive Forces, respectively. A. Modin, the author of Section II, is a research worker at the Laboratory of Economic-Mathematical Methods.

Kantorovich dwelt in detail on the attempts of some bourgeois economists to prove that utilization of objectively conditioned estimations in planning practice represents a shift to the theory of marginal utility. In an attempt to pass off their desires as actuality, they go so far as to falsify factors. They are aided in this by the fact that periodical articles by some Soviet economists have attempted to prove the same point. Academician V. Nemchinov spoke of this matter with particular emphasis at the Plenary Meeting of the Scientific Council on the Application of Mathematical Methods in Economics held at the time of the conference.

In his paper, "Optimum Planning of the Location and Specialization of Production," A. Aganbegian said that the Laboratory of Economic-Mathematical Research was studying problems of the distribution of industries and enterprises. Thus, problems of the location of the fishing fleet were solved, an optimum plan for the reconstruction of mines in the Kuznetsk Coal Basin was drawn up for 1962-1970, and an optimum variant was developed for the specialization of hardware production. (This work is being carried out under contracts with the organizations concerned.)

Academician Nemchinov stressed the role played by the Siberian Branch of the Academy of Sciences in the development of economic-mathematical methods. The latter's sphere of application is practically unlimited. The methods can be used with success wherever we have to deal with computations. And economics is impossible without calculations of the expenditure and results of production. Therefore, those economists are absolutely wrong who consider that the application of these methods should be limited to production problems alone, that they cannot be used in planning the whole of the national economy. In this connection, Academician Nemchinov dwelt on the problem of measuring use value.

Papers devoted to specific subjects were discussed at the section meetings.

Location of Enterprises and Industries. Significantly, some of the problems raised by those who read papers referred to separate industries and completely ignored the question of the integrated location of many industries. This was partially due to the preparations currently under way for a special conference on questions of the interindustry balance.

The greatest difficulty in tackling questions of the location of enterprises of a particular industry lies in the fact that the optimum rate of effectiveness of capital investment has not yet been established. Hence, in solving these problems one must proceed from more or less vague assumptions concerning the magnitude of this rate. This, naturally, reduces the practical value of the estimates, turning them rather into a general statement of what is desirable. To overcome this difficulty, the problem is usually solved for several magnitudes of the rate of effectiveness, thus producing several possible optimum plans.

Yet another difficulty, inherent to any economic-mathematical problem, should be noted. This is the collection and the quality of data. It is estimated that more than 95% of the labor involved goes into data collection and processing. What is most unpleasant, however, is that owing to the low quality of the data, which is due primarily to inadequate accounting and reporting, the accuracy of the obtained optimum is sometimes questionable.

Transport Problems. One of the most fruitful areas of work of the conference involved the discussion of papers dealing with the methods of optimum planning in transport. Linear programming is widely used here. The transport problem is the simplest; its preparation involves comparatively little expenditure, and its solution also involves little work.

Considerable interest was displayed in papers presented by D. Belov (Leningrad) and B. Geronimus (Moscow), and A. Aganbegian (Novosibirsk), which dealt with experience gained in the use of linear programming in planning motor transport. The paper of V. Savin (Inland Waterways Engineering Institute, Gorky) on the application of the method in planning river transport also evoked interest.

Agricultural Problems. Papers were presented on the distribution of agricultural

production by zones, specialization of agricultural enterprises, and the make-up of tractor fleets in state and collective farms. Interesting results were obtained by Aganbegian and V. Mikheeva (Computer Center of the State Planning Committee) in solving problems concerning the distribution of farm production. G. Zhuravlev (All-Union Farm Mechanization Institute) dealt with methods of stating and solving problems related to determining the structure of the machine and tractor fleet.

Population Distribution in Siberia and Study of Working Time. Personnel of the Institute of the Economics and Organization of Production, Siberian Branch of the USSR Academy of Sciences, discussed studies of the patterns of population reproduction in Siberia and of working time.

Most of the conference papers were devoted to the organization of industrial output. It should be noted, however, that this sphere was dealt with least adequately, since for various reasons, organizations engaged in the most intensive research in this area did not take part in the conference. This was largely due to preparation being under way for a conference on the use of mathematics in planning machine-building.

Most conspicuous was a paper by S. Dumler (Institute of Production Organization, Minsk) on experience in modeling production processes with electronic computers. Methods of modeling production processes permit a substantial expansion of the sphere of application of computers for production planning and management; they can be used even when a strict mathematical description of a process is difficult or impossible.

Statistical Methods. Various aspects of this problem were discuseed, mainly questions connected with the solution of particular production problems. Some calculations showed that in some cases statistical methods give good results that are more accurate than those obtained by conventional intuitive computations.

Discussion of General Methods of Solving Linear Programming Problems with Computers. Interest developed in a paper presented by V. Bulavskii (Institute of Mathematics, Siberian Branch of the USSR Academy of Sciences) on "The Iterative Method of Solving Linear Programming Problems," as well as in part of a paper by R. Zviagina (Institute of Mathematics, Siberian Branch of the USSR Academy of Sciences) devoted to the programming of Danzig's and Wolf's algorithm. These papers reflect attempts to solve the difficulties arising from the large volume of linear programming problems.

A method suggested by E. Filippovich (Automation Institute, Kiev) in his paper "Solution of Problems of Fractional Linear Programming" apparently permits moving, in some cases, from linear programming to more accurate nonlinear models.

Nonlinear Problems of Optimum Planning. A review of existing methods was made in the section by A. Kaplan (Institute of Mathematics, Siberian Branch of the USSR Academy of Sciences), and several reports were made on new results. The statement of several nonlinear problems for the power industry was described in papers by A. Krumm and Iu. Syrov (Power Institute, Siberian Branch of the USSR Academy of Sciences).

Discussion of Methods of Solving Particular Problems of Optimum Planning. Universal methods (for example, the simplex-method in linear programming) are obviously far from being the best in the solution of every concrete problem, inasmuch as they cannot utilize the specific characteristics of the problem. That is why elaboration of methods of solving particular problems is as interesting as the elaboration of universal methods, and it is hardly surprising that the subject was discussed in a rather large number of papers.

G. Rubinshtein (Institute of Mathematics, Siberian Branch of the USSR Academy of Sciences) presented, in his paper "On Simplified Methods of Solving Individual Types of Linear Programming Problems," a classification of linear programming problems. He made an interesting suggestion concerning problems for which it is or is not worth while to develop specialized algorithms. There was an attentive response to a paper by V. Cherenin (Computer Center, USSR Academy of Sciences) on "Solving

Certain Combined Problems in Optimum Planning by the Method of Consecutive Computations."

A number of papers were devoted to methods of solving transport problems and some modifications of them. The enhanced attention given to such a seemingly narrow group of problems is explained by their significance in terms of application. Interest was displayed in papers devoted to the transport network problem submitted by A. Lur'e (Institute of Economics, USSR Academy of Sciences) and N. Shor (Institute of Cybernetics, Ukrainian Academy of Sciences). It seems that network algorithms can be used successfully to solve transport problems of considerable volume, which is just what is needed for practical purposes. Two papers by V. Verkhovskii (Institute of Integrated Transport Problems, Moscow) devoted to multi-index transport problems are doubtlessly of interest in solving problems of optimum distribution in a multi-product setting.

Discussion of Other Methods of Solving Planning and Economic Problems. Much discussed was a summary report by Iu. Volkov (Institute of Mathematics, Siberian Branch of the USSR Academy of Sciences) on "Whole-Number Solutions of Linear Programming Problems."

In economic problems one must often deal with indivisible quantities (for instance, in planning automobile haulage one can route only a whole number of vehicles). But existing methods of linear programming do not permit taking into account the conditions of whole numbers. Volkov's report reviewed algorithms recently developed for whole-number programming. So far, however, these algorithms are not very effective, which was pointed out in the discussion. The development of effective algorithms for solving problems of whole-number programming is a difficult but very important task.

In the discussion of the paper "A Problem in Optimum Regulating with Random Inputs," presented by K. Latyshev and I. Romanovskii (Leningrad State University), the following problem attracted attention. In solving an economic problem for the optimum, one must only consider a limited time interval (the "planning period"). But attempts to achieve a maximum effect for a given planning period may serve to worsen the initial data for the following period. For the particular problem involved (optimum control of the simplest power grid), the authors found a way out, but in the general case, especially in problems of national economic planning, substantial mathematical and methodological difficulties arise.

It is to be hoped that 1963, as the plans of research bodies seem to indicate, will bring new achievements in the use of mathematical methods for economic research and planning.

II

The Second Coordinating Conference on Questions of Applying Mathematics and Computer Techniques in Economic Research and Planning was held in December 1962. It was attended by representatives of organizations whose work in this field is coordinated by the Scientific Council on the Applications of Mathematics and Computer Techniques. More than 70 organizations were represented, as compared with 56 at the first conference in November 1961.

The conference was opened by Academician V. Nemchinov, Chairman of the Scientific Council on the Application of Mathematics and Computer Techniques of the USSR Academy of Sciences. He said that the purpose of the conference was to sum up the work carried out in the principal fields over the last year and to consider the plans for 1963.

The main task, he stressed, was to embark in 1963 on the second stage in the work, namely, the widespread introduction of the results of research. The growing role of mathematical methods and electronic computers, as well as the growing demands made upon them, are to be seen in the fact that, for the first time, some of the topics have been included in the state plan of scientific research. Among these are the practical utilization of interindustry balance methods in planning, elaboration of rational systems of economic information, mechanization

and automation of planning material and technical supplies, and analysis of socialist reproduction. At the same time, Academician Nemchinov cautioned the meeting against giving unwarranted publicity to work being done, since it is sometimes unsubstantiated. We must not only popularize modern methods, but also let the public know about the difficulties that have to be overcome.

N. Kovalev spoke of the work of the USSR State Planning Committee's Computer Center. He informed the conference that the interindustry balance for 1963 had been drawn up, electronic computers had been used to calculate the breakdown of the population by years and regions of the country, and, for the first time in planning work, specific indices of the economic plan were drawn up for the major economic areas by years of the Seven-Year Plan, with specific per capita indices. He noted that the use of computers encountered considerable difficulties of an economic nature and technical faults in mass-produced computers. He stressed that the input and output devices were so imperfect that for every hour of computer operation there were dozens of hours of preliminary and input work.

Iu. Oleinik of the Computer Center of the USSR Academy of Sciences stressed that the practical implementation of mathematical methods required close contact with those who use the results, and that this can be achieved only by elaborating methods that have practical importance and a wide field of application. The USSR Academy of Sciences' Computer Center has worked out several programs for solving economic problems and has compiled a library of standard programs.

Oleinik pointed out that their major achievement had been the introduction, in Moscow in 1962, of ten-day planning of haulage of principal cargoes with electronic computers. This was made possible by the assistance rendered by the Moscow City Committee of the Communist Party. At present, haulage is planned of bulk cargoes, flour, sugar, packing, milk products, bread, etc. Oleinik remarked that in many cases the existing system of planning indices prevented the introduction of mathematical methods. Thus, for example, rationalization of freight haulage means a saving of some three million rubles for the state, but it in no way cuts the expenses of some of the truck fleets since its purpose is to reduce the volume of work involved in transporting a given quantity of freight; unfortunately, the plans for trucking are drawn up in terms of ton-kilometers, without taking optimum work distribution into account.

Oleinik also dealt with some of the technical difficulties involved in using electronic computers. He suggested that a standard-design computer center for economic calculations be drawn up, along with staff specifications.

V. Mikhalevich (Institute of Cybernetics, Ukrainian Academy of Sciences) spoke of the achievements of the institute in working out programs and computing the distribution of cargo routes among different types of transport in the Dnieper River area, problems for the optimum planning of industrial enterprises, the designing of big projects and roads, plant location, and estimates of material and technical supplies — all with the help of electronic computers.

He indicated that given the present level of computer techniques, it is difficult to solve problems with a considerable volume of information. Thus, if it takes a computer such as the BESM-2 an hour or an hour and a half to solve a problem, cataloguing the numerical data from the tape takes scores of days which otherwise could be put to better use.

Mikhalevich suggested that an algorithmic language be drawn up for planning and economic problems and the means of automatic programming. To ensure the widespread introduction of computers, it is necessary to begin elaborating the scientific and technical basis of an integrated system of computer centers. To achieve this, the State Committee of the USSR Council of Ministers for Coordinating Research Work should provide greater coordination of work in this area. The number of computer centers is increasing rapidly, but they are not suitably staffed with the required specialists,

and it is therefore important to take steps to train the appropriate personnel.

V. Belkin of the Institute of Electronic Control Machines reported on work being carried out to compute uniform-level prices and draw up an optimum fuel-power balance. He noted, quite correctly, the need to draft complex models (e.g., a model of the fuel-power balance), since with the existing method of planning, when every planner deals only with one specific fuel, it is impossible to obtain satisfactory results.

A. Kaplan (Siberian Branch of the USSR Academy of Sciences) spoke of the elaboration of mathematical methods and programs for solving economic problems and, in particular, a problem for the Altai Tractor Works on the ordering and cutting of sheet metal.

Considerable interest was shown in a report by A. Aganbegian that dealt with the research being done by the Laboratory of Economic-Mathematical Research of the Institute of Economics, Siberian Branch of the USSR Academy of Sciences. The Laboratory is working on the distribution of industry, improvement of the methods of planning industrial enterprises, and some sociological researches. In particular, he told of the solution of the problem of optimum specialization of hardware manufacture in the Novosibirsk Economic Council, optimum specialization of semi-finished fiber products in the pulp and paper industry, optimum location of means of communication, and distribution of fishing vessels in fishing areas.

A characteristic feature of the laboratory's work is that it is carried out under business contracts with the organizations concerned. Aganbegian noted that work under contract is justified when there exist tested methods. The client is provided with several solutions for different conditions and criteria. Several sociological studies have now been undertaken. They involve not only economic factors, but psychological factors as well. Such work has never been undertaken in the country before.

A. Nekrasov (Siberian Branch of the USSR Academy of Sciences) described several projects relating to the fuel-power balance, and the elaboration of a program for settling accounts between power suppliers and consumers when the consumers are many and diverse.

A. Dlin of the Moscow Regional Economic Council told of an interesting experiment in organizing communications with enterprises along communication channels. He suggested that scientific methodological departments be set up in the economic councils to plan, summarize and control the introduction of new problems.

I. Safronov (Computer Center, USSR State Planning Committee) dealt with the question of rational organization of economic computer centers, especially with combining the whole complex of computer techniques, both electronic and perforation.

N. Fetisov, L. Mints, and I. Safronov proposed expanding work on the general and organizational problems of introducing mathematical methods and electronic computers into planning practice, strengthening ties with the personnel of planning agencies and design institutes, and making this work a matter of state importance.

A. Kaplan, (Siberian Branch of the USSR Academy of Sciences), V. Karmanov (Moscow State University) and others indicated that libraries of standard programs are being organized at many computer centers. The conference endorsed this.

In his concluding speech, Academician Nemchinov noted that the principal task in research and practical work is that of improving the system of information and adopting it to the new technologies, and of creating a system of standards that can serve as the basis for all planning estimates.

The conference recorded in its decision that the immediate task of all organizations working in the area of applying modern mathematical and computer methods in planning and economic analysis is to expand their research on developing economic-mathematical models and to introduce them into national economic planning practice.

The conference also called for an improvement in the organization of scientific work.

The Scientific Council was instructed to

ensure regular control over the progress of work in the coordinated organizations, to prevent excessive parallelism in research, and to discuss reports from organizations on the fulfillment of their most important research themes at regular sessions.

Voprosy ekonomiki, 1963, No. 4

G. Prudenskii

MATHEMATICAL-ECONOMIC METHODS AND PROBLEMS OF THE ORGANIZATION OF PRODUCTION*

Further elaboration of a scientific system of planning and industrial production now requires an organization of economic research in which contemporary mathematical methods can be used to an ever increasing extent. It is expecially important to apply such methods in the economics and organization of production.

A plan for economic research on the economics and organization of production in Siberia for the next two years was discussed and adopted in October 1962 by the Joint Scientific Council for Economics of the Siberian Branch of the USSR Academy of Sciences, in collaboration with practical workers of industrial enterprises of Siberia and representatives of the RSFSR State Planning Committee, the Supreme Economic Council of the RSFSR, the State Committee of the RSFSR Council of Ministers for Coordination of Scientific Research, and the councils for coordination and planning of the activity of economic councils. A characteristic feature of the plan is a new territorial coordination of scientific research to eliminate overlapping and concentrate the efforts of Siberian economists and those of central institutes on the crucial problems of development of the productive forces of Siberia. Another essential feature of the new coordination plan is an organization of the research so that mathematical-economic methods constitute an organic element -- whether the question be the distribution of production and new enterprises, or the organization of labor and the utilization of manpower in Siberia. Finally, the Laboratory of Economic-Mathematical Research of the Institute of Economics and Organization of Industrial Production of the Siberian Branch of the

*This article contains the main propositions of a report delivered by the author at the Conference on the Exchange of Experience and Prospects for the Application of Mathematical Methods and Electronic Computers in Planning, held in Novosibirsk, October 17-19, 1962.

The author is a Corresponding Member of the USSR Academy of Sciences.

USSR Academy of Sciences has been made the leading organization for a number of the research themes.

Of special importance at present are three main groups of problems into which the investigation of the economics and organization of production in our country can be subdivided: the economics and organization of labor; the economics and organization of means of production; and problems of controlling and planning production.

In the area of the organization of labor, extensive experience has been accumulated in the use of mathematical methods for studying outlays of working time. One of them — the method of instantaneous observations — has been extensively used in studying working time reserves and the utilization of equipment and has become part of the equipment of the statistical agencies.

The task of determining the optimum combination of operations and functions in the organization of labor still presents many unsolved problems requiring the most serious attention on the part of economists. Such investigations were carried out at the Ural Machine Plant in 1939-1940 in connection with the development of multi-machine-tool servicing and the combining of occupations. We refer to the method of standardizing multi-machine-tool operations on the basis of the theory of probability. The research was not, however, advanced beyond the experimental stage. Further investigations are needed, and the Institute of Economics of the Siberian Branch of the USSR Academy of Sciences intends to carry them out on the basis of some propositions of the theory of combination.

The use of mathematical methods and electronic computers in establishing labor standards has received very inadequate elaboration. The research should begin with mass production, though there have already been experimental investigations for serial and individual types of production. In particular, the Gorky Designing-Technological Institute has been working successfully along these lines for several years. Some problems of mathematical-economic analysis of wages, the effect of skills on the productivity of labor, and systems of pay scales and pay rates have been discussed in the press. The latest computing technique has been widely used aborad for the calculation of wages. It is clear that this experience must be studied thoroughly and applied widely under our conditions.

Problems of the effective use of means of production are directly linked to problems involved in the modeling of production processes. The main direction here is the establishment of an optimum production process, which is the basic task of a rational organization of production. This is a vast and complex problem that embraces many questions like the charging of equipment, the best utilization of production capacities, the rhythm of production, the most effective use of primary materials, the choice of the technological conditions of operation, etc. Such complicated technical-economic problems require an integrated economic and technological-industrial analysis using electronic computers and other kinds of modern computing techniques.

Attempts at solving some problems of calender and technological planning have been made in the past three odd decades. However, their solution, without the application of latest mathematical methods, was rather ineffective. For example, numerous prewar attempts to determine the optimum labor requirements per unit of output were not successful. Wider possibilities for the solution of these problems appeared only with the enrichment of economics by new mathematical-economic techniques.

Production processes must be made optimum at all stages and in all sectors of social production. Unfortunately, no such overall mathematical-economic model has yet been devised. Therefore, only particular problems, which are not integrated into an overall problem to find the best variant of the production process as a whole, are solved at present as regards the organization of production (e.g., the determination of the optimum loading of equipment). A standard mathematical-economic model has been worked out for solving such particular problems. Questions of the utilization of

transport facilities, agricultural machinery, industrial equipment, etc., can be reduced to this standard model. In its conventional formulation, this static problem is a particular case of the tasks of linear programming, or what is known as the distribution (lambda) problem. In some cases it can be complicated by the introduction of additional conditions. Such problems are limited, however, primarily because they do not take into account the utilization of equipment over time, the sequence of the starting up of the parts, the production cycle period, the combination of operations, and several other factors. For that reason even a well-developed standard model of the production problem being considered cannot be applied in an overwhelming majority of sectors, not excluding machine-building. In practice, simple conditions must be selected especially for the model; consequently, conditions are selected for the model rather than models being selected for the conditions.

Problems for the optimum production program for a sector, workshop, or plant constitute kindred types of problems. Some of them are dealt with in foreign socialist countries. The ever greater transition to flow-line production represents a progressive tendency in the organization of production. It brings with it new problems having to do with establishing an optimum flow, selecting equipment for the flow lines, the loading of the lines, etc.

An important aspect of the problem of optimum processes of production is the rationalization of shipments. The shipment problem is known to be the simplest problem of linear programming. But in concrete conditions it is often necessary to solve problems involving optimum transportation routes (e.g., of trucks), which is a more complicated problem.

Extensive experience in this area has been accumulated at the Research Institute of Automobile Transportation, which has been engaged in fruitful research since 1959 to apply mathematical methods and electronic computers for planning and organizing automobile shipments. These problems are being dealt with at other laboratories and research institutions as well. In particular, the Economic-Mathematical Research Laboratory of the Institute of Economics of the Siberian Branch of the USSR Academy of Sciences has solved, at the request of the Siberian Academy Construction Agency, a problem for selecting the optimum routes of trucks. It was found that the same freight can be shipped by half the number of trucks, with considerably better economic performance indices. The problem's calculations took up only 39 minutes of electronic computer machine time.

Mathematical-economic methods are being used ever more extensively not only in machine-building but also in several other branches, and in particular in the chemical industry. Despite the specific problems stemming from the continuous nature of chemical production, the models and techniques worked out will apparently be applied in oil processing, food and other industries. Besides, they are important for general methodological purposes.

Special emphasis should be given to the need for further research into the rational utilization of raw and other materials. Problems of two kinds are generally dealt with here: first, rational cutting of materials, and second, optimum mixtures (above all in the chemical and oil-processing industries). We should mention, in particular, the work done by the Mathematics and Economics Department of the Mathematics Institute of the Siberian Branch of the USSR Academy of Sciences on the optimum cutting of rolled sheet metal for the Altai Tractor Plant. A study has been made to determine the optimum plan for the production of semi-finished wood fiber products in the pulp and paper industry, which makes it possible to disclose the main trend of development of the pulp industry at the present stage. Of course, there are many other types of problems connected with the rational utilization of materials, problems whose solution requires further experience on our part (the choice of primary materials for the elements of machine construction, designing of cutting instruments, etc.).

As for the problems involved in determining optimum technological conditions, these have not, unfortunately, received extensive treatment,

though some research institutions (for example, in Gorky, Minsk, Rostov, etc.) have accumulated valuable experience, especially in machine-building. Investigations are also scheduled for other industries. The experience in this field of the democratic countries, especially of the Hungarian People's Republic, should be used more extensively. In Hungary such investigations have been conducted successfully not only at research institutions, but also at large enterprises like the Dunaievvares Metallurgical Works and the Csepel Works (where there are special cybernetic teams which are increasingly important in the control of production). The method of simulation, which makes it possible to "play" the entire course of the technological process on an electronic computer and choose the best variant, is quite promising in this respect.

The organization of information on the process of production, and, in particular, the automation of primary accounting, are essential for operative solution of problems of the optimum technological processes. Unfortunately, the standard rating system, accounting, reporting, and technical and technological records at many enterprises are in a state precluding the application of contemporary mathematical methods and electronic computers for the organization of production. There are also major defects in the obtaining of essential information. Thus, the utilization of equipment is calculated mainly by time studies involving many time-study specialists. It would therefore be expedient to develop the mass production of instruments for the automatic calculation of the utilization of equipment.

Automation of the collection of technical and technological information is a special problem which involves the coding of technological charts, blueprints, etc. Work is in progress along these lines, in particular, at the Gorky Automobile Plant, where they have worked out and are introducing calculations by electronic computers of the technology of processing parts, with the computers themselves picking up the data off the drawings. Definite headway has been made in this area at the Institute of Cybernetics of the Ukrainian Republic and at several other organizations.

The most encouraging trend in the establishment of optimum technological processes is their integrated modeling, which combines the automatic collection and treatment of information and the posing of technical-economic problems on the basis of the information thus collected and processed. The results of the optimum solution can immediately be introduced with the aid of automatic control of the course of the production process. This integrated modeling requires the extensive application of different mathematical methods — those of mathematical statistics, optimum programming, and cybernetics. At the same time, it requires the development and utilization of an array of modern technical means, from transducers to electronic instruments for regulating and controlling production. It is also obvious that integral modeling of the process of production is closely linked with its integral automation. It is expedient to introduce it first for automated sections. Such work is being conducted at several advanced enterprises which the government has decided to transform into model enterprises of integral automation.

It would be wrong, however, to abandon at this stage the simpler means of solving technical-economic problems, and, in particular, punched card equipment. The Laboratory of the Economics and Organization of Production of the Zlatoust Metallurgical Plant has accumulated considerable experience in this respect. The laboratory has been successfully using mathematical statistics and punched card computers to study the outlays of working time and the utilization of equipment, to determine technical-economic standards, etc. There has been experience in the use of such methods and forms of work at Rostov, Kharkov, Moscow, and some other cities of the country.

Attention should be directed to the need for a thorough treatment of problems concerning the economic effectiveness of the introduction of new equipment and organization of production. A number of investigations in this field are in progress in Moscow and elsewhere.

Development of the methodology for economic analysis and planning of enterprise performance indices by multiple correlation methods is a highly promising trend, in our opinion. The multifactor correlation models of labor productivity costs of production, and profitability will contribute to better substantiated plans. Such models establish the quantitative dependence and the closeness of correlation between the indices planned and their determinants, as well as between these determinants themselves. The laboratory within the Department of Economics of the Kharkov Engineering and Economics Institute has accumulated useful experience with respect to these calculations. Using the methods of multiple correlation, the laboratory is working on the substantiation of long-range standards for machine-building enterprises. Such investigations are also in progress at the Laboratory of Economic-Mathematical Research of the Institute of Economics of the Siberian Branch of the USSR Academy of Sciences. The target is to construct the correlation model of labor productivity, costs of production, and profitability, taking into account a considerably larger number of factors, which will make the model more accurate. A program of multiple correlation for electronic computers has been drawn up which will make it possible to take scores of factors into account simultaneously, and work is about to be completed on the construction of a nonlinear model of multiple correlation with a hundred factors. Work is also in progress on utilization of the methods of multiple correlation for establishing the connections between the economic indices of the performance of an enterprise in order to identify the indices which best characterize this performance. In other words, the problem is to single out those economic indices in the system of indices characterizing the given process which would furnish information as its most rational course. Employing the theory of information, the laboratory has worked out methods for such calculations. They have been applied experimentally to disclose the best index for describing the fulfillment of the plan and industrial production growth, on the basis of data secured in a special survey by the USSR Central Statistical Administration.

Multiple correlation methods are especially promising in the substantiation of economic-planning standards, such as the standards for overhead expenses, managerial personnel, circulating assets, etc. A new trend in the use of multiple correlation methods is their application for determining the optimum size of an enterprise (a mine, a lumbering enterprise, a state farm, etc.) in those cases when this size depends on a large number of factors and does not lend itself to calculation by other methods. It should be borne in mind, however, that each factor operates in a certain interdependence rather than in isolation. Therefore, such calculations are arbitrary to a certain degree, and must be checked carefully in the course of economic analysis.

As for the problems of controlling and planning production, there have appeared at least four main trends involving the application of mathematical methods in the analysis and planning of the operation of enterprises: 1) attempts to achieve optimum economic indices of the performance of an enterprise with the aid of linear programming and other mathematical methods; 2) use of multiple correlation and other methods of mathematical statistics in analysis and planning; 3) construction of a matrix model of the technical-industrial-financial plan; 4) treatment of production control problems with the aid of cybernetics. The development of new methods of calender planning can also be singled out as an independent trend in this field.

Under the present-day conditions, the problems of improving the planning, control and operation of enterprises become of increasing importance. Our Party Program emphasizes the need for improving the planning of the operation of enterprises in order to enhance their interest in higher plan targets, the spread of advanced experience, the introduction of new equipment, and the fullest utilization of the available intra-enterprise reserves of production. The application of mathematical methods to the solution of these problems would be of immense value and

would advance the development of the theory and methodology of the analysis, planning, and control of enterprises.

The available experience in employing mathematics in planning makes it possible to determine the role of the economist in both research and production. The application of mathematical methods in economics usually begins with the statement of the economic problem itself, the selection of data for solving it, and the development of an mathematical-economic model. At this important stage it is the economist and economic theory that are decisive. Hence the introduction of mathematical techniques in the organization of production, far from absolving the economist from his economic responsibilities, implies painstaking economic research, improvement of economic work in industry, and the development of research to the required stage of theoretical generalization. When the problem has been formulated and the information collected, the mathematician comes to the fore. However, analysis of the numerical results of this work again requires the active participation of economists, specialists, and engineers. Therefore, economics must advance in order to ensure the extensive application of mathematical methods in industrial production.

Thus, the extensive application of mathematical methods and electronic computers in the economics and organization of production largely depends on the economist himself. However, mathematicians must develop the most acceptable and practically expedient methods of calculation, especially in the solution of integrated problems (integrated analysis of reserves, integrated development of economic areas, etc.). Specialists in electronics, who are called upon to improve the designs of electronic computers, have an important role to play. Cheap and small electronic computers, simple in operation, are necessary for the extensive application of electronic computers in the economics and organization of production.

Numerous laboratories must be set up at industrial enterprises to provide solid facilities for the application of mathematical methods in planning. Such laboratories should be set up first at the larger enterprises.

We have entered upon a new stage in the joint work of economists and mathematicians; this stage involves their genuine cooperation and not just their "coexistence," as before. This friendly, creative work raises economics to a higher level, for, as Comrade N. S. Khrushchev put it at the 22nd Congress of the Party, "Life itself demands from planning and management a new, much higher order of scientific substantiations and economic calculations."

* * *

Price Policy

Voprosy ekonomiki, 1963, No. 2

V. Diachenko

THE SYSTEM OF PRICE-FORMING FACTORS AND THE PRINCIPLES OF THEIR CLASSIFICATION

The November 1962 Plenary Meeting of the CPSU Central Committee drew attention in its resolution to the need for raising the scientific level of national economic planning. One serious flaw here, the Plenary Meeting pointed out, is that economic plans are not always based on careful economic calculations. An important obstacle in the achievement of the necessary soundness of economic plans is the grave defects in existing system of price formation. "An abnormal situation has arisen in setting the prices of industrial goods," Comrade N. S. Khrushchev pointed out in his report at the meeting. "Without a proper solution of the problem of price formation and the establishment of scientifically based prices, it is impossible to eliminate many serious shortcomings in the planning of production, to introduce complete cost accounting, and to provide conditions for the profitable operation of enterprises." Confusion in the price system makes it difficult to determine the economic effectiveness of production, capital investments and technical progress, and undermines implementation of the principle of material incentive.

The propositions contained in the CPSU Program are of tremendous importance to research on price formation and improvement of the price system. Price improvemnnt in accordance with these propositions will make for more effective use of the cost levers of economic management, since most of the indices of development and improvement of socialist production depend on an economically substantiated price system. The extensive revision of wholesale prices in heavy industry and of freight transport charges currently under way in accordance with a party decision constitutes an important stage toward this goal. Later, wholesale prices will be revised in the light and food industries.

The fact that prices can be systematically fixed and revised in accordance with the objective needs of social development constitutes one of the advantages of the socialist economic system over the capitalist system. But for this

The author, a Corresponding Member of the USSR Academy of Sciences, is head of the Department of Price Formation of the Academy's Institute of Economics.

advantage to be properly used, we must know what determines the level, relationship and dynamics of prices as a whole and for individual types of output, what factors go into planned price formation, and how they do so. One of the principal reasons for the shortcomings in price formation is that inadequate account is taken of the system of price-forming factors and of the influence each of them exerts individually and in their interconnection.

By price-forming factors we mean only the existing or potential objective circumstances affecting the level of prices in one way or another. Hence, knowledge of the factors going into the fixing of planned prices is tantamount to revealing and utilizing the operation of the objective laws of price-formation in national economic planning. It goes without saying that the system of price-forming factors must reflect the peculiar features of the socialist economic system and be predetermined by its basic principles: protection and consolidation of public socialist property, planning, subordination to the development and perfection of socialist production, steady improvement of the material and cultural standards of the people, strengthening of the alliance between the working class and the peasantry, etc.

Price is the monetary expression of value, the magnitude of which is determined by the socially necessary outlays of labor. It is therefore necessary, first of all, to distinguish between the factors influencing prices through changes in the socially necessary outlays of labor and the factors that cause prices to deviate from value. This distinction is of fundamental importance.

The main cause of the differences of opinion that have arisen in the discussion of the fundamentals of price formation in a socialist economy has been the confusing of two different questions: 1) What determines value? and 2) Does value serve as the immediate basis of planned price formation? This confusion, in turn, resulted from identification of the indices employed to calculate value with the factors determining value.

We know that our current bookkeeping and statistical accounts do not contain such indices as value or socially necessary outlays of labor. Our accounting deals not with value but with forms of value: cost of production, price, profit, etc. Value can be determined only with the aid of special calculations. The proposed methods of calculating value come down to this, that some proportion of the sum of the surplus product is added to production costs. This approach to the calculation of value is quite valid until we learn to determine the socially necessary outlays of labor directly in units of labor time. But some comrades do not stop there. They assert that the distribution of the surplus product constitutes a value-forming factor and that, therefore, the price of production or any other modified form of value expresses the socially necessary outlays of labor directly, and not through value.

Value is created in the process of production only; its magnitude is determined not by the conditions under which the product is sold or the newly created value is distributed, but by the conditions under which the product is created. Newly created value is divided into the necessary and the surplus product; it is not made up of them. Establishment of the proportions in which the newly created value and that part of it which corresponds to the surplus product are distributed is influenced by a number of factors, many of which do not affect the magnitude of value (political factors, for instance). Before the surplus product is distributed, it must be created. To attribute to the distribution of the surplus product the role of a factor determining value is to deny the uniform substance of value: this leads to as many different formulas of value as there are ways of distributing the surplus product. It is equally incorrect in principle to include among the value-forming factors the utility and scarcity of the articles, since this leads to a denial of the objective character of value.

To establish the factors affecting price through changes in the socially necessary outlays of labor, we must proceed from the following proposition.

1) Value is created by living human labor.

2) Value cannot be identified with labor, as it is a specific form of expression and regulation of the social costs of production relating only to commodity production. The prices of commodities express directly not the outlays of labor, but the value determined by the outlays of labor. 3) The value of each commodity includes the value transferred to the new product and the newly created value. The relation between these two parts differs with different industries and changes with time.

To produce a particular commodity, fixed and circulating assets and trained workers are required. This does not mean, however, that the investments in production assets (like the costs of labor training) must be included among the items determining the socially necessary labor required to produce the given commodities. Outlays to create conditions for production are also socially necessary, but they are a result of this or that distribution of the value of the aggregate social product. They are made out of the surplus product created in the preceding reproduction cycles, and they are reflected in the value of the given product through the increase of the transferred value.

The amount of living and materialized labor spent on a unit of output depends upon the technical equipment per unit of labor, the organization of production and labor, the skill and efficiency of the workers, and the natural working conditions. As production technology develops and improves, the total outlays of labor per unit of output decrease, the share of the transferred value in the aggregate value of the products of labor rises and that of newly created value declines.

The socially necessary outlay of labor required to produce commodities is the amount of labor required under socially normal production conditions of average skill and intensity for the given time, and only within the limits of the social demand for the given type of product. They cannot, therefore, be viewed apart from the proportions of reproduction. In an unorganized economy, the volume of social demand acts through fluctuations in supply and demand. Under conditions of planned material and technical supply, where the supply and demand mechanism is inoperative, the effect of this factor may make itself felt in a disproportion between the commodities produced and the structure of consumption and in the building up of above-plan and superfluous stocks of commodity-material values.

The fact that the social demand for the products of labor is taken into account in calculating value does not at all mean that it is determined by the demand for the given commodity. The social demand merely indicates the limits within which the production conditions are deemed socially normal and conforming to the socially necessary outlays of labor. For example, if the social demand for a given product is 1,000 units and the existing factories produce or can produce more than this amount, the socially normal conditions for the production of the given commodity will be those which characterize a more efficient group of factories capable of putting out 1,000 units.

The volume of social demand is also related to the effect of natural conditions of labor on the magnitude of value. The need to satisfy social requirements where there is a scarcity of land dictates the use even of the worst plots of land. Under capitalism, the principle of adjustment to the worst natural conditions of employment of labor and capital fully conforms to the pursuit of profit as the aim of capitalist production. Under socialism, application of this principle may be dictated only by the need to secure, on the basis of cost accounting, normal conditions of reproduction on farms and in enterprises using the worst plots of land. Orientation toward the average-zonal conditions of production in agriculture and the extracting industries means that society regards the high actual outlays of labor on the worst lands merely as an indication of the shortcomings of production specialization or of the need to make greater investments in these lands at the expense of society as a whole. Natural labor productivity depends on how the land and its natural resources are used. Hence, the socially necessary outlays are those for producing crops or raw materials which are best suited (given

the existing development of the productive forces) to the specific natural conditions.

In those industries where natural labor productivity plays an important role, the level of socially necessary outlays of labor may vary with the seasons or cycles (different crop yields, varying productivity of mineral strata, etc.). It follows that changes of prices in dependence upon the harvest cannot be regarded merely as a deviation of the price of the agricultural produce from its value.

The social costs of production are not limited to expenses in the production sphere; they include supplementary expenditures connected with the continuation of the production process in the sphere of circulation. Here transportation costs play the main role. The value of each article transported is enhanced by the cost of transportation socially necessary to deliver it to the point of its consumption (consumer goods to the place of sale). This is where the geographical factor (location of production and consumption or sale of the product) affects the size of the socially necessary outlays. Since transportation costs objectively depend on distance, prices f. o. b. station of departure are best suited to the task of bringing prices closest to the socially necessary outlays of labor.

Depending on the framework of the social division of labor, production of goods may be of national or local importance. The natural resources may likewise be used either locally or nationally. Transportability of products is one of the major criteria for such delimitation, as the maximum socially necessary transportation distances may be either national or regional, limited to certain gravitation areas or to the boundaries of the local market. All this serves as a basis for the formation of regional or local levels of socially necessary outlays of labor, which are the basis for the territorial differentiation of prices.

A generalized index showing alterations in socially necessary labor outlays may be the dynamics of labor productivity, it being determined in the main by the same factors that determine the socially necessary labor outlays. However, in applying this index the following points must be taken into account.

First, the data of the current statistical accounts include the changes in labor intensity in the labor productivity index. But labor productivity and labor intensity affect the socially necessary labor outlays differently.

Second, with the growth of labor productivity, the value transferred to the new product per unit of labor time increases and the relationship between the newly created and the transferred values in the aggregate value of the products changes. It follows that although increased labor productivity results, in general, in a reduction of the socially necessary labor outlays per unit of output, this reduction is not inversely proportional to the growth of labor productivity. The relationship between the dynamics of productivity and the dynamics of the value of a unit of output differs for branches of industry (in connection with the existing ratio between living and materialized labor) and depending on how the increase in labor productivity has been brought about.

Third, a rise in the workers' skill as a factor in increasing labor productivity may result (especially in connection with technical progress) in labor becoming more complex, producing greater value per unit of labor time. This too has the effect of upsetting the inverse proportionality between the dynamics of labor productivity and the dynamics of value of a unit of output.

Fourth, labor productivity data are unrelated to the social demand for each product, while only the labor outlays within the framework of the social demand are socially necessary. Hence, the dynamics of labor productivity, while reflecting the growth of physical output, may not reflect the shifts in the value of the output.

To avoid the distorting effect of the changes in the ratio between the transferred and the newly created values accompanying the changes in labor productivity, a productivity index calculated on the basis of net output should be employed. It is easy to see that it is precisely such a productivity index that conforms to the Marxist dictum that value is created by living human labor.

The labor productivity index must be applied in the daily practice of price formation since it can be easily determined by the current accounts

data. But it must not be forgotten that this index is, for the reasons explained above, a conventional, purely orientational, approximate index. To analyze and periodically revise the existing price system, it is necessary to calculate the socially necessary outlays, even if the results of this calculation are not absolutely precise. In any further elaboration of the methods of calculating the socially necessary labor outlays, the costs connected with the continuation of the production process in the sphere of circulation and the volume of social demand for each product should be taken into account. The value of the transport production should be "distributed" over the various industrial and agricultural products in accordance with the distances they are carried and their transportability. Obviously, without a proper account of the indicated costs in the circulation sphere and the social demand for the given product, the calculation of value may be distorted as a result of the actual deviations from the socially necessary outlays. This is precisely where the methods of calculating socially necessary outlays of labor proposed earlier are defective.

The socially necessary labor outlays are the basis of price formation. It therefore follows that, in accordance with the instructions of the CPSU Program to the effect that prices should more fully reflect the socially necessary labor outlays, the factors influencing prices through the magnitude of value or the socially necessary labor outlays should determine the main direction of price changes, while the other factors should be taken into account only to the extent that they are required to justify those deviations of price from value which are objectively dictated by the needs of economic development.

The possibility of price diverging from value is inherent in price itself, which represents a monetary, i.e., indirect expression of the socially necessary labor outlays. As a result of these divergencies, part of the value of some commodities is realized in the proceeds from the sale of other commodities or fails to find an expression in price at all; the real incomes of the enterprises and population change, the incentive to produce and acquire the particular commodities either grows and strengthens or declines and vanishes.

The fact that the general movement of prices in the socialist economy is based upon the dynamics of the socially necessary labor outlays does not preclude the possibility and necessity of prices deviating from value under the pressure of economic needs. One cannot reduce the laws and tasks of planned price formation merely to calculating and the most accurate reflection of the social costs of production, i.e., to the accounting function of price. The building of communism requires that price be comprehensively used in all its functions. Underestimation of the factors making for the objectively necessary deviations of prices from value can only have negative effects. Price formation involves not only a monetary account of the socially necessary labor outlays but also economic stimulation of the development and improvement of production, the establishment of correct relations between town and countryside and between the working class and the peasantry, proper proportions between the volume and structure of production and consumption and between the distribution of the social product and monetary incomes, the problem of the real incomes of the population, etc. While value reflects the socially necessary proportions in the distribution of labor, prices serve also as a means of achieving these proportions. It is therefore necessary to take into account the entire system of factors affecting the level and relationship of prices.

Deviations of prices from value may be due to various circumstances, which may be reduced to the following basic groups: a) the need for a certain level of profitability; b) an account of the consumer properties of the goods produced; c) an account of the social significance of certain types of output; and d) matching supply and demand.

Fixing the prices of goods in exact accord with their value means that there will be substantial differences in profitability for the different lines of production, industries and enterprises. This is due to the interbranch and intrabranch differences in the rates of surplus

product, the amounts of labor, material and assets required per unit of different goods, and the level of labor productivity and cost of production. Since labor embodied in the means of production does not create new value, it follows that, other conditions being equal, a higher proportion of wages in the cost of production (larger labor consumption) means that in producing the given commodity the enterprise creates more surplus value even if its rate is the same. As a result, the rate of profitability is higher. And, on the contrary, a higher proportion of outlays on the means of production in costs (more materials and assets per unit of output) reduces the relative size of the surplus product and the rate of profitability. Further, inasmuch as more productive labor within a branch creates more value, any rise in productivity (provided wages fail to rise in the same proportion) means both an absolute and relative increase in profitability. The prices of finished goods being the same for all enterprises, the total mass of the surplus product is distributed, as it were, among the enterprises producing the given commodity in proportion to its output and in inverse proportion to its cost. The relative cost of transport is of great importance: the higher the share of transport charges in the cost of production, the lower is the relative and absolute rate of profitability.

On the scale of the national economy, interbranch differences in level of profitability are of no substantial significance, for they do not predetermine the distribution of social labor among the branches of industry. The situation is different as regards different enterprises of the same industry and different lines of output within one and the same enterprise. Cost accounting demands that each normally operating enterprise receive a certain profit and that each enterprise have a material interest in producing the assortment of goods required by the economy. On the collective farms, the level of profitability must be high enough to ensure the needs of expanded reproduction on each farm.

The level of profitability can be brought into accord with objective needs, first, by a change in the cost of production; second, by direct redistribution of monetary accumulations (deductions, taxes, etc.); and, third, by fixing prices that deviate from value. In the last case, ensuring the required profitability acts as an independent price-forming factor.

The objectively necessary branch level of profitability, dictated by the needs of expanded socialist reproduction, is attained through fixing wholesale prices in industry and zonal procurement prices (purchase prices for the collective farms, delivery prices for the state farms). To ensure the profitability of enterprises operating under worse than average conditions, use is made of wholesale prices that are oriented, in one measure or another, on individual costs. The effect of transport costs is neutralized by applying the c.i.f.-station of destination system.

A general principle applied in assessing the consumer qualities of commodities for purposes of price fixing is that commodities with the same consumer qualities must be uniformly priced, in other words, that there must be a single price for an equal satisfaction of consumer needs.

By consumer properties of goods considered in price formation, we mean: a) the quality of the different samples of one and the same commodity; b) the interchangeability of different commodities in industrial or personal use; c) the conjunction (interconnection) of different commodities in the process of reproduction as objects of labor, means of labor and finished products. Price relations should conform to the quality and interchangeability of the commodities and take into account the conjunction of the different commodities in the process of reproduction. Since there cannot be complete conformity between the social costs of production of the various commodities and the economic effect obtained from their use, a divergence between price and value must exist. As a result, the consumer qualities of commodities serve as a price-forming factor: fixing of prices in accordance with the consumer qualities of the commodities causes the prices to deviate from value and part of the value to be redistributed through the price system. The price system should stimulate the achievement of a rational structure of production and consumption and savings in

outlays, and take into account changes in the demand for the consumer properties of commodities resulting from technical progress.

The basis for differentiating prices in dependence on the quality of the products is that higher quality is tantamount to a saving of social labor, since quality to some extent replaces quantity. Differentiation of prices should stimulate higher quality by bringing profitability to the producer and extra benefits to the consumer. For the quality of a commodity to be taken into account in the formation of its price, a scientific system of indices or criteria for assessing the quality in each homogeneous group of commodities must be worked out and checked in practice.

The interchangeability of products in the fixing of planned prices must be taken into account with a view to the economic effectiveness with which one and the same need is met by different products. This will make it possible to promote a rational structure of production and consumption of interchangeable products, replacement of commodities in short supply by others, the introduction of new, economically more advantageous and more progressive lines of output. This factor can be accounted for in price formation by the fixing of a single price on all interchangeable products in terms of some conventional unit of utility, and also by making the prices of the interchangeable products dependent upon the price of the principal product. For this factor to be taken into account in price formation, a system of technical-economic indices of interchangeability in industrial or personal use should be worked out by groups of products.

The contiguity of the different links of the reproduction process serves as a basis of chain connections in price formation. An account of contiguity in planned price fixing should be based upon the socially necessary outlays of labor. Deviations may be caused by marked differences in labor productivity at the enterprises successively processing the primary material and by other factors affecting the profitability of the enterprises. An important area for considering contiguity is the establishment of a proper interconnection between the prices of the means of production for the countryside and the prices of farm produce. The basis for determining and accounting for contiguity should be the interbranch balances.

The social significance of the products of labor also depends on what needs they meet. The socialist state has used the price system extensively (by cutting and, sometimes, raising prices) for such social purposes as the maintenance and education of the growing generation, health protection and the speedy advancement of culture, lightening domestic chores and drawing women into public life, etc. Achievement of these social aims may be regarded as a special kind of price-forming factor. In the period of the comprehensive building of communism, the need for such differentiation of prices does not disappear, and may even be enhanced in some cases in view of the growing role of public consumption funds and the preparation of conditions for the transition to free distribution.

The relation between supply and demand is one of the factors that determines, not the magnitude of value, but the deviation of prices from value. In the socialist economy, this factor undoubtedly operates in retail trade. The July 1960 Plenary Meeting of the CPSU Central Committee called for the practice of revising retail prices to be improved so as to make them reflect more fully the labor requirements per unit of output and the changes in demand. A price system that does not take sufficient account of the relationship between supply and demand artificially increases the shortage of some goods, causes speculation in them, acts as one of the causes of the stocking up of other goods in the trade system, and has an adverse effect on money circulation. At the same time, this makes itself increasingly felt in the circulation of the means of production, and first of all in the relations between the state and collective-farm production sectors.

To determine the character and extent of the influence exerted by the relationship between supply and demand on prices, and to make sure that this influence is reflected in the planned prices, it is important to bring out the factors conditioning the relationship between supply and

demand. A distinction should be drawn between the following disproportions: a) short-term disproportions due to relatively independent changes in the volumes and structures of production and demand, and long-term disproportions created by modernization of the economy or by a faulty or insufficient account of supply and demand; b) regular (such as seasonal changes in production and demand) and sporadic disporportions (changes in demand under the influence of fashion); c) general and local disporportions; the former usually reflects discrepancies between the volumes and structures of production and consumption, the latter — defects in planning and organizing trade.

Supply and demand should be balanced primarily by adjusting the structure of demand to the most rational structure of supply at the given period and by expanding output in accordance with the growth of effective demand. As goods and food products become abundant, the need to deflect prices from value in order to balance supply and demand gradually diminishes, continuing only where output of a particular commodity cannot immediately be stepped up to fully meet the demand for it.

The role of price, however, consists not in automatically balancing supply and demand but in actively shaping them. The price system will continue to act as one of the means of shaping demand in connection with the tasks of communist construction. It must be borne in mind, however, that differentiation of prices with a view to influencing the relationship between supply and demand is possible only under certain economic conditions, without which it becomes inexpedient:

1) for a real price reduction output must be increased enough to cover the increase in effective demand;

2) account must be taken of the elasticity of demand, which is conditioned by the nature of the individual requirements. Price reductions on goods in daily, inelastic demand, while resulting in only small increases in the purchases of them, have the effect of releasing resources for enhancing the demand for other, more valuable goods. Unless the output of the latter is stepped up beforehand in sufficient quantities, shortages will ensue, with all the consequences therefrom. Price reductions on goods in highly elastic demand lead to a speedy increase in their sales to the point of satiation of the demand for them;

3) special attention must be given to the interchangeability of different goods. Reduction of the prices of some goods causes a decline in the demand for other, interchageable goods and may cause or aggravate the irrational use of goods sold at reduced prices.

It is important to ensure elasticity of the prices themselves, to correspond to the tasks of taking account of and shaping demand. This is done with the aid of seasonal prices and the recently introduced system of temporary price rises on new types of commodities of personal use. (1)

The divergence between price and value cannot be endless. The lowest limit, beyond which the objective basis for cost accounting is undermined, is the cost of production; the upper limit is determined by the income level and is connected with the interchangeability of commodities. The fixing of prices below costs of production is permissible only in special circumstances, and only as a temporary measure. Excessively high prices limit sales and consumption, and are also possible only within certain bounds.

* * *

Of great importance to the theory and practice of price formation is the delimitation of stable and transient divergencies of prices from value. This division is related to the question of the modification of value.

We know that under capitalism, owing to the operation of its economic laws, value is modified into the price of production, which expresses stable divergencies of commodity prices from value. The price of production becomes the immediate basis for the prices, the center of their fluctuations under the impact of supply and demand. The principle of "equal profit on equal capital" expresses the essence of this form of value modification.

There is no reason to consider that socialism necessarily implies a return to value as the immediate basis of price formation, for the aim of socialist production is not simple commodity production. On the other hand, the price of production represents a modification of value that does not conform to the character and laws of socialist production. And if some economists still regard the price of production as a socialist modification of value, it is not because they do not see the difference between socialist and capitalist economies but because they do not find any other modification better suited to the socialist economy.

The price-formation practice permitting the existence of different price levels very remotely related to the calculated costs of production interferes with disclosure of the law that would govern a stable, unavoidable deviation of prices from the socially necessary production outlays under socialist conditions. Herein lies the significance of the experimental verification, now under way with the aid of electronic computers, of the different conceptions of the socialist modified form of value as the direct basis of prices.

Stable deviations of prices from value may be caused by the need for: a) ensuring a certain profit to each enterprise (cost-accounting profitability); b) ensuring a national economic profit to each branch of production; c) taking account of the consumer properties of the goods produced.

In the first case, the principle would operate that each enterprise fulfilling its plan must make at least a minimum profit regardless of its technical equipment per unit of labor. The justification for this principle would be the creation of material incentives on the basis of cost accounting. This would mean in practice that prices would be based on the cost of production in the organizationally and technically most backward enterprises, on the highest cost of production. It is easy to see that such modification of value would be tantamount to retarding technical progress, the development and perfection of socialist production, which contradicts the basic economic law of socialism. Each enterprise must apparently be ensured cost-accounting profit not through modification of value, but by fixing its wholesale (or calculated) prices and differentiating the deductions from its income into the budget.

In the second case, the basis for the modification of value would be provision of the necessary resources for the needs of expanded socialist reproduction. For such a modification the ruling principle would be that each branch of industry takes an equal part in the creation of public funds, this being assured by a corresponding rate of branch profitability as expressed in prices.

The third variant of the socialist modification of value would be based on the principle of an equal price for an equal satisfaction of a need. The basis of such a modification is the fact that socialist production is not subordinated to the extraction of profit but aims at meeting the diverse social and personal needs of the members of society, the important thing being not the volume of output as such but a fuller and more effective satisfaction of the need for a given product.

We do not yet have a complete scheme of this variant of modification of value, although, in connection with the fight for higher quality of output, the suggestion has been made in the press that the volume of output should be calculated with a view to the national economic effectiveness of its various components. Prices should correctly reflect the quality of the goods produced, stimulate improvements of quality, and take into account the interchangeability of various commodities, which is also connected with the consumer properties of the commodities. Writing in the Ekonomicheskaia gazeta (October 27, 1962), V. Zhigalin, Chairman of the Moscow City Economic Council, justly remarked: "The present practice of assessing the economic efficiency of machines by the cost of production is absolutely unsuitable to socialist economic conditions. A machine should be assessed only as a complex -- in terms of the total technical-economic effect of its production, operation and maintenance."

An account of the consumer properties of

goods as a basis for modification of value is restricted by the possibilities of comparing the various consumer values. Hence, this principle of modification of value can, in our view, only supplement the modification based upon the provision of resources for the needs of expanded socialist reproduction.

Thus, among all the groups of factors causing prices to deviate from value, the ensuring of profitability and the consideration of consumer properties of the products attract most attention, as it is with them that modification of value appropriate to the socialist economy seems to be connected. The influence of these factors on the level and relationship of prices should be examined with particular thoroughness and care.

Irrespective of how important the calculation of the magnitude of value and its modification may prove to be in the fixing of planned prices, the most important role in price formation will continue to belong to the cost-of-production index. The planned cost of production serves as a social criterion of permissible expenditures in the individual enterprises and on the various lines of output, and as a basis for fixing the planned profitability. And fulfillment of planned cost-of-production targets serves as an index of the results of operation of the enterprise. Most of the price-forming factors affect profitability through cost of production. For this reason, calculation of value and its modification must be based upon the cost-of-production index, which serves therefore as the point of departure for price formation. It is important that the cost-of-production index be reliable, since prices can be based only on an economically sound cost of production.

Distortions of the cost index, deviations of the calculated cost from the real cost, reflecting the socially necessary outlays of labor on the production of commodities, stem in practice from the following: failure of the prices of the means of production, as calculated in the costs of production, to coincide with their actual value; divergencies between the depreciation rates and the actual wear and tear of the means of labor; different relative wage levels; different relative social insurance charges on wages; incorrect allocation of the outlays of raw and other materials used together; unequal outlays on account of future years; inclusion in the cost of production of mismanagement expenses (fines, etc.) and of some elements of the net income of society (interest on loans, for instance).

To improve the cost-of-production index for the purpose of price formation, it must cover all actual production outlays to the fullest and most precise degree and be free of all attendant elements that are not related to production costs. Since the point of departure in price formation should be the normative, planned, rather than the actual, cost of production, it is necessary to perfect the normative basis of cost calculation.

Average branch production costs (national or local, depending on the character of the formation of the socially necessary level of outlays), rather than the lowest or highest costs, should be taken as a guide in price formation. Orientation toward average branch costs conforms to the reduction of individual labor outlays to the socially necessary. To strengthen the stimulating role of the normative production cost index, it might be advisable, in calculating it, to exclude the enterprises with excessive costs (such enterprises should be completely overhauled or shut down in the nearest future) and to correct this index with account of the progressive rates of reduction of planned production costs. There are also good reasons for excluding from the average branch costs the data on those enterprises whose production costs are unusually low owing to unique natural conditions.

* * *

The above analysis of the circumstances affecting the level and dynamics of prices permits us to make the following classification of the price-forming factors:

1) Factors affecting prices through changes in their basis — the socially necessary labor outlays (magnitudes of value): the technical equipment per cent of living labor; the

organization of production and labor; the workers' skill and efficiency; the natural conditions of labor; the social need for each type of product; the conditions for the sale of the products, determined, among other things, by the location of their production and consumption (or sale, in the case of consumer goods). These factors should predetermine the main direction in the dynamics of prices so that they will increasingly reflect the social cost of production.

2) Factors causing prices to deviate from value: assurance of a necessary level of profitability; account of the consumer properties of the products; account of the social significance of individual products; matching of supply and demand. These factors characterize the active role of planned price formation in material stimulation, as well as in the distribution of the national income and the whole of the aggregate social product.

Use of price formation as a means of ensuring the necessary level of profitability is necessitated by the fact that, owing to substantial differences in the amounts of labor, materials and capital required per unit of various products, and also to the unequal norms of surplus product in the different branches, a product for society created in a branch of industry often proves to be insufficient for expanded reproduction in the branch and participation in the national expenditures or, on the contrary, exceeds these requirements. Besides, owing to unequal labor productivity in the enterprises of one and the same branch of industry, resulting from different levels of technical equipment per unit of labor or some other reasons beyond the control of these enterprises, the planned (normative) cost of production at the enterprises with less favorable conditions proves to be considerably above the average for the branch. Sale of the products at one and the same price will not bring these enterprises a cost accounting profit, and frequently will lead to losses. The necessary level of profitability for the branch is secured by basing the wholesale prices of the branch (or supplying organizations) on the planned average cost of production for it, while a cost accounting profitability for each normally operating enterprise can be assured by adjusting its wholesale prices to the planned individual cost of production.

The general principle for taking account of the consumer properties of goods is to fix equal prices on products of labor with equal consumer properties (equal prices for equal satisfaction of needs).

Account of the social significance of the various products is closely related to the acaount of their consumer properties, but its aim is not to ensure an equal price for equal satisfaction of a need but to stimulate the consumption of some products and curtail the consumption of others, in accordance with tasks of a social nature.

Price must be used to match supply and demand in those cases when, to one degree or another, they cannot be balanced by expanding output.

The importance of the various price-forming factors differs with the different branches of production and commodities. Thus, while the factors determining the socially necessary outlays of labor for the production of a commodity or value are universal in character, the natural factor is particularly important in agriculture and the extracting industries. The geographic factor assumes special importance in the costs of goods that are difficult to transport (necessitating higher transport costs). Matching supply and demand has very limited relevance as regards means of production, but it plays a big role with respect to consumer goods. Account of the social significance of commodities applies, as a rule, to consumer goods too, but only to a limited number of them. As regards means of production, this factor has some practical significance only in the fixing of prices of farm machines and some other means of production used by the collective farms.

Account of the totality of price-forming factors determines a rational system of prices, which in most general outline appears as follows.

The decisive place in the system of prices should belong to the wholesale price of material

and technical supply (now called the wholesale price of industry). It must be based upon value (the socially necessary labor outlays), with deviations resulting from the need to ensure branch profitability and to take account of the consumer properties of the goods, and thereby express the socialist modification of value. The initial indices in fixing it must be the average branch cost of production of the given commodity and the branch rate of profitability, ensuring expanded reproduction by the branch and its participation in the satisfaction of the general needs of the state. In the extracting industries, the price of material and technical supply may be based upon the regional (local) levels of socially necessary labor outlays.

Procurement prices of agricultural produce (the same for state and collective farms) must be based upon zonal social costs of production, with deviations dictated by the need to ensure expanded reproduction by the farms and to consider the consumer properties of the produce. The sums formed by the difference between the wholesale prices at which agricultural produce is supplied and its procurement prices should go to meet state needs and cover the distribution costs of the procurement and supply-marketing organizations. Because farm produce is procured at zonal prices and sold at uniform wholesale prices, the difference between the wholesale and procurement prices has elements of rent income in it.

Cost accounting profitability for each normally operating enterprise is ensured by the wholesale prices of the enterprise or the calculated prices. They are fixed by adding to the planned (normative) individual cost of production a profit in an amount required to create an incentive fund and a fund to meet the current needs of expanded reproduction (an increase of circulating assets, small-scale modernization), all this with account of the consumer properties of the product. At these prices the product is handed over to the supply and marketing organizations or to the enterprise's own marketing department which sell it at the wholesale prices of material and technical supply.

Retail prices must be based upon the wholesale prices of material and technical supply, with deviations dictated by the need to match supply and demand and to take account of the social significance of the various products, and with the addition of that part of the distribution costs which cause the value of the product to be enhanced. The deviations from the wholesale prices of material and technical supply caused by the need to match supply and demand might best be used for the creation of a special fund to regulate retail prices.

Transition to such a price system cannot be effected by means of a single legislative act. It requires certain material and organizational preparations, including changes in the allocation of social labor among the different branches of production, accelerated expansion of the output of consumer goods in short supply, improvement of the materials and technical supply system, etc.

In fixing planned prices one finds that certain price forming factors affect prices in different, sometimes opposite, directions. Thus, as a result of a price reduction made because of the social significance of the given commodity, the profitability of the production may drastically decline, or it may even begin to bring losses. This makes it necessary to combine direct (through deductions into the budget and other funds) and indirect (through the price-formation machinery) methods of regulating profitability, to properly determine the role and order of operation of the individual factors.

We must accelerate the elaboration of methods for taking into account and measuring value and its socialist modification and ensure their comprehensive and careful verification. It is also important to create scientifically sound and practically tested systems of indices and criteria for assessing the quality and interchangeability of products, to devise methods of disclosing the chain connections in price formation based upon the contiguity of various products in the reproduction process, and to work out a normative base and improve the cost of production indices so that they can serve as a more reliable starting point for planned

price formation. Considering that some of the factors are of unequal significance for different branches of industry, lines of production and types of prices, the general scheme of price-forming factors should be given concrete shape and the methods of calculating them for the purpose of fixing planned prices should be elaborated so as to give each factor a quantitative expression.

The solution of these tasks requires close cooperation between the practical and scientific workers of a number of specialities, as well as systematic participation of the industrial research institutes in the study of problems involved.

Footnotes

1) It should be pointed out that seasonal price differentiations are dictated not only by the seasonal nature of production and demand but also by seasonal differences in the cost of production in some lines of output (livestock breeding, for example).

* * *

Comparison of Soviet and Other Economies

Voprosy ekonomiki, 1963, No. 1

L. Berri and Iu. Shvyrkov

STRUCTURE OF PRODUCTION IN THE USSR AND FOREIGN COUNTRIES

(Based on the Materials of Interindustry Balance Sheets)

Interindustry balance sheets characterizing the interrelations between branches of material production provide extensive material for studying the structure of production and the influence exerted on it by technical progress. The structure of social production depends on the level of development of the productive forces and on the nature of the social system of the given country. It is out of the question, therefore, to think in terms of copying the structure of production of the more technically developed capitalist countries in our long-term plans. However, a discerning study of the production structures of the capitalist countries, chiefly those with a high level of technical development, is of considerable interest to planning personnel.

At present, interindustry balance sheets exist or are being drawn up in thirty countries. In Table 1, we furnish data concerning the more important interindustry investigations. (1)

The analysis of production structure given in this review is based on a study of tables of interindustry ties in the USSR (2) and the USA, (3) and in a group of Western European countries belonging to the European Economic Community. (4) We also used tables of interindustry ties in Hungary, (5) Great Britain, (6) Japan, Italy, Norway, (7) France, (8) and Yugoslavia. (9) The great interest displayed in the capitalist countries with respect to interindustry studies stems from the increasing effort, roused by the sharpening of the general crisis of capitalism, to anticipate economic fluctuations and to employ government regulation in order to lessen the grave consequences of cyclic economic development. The differences that obtain in the tables of interindustry ties in the socialist and capitalist countries are of a fundamental nature. They stem from the fact that the tables for the socialist countries are based on the Marxist-Leninist theory of reproduction. This is reflected, first of all, in the differing conceptions of the sphere of material production. As is known, the balance sheets are presented as a table of four quadrants. The first and second quadrants (horizontally) present the distribution of production, while the first and third (vertically)

Table 1

	Year for which data in table are given	Year of publication	Number of industries in the working table	Number of industries in the published table
Australia	1947	1957	106x266	79x150
	1954	1958	120x100	40x40
Argentina	1950	1958	200x200	23x23
Belgium	1953	1958	no data	51x51
Great Britain	1948	1958	400x400	48x50
Hungarian People's Republic	1959	1961	109x109	109x109
Spain	1954	1958	no data	142x28
Italy	1950	1952	56x200	-
	1953	1955	25x300	25x25
Canada	1949	1956	no data	50x51
Norway	1954	1960	125x125	31x31
USSR	1959	1961	83x83	73x73
USA	1939	1951	96x96	30x38
	1947	1951	450x450	45x45
Sweden	1957	uncompleted	60x60	-
Japan	1951	1955	527x182	182x182
	1953	1957	no data	80x80
	1955	uncompleted	300x300	-

Table 2

Structure of Production Based on Interindustry Investigations
(in % of total)

	Great Britain (1948)	Italy (1950)	France (1956)	USA (1947)	Japan (1951)
Ferrous and nonferrous metallurgy	7.4	5.1	7.6	7.5	13.7
Fuel	5.4	1.4	5.8	3.7	2.3
Electric power	1.4	1.6	1.1	1.2	1.1
Machine-building	21.1	8.5	11.9	12.7	6.3
Chemical industry	4.1	5.5	4.9	4.2	6.2
Timber and paper	2.7	1.7	3.8	3.8	3.9
Products of nonmetallic minerals	2.2	1.7	2.1	1.3	1.6
Light Industry	11.9	11.6	11.8	6.8	11.9
Food industry	12.1	19.9	14.9	10.2	14.1
Agriculture	4.9	19.5	13.0	10.4	11.3
Transport and communications	7.6	3.0	4.8	5.7	4.8
Other branches, trade, services, and public catering	19.2	20.5	18.3	32.5	22.8

indicate the components of its value. The first quadrant of the interindustry balance sheets of the socialist countries presents only the movement of goods and services of the branches of material production. Trade, transport, and services of supply and sales organizations are included in the first quadrant only to the extent to which they participate in the process of material production.

In the capitalist countries, all types of services are included in the first quadrant of the interindustry balance sheet. In some cases this also applies to medical services, the activity of insurance companies, theaters, movies, domestic services, educational expenditures, communal services, etc. The greatest number of services not related to the sphere of material production are included in the first quadrant of the interindustry balance sheets of the European capitalist countries. In Britain, the services sector of the first quadrant, for example, covers the services of public organizations, the armed forces, education bodies, and the like. The "production" of these "producers" comprises some 48% of the sector's output. This conception of productive activity is based on the dogmas of vulgar bourgeois political economy, which asserts that any type of activity yielding income is productive.

The structure of the second and third quadrants in the interindustry balance sheets of the socialist and capitalist countries also has fundamental differences. The grouping of items in these quadrants in the capitalist balance sheets does not make it possible to determine the share of the working people in the national income. In the 1947 balance sheet of the United States, for example, the third quadrant, which includes elements of newly-produced value, does not contain the primary elements of net output in the form of workers' wages, farmers' incomes, and entrepreneurs' profits; it only includes depreciation, the government sector (taxes) and housekeeping. Even the remuneration of workers and the "services" of entrepreneurs are included under housekeeping. Thus, in substance, the tables of interindustry ties in the capitalist countries do not offer data on the structure of net output, which makes it impossible to compare the indices of the third quadrants of interindustry tables drawn up in the socialist and capitalist countries.

However, all in all, it is possible to compare the interindustry balance sheets of different countries, although such comparisons can only be approximations. We must exclude from the first quadrant of the tables of capitalist countries the branches belonging to the nonmaterial sphere, and must ensure comparability of industries as regards structure of production and the character of prices. It is impossible to exclude all the industries belonging to the nonmaterial sphere of production, because in some nations' tables material production and services not related to it are given in one and the same sector. (10)

The number and composition of industries differ from table to table, depending on the country. It is thus very difficult to produce a single classification. When comparing interindustry tables, we should also consider another important methodological factor arising from different conceptions of a branch of industry. (11)

Construction is presented in different ways in the various tables. In the Soviet table all building materials, parts and other resources required in building and assembly work are presented in the "construction" column of the first quadrant, and therefore enter productive consumption. Only the output of the construction and machine-building industries is given under the columns "accumulation fund" and "fund for covering wear and tear and general overhauling of fixed assets" in the second quadrant. Foreign balance sheets refer a considerable portion of the resources of this group to the second quadrant. In view of the differences in reflecting construction in the tables and the impossibility of singling out the essential elements in the structure of outlays of building materials, as given in the second quadrant, the authors were compelled to shift construction from the first to the second quadrant in the Soviet, Hungarian and British tables.

It should be noted that some interindustry

tables do not indicate the intrabranch turnover. (This applies to Britain, France, and several other Western European countries.) This is a substantial shortcoming, because the share of intrabranch ties is, on the whole, very high. To make indices more comparable, we have had to exclude intrabranch turnover from the structure of outlays in quite a number of cases.

This survey attempts to make the indices of ten countries comparable. The investigation of H. B. Chenery and P. G. Clark compares the tables of interindustry ties of four countries — the United States, Italy, Japan and Norway. In view of the above-mentioned differences in methods of drawing up interindustry tables, comparisons are possible only for a small number of large-scale industries in which a certain homogeneity of production exists. The tables that compare data for the USSR, the United States and the Western European countries deal with 16 branches (of which 13 are branches of industry), while in the other tables the comparison involves 22 branches (of which 19 are branches of industry).

Special mention should be made of the difficulties in comparing data that stem from differences in the assessment of production. The balance sheets of the USSR, Italy and Britain are based on consumer prices, and, hence, the value of the objects of labor in the first quadrant includes the cost of transportation and distribution. In most of the other countries the balance sheets are based on producers' prices, which, in our opinion, reflect the production relations of branches more correctly. For this reason we have had to re-evaluate Soviet data, translating it from consumer prices into producers' prices. This work was done by the Economic Research Institute of the State Planning Committee of the USSR. The data for Italy and Britain are given in consumer prices. Since the interindustry balance sheets are given in national currencies, the data supplied below reflect the influence not only of technological and structural factors, but also of value factors, as conditioned by the distinctive features of production in each of the countries considered.

* * *

The national interindustry balance sheets enable us to compare the branch structures of social production in the various countries in a fairly detailed breakdown. The structure of production in each country reflects the level of development of its productive forces and the character of its relations of production, and also its part in the international division of labor.

The data in Table 2 give a definite idea about the structure of the social product in the more developed capitalist countries. (12) It is interesting to note that the share of ferrous and nonferrous metallurgy, the fuel industry, and electric power in the gross product of the United States, Britain, and France is more or less the same. The share of electric power is also more or less the same in most of the industrially-developed countries. The share of machine-building differs. Its great magnitude in Britain stems partly from the fact that it includes distribution and transportation expenses and that exports are relatively greater. The U.S. index is somewhat lower than it should be. The share of the chemical industry in the United States and Britain is considerably lower than in France, Italy, and Japan. The reason for this is that in the latter three countries, industry as a whole, and especially new branches of industry, developed more rapidly after the war than in the United States and Britain.

The branch structure of the social product, which arose spontaneously in the five capitalist countries under review, reflects the structure of social requirements and the level of technical development. The structure of social requirements, in turn, depends on the level of development of the productive forces and the class composition of society, which determines the structure of effective demand, etc. The operation of these factors in the industrially-developed capitalist countries explains the existence of a certain homogeneity in the branch structures of the social product. Yet there are also important differences. In the United States, the branches of heavy industry account for 34.4% of the gross product, while the light and food industries and agriculture account for 27.4%.

In the case of Italy the percentages are 25.5 and 51% respectively, which indicates that it is lagging behind.

Developed heavy industry, especially machine-building, constitutes the material basis for expanded reproduction and high rates of accumulation. But that alone is not enough. The character of the relations of production is of immense importance in a country's economic development. The rates of expanded reproduction are much higher in the USSR than in the United States, although the branch structures as a whole are similar in the two countries.

The data of the national interindustry investigations enable us to compare the structures not only of production, but also of consumption. When determining the structure, data concerning exports should be excluded because this part of output is not utilized within the country. The structure of consumption differs substantially from the structure of production only in countries with large-scale foreign trade.

It should be emphasized in this connection that analysis of the volume and structure of exports is important for the study of its direct and indirect influence on the structure of production in a country. The interindustry balance sheets furnish valuable information in this area. Indices for total outlays, obtained on the basis of interindustry balance sheets, help us determine the so-called full export of production, that is, the total output going for the manufacture of export articles, account being taken of the direct and indirect demands made by the exporting branches on all the related and interconnected branches of the national economy. (13) Table 3 provides data from interindustry balance sheets concerning direct exports of electric power, fuel, and ferrous metals, and a computation of full exports for the United States, Japan, and Italy.

In the USSR the full export of fuel exceeds its direct export by 120%; the corresponding figure for ferrous metals is 100%. The full export of electric power comprises about 5% of its total production. If a country exports little metal and much machinery, the full export of metal greatly exceeds the direct export. Most

Table 3

Direct and Full Exports (in % of production)

	Electric power			Fuel			Ferrous metals		
	Exported directly	Exported, including all outlays	Number of times full exports exceed direct exports	Exported directly	Exported, including all outlays	Number of times full exports exceed direct exports	Exported directly	Exported, including all outlays	Number of times full exports exceed direct exports
USA (1947)	0.0	4.2	-	7.3	15.0	2.1	4.8	13.1	2.7
Japan (1951)	0.0	7.3	-	0.06	13.2	22.1	6.3	17.6	2.8
Italy (1950)	0.5	8.2	16.4	4.6	18.0	3.9	3.1	15.9	5.1

countries do not export electric power, but a certain part of the capacity of electric power stations works for export purposes. The above data show that even countries with a relatively small volume of exports must expend a considerable amount of electric power, fuel, and ferrous metals on the production of export goods. The full exports index is influenced by a number of factors — the structure and volume of direct exports, the structure of outlays in the exporting branches, etc.

Table 4

Structure of Material Outlays in the Soviet and British Instrument-Making Industries

(in % of total)

	USSR (1959)	Great Britain (1948)
Ferrous and nonferrous metals	36.3	25.0
Fuel	2.1	1.7
Electric power	3.9	1.9
Machine-building output	34.1	44.7
Chemical industry output	7.4	6.8
Rubber goods	0.5	0.7
Timber and woodworking industry output	3.2	3.3
Paper industry output	1.5	7.2
Products from nonmetallic minerals	4.7	4.3
Textile and sewing industries' output	4.9	3.1
Leather industry output	1.0	0.2
Food industry output	0.4	2.1

To achieve a more accurate comparison of the economic structures of different countries on the basis of interindustry balance sheets, we must compare the structure of outlays for the various branches of material production, since it directly reflects the influence of technical progress on the branches concerned. The methodological difficulties referred to above make analysis of the structure of outlays in the different branches more difficult. For this reason, let us confine ourselves to a comparison of outlays in the instrument-making and food industries, and in agriculture.

It should be noted that for some items (chemical industry output, rubber goods, timber, products of nonmetallic minerals) the indices are very close. The share of electric power in the Soviet instrument-making industry is greater than in Britain's, which is a positive fact. But the fact that the share of ferrous and nonferrous metals is higher in the Soviet Union, while the share of machine-building output is lower, shows that cooperation is more highly developed in the British instrument-making industry. Another reason for the high share of ferrous and nonferrous metals in the structure of material outlays in the Soviet instrument-making industry is the relatively great weight of some of our designs.

The relatively large metal outlays in the U.S. food industry are an indication of a highly developed canning industry. The considerable shares of electric power and of machine-building and electrical engineering products in the Soviet food industry are confirmation of extensive mechanization. The Soviet food industry lags substantially behind its American counterpart in the consumption of chemical products. The indices for the paper and glass industries indicate that the Soviet food industry is inadequately provided with containers and packaging.

It is of definite interest to compare outlay structures in agriculture, to examine the share of industrial products in all outlays (or in gross output) of agriculture in countries with varying levels of agricultural development. The decisions of the March (1962) Plenary Meeting of the Central Committee of the CPSU, which pointed

Table 5

Structure of Material Outlays in the Food Industries of the USSR, USA and Western Europe
(in % of total)

	USSR (1959)	USA (1947)	Western Europe (1953)
Ferrous and nonferrous metals	0.3	2.7	0.4
Fuel	1.5	0.5	1.4
Electric power	1.6	0.4	0.5
Machine-building and electrical engineering industries' output	1.7	0.4	0.8
Chemical industry output	0.4	6.9	1.6
Timber and woodworking industries' output	1.2	0.5	1.1
Glass and cement industries' output	0.2	1.2	0.8
Paper industry output	0.3	2.4	0.5
Light industry output	0.9	1.1	0.4
Farm products	79.6	71.6	85.1
Transport and communications	3.5	4.7	3.2
Trade, services, and other branches	8.8	7.6	4.2

Table 6

	USSR	USA	Britain	France	Italy	Western Europe
Ferrous and nonferrous metals	0.3	2.3	-	3.0	-	-
Fuel	16.2	11.1	26.5	19.5	2.8	4.0
Electric power	1.8	1.4	-	6.1	0.8	4.0
Machine-building output	27.8	4.4	16.0	-	-	5.0
Chemical industry output	7.7	21.1	37.2	32.1	23.7	39.0
Rubber goods	0.3	3.1	4.3	0.2	-	no data
Nonmetallic mineral products	0.4	1.6	4.5	5.9	0.5	-
Timber, woodworking, and paper products	1.9	3.7	0.1	-	0.1	9.0
Light industry output	2.9	2.2	1.3	6.3	-	8.0
Food industry output	29.6	57.8	-	5.2	33.1	82.0
Total	88.9	108.7	89.9	78.3	61.0	151.0

to shortcomings in the supply of equipment and materials for farming and set concrete tasks for the intensification of this branch, makes such a comparison especially significant.

Table 6 describes the structure of outlays of industrial products, in corresponding currency per 1,000 units of gross agricultural output, in five countries and in Western Europe as a whole.

The Soviet figures for fuel and electric power outlays in agriculture are good. Spare parts for machine repairs account for most of the current outlays of machine-building products. The way to reduce their consumption lies in developing specialized production of spare parts and in improving daily maintenance of agricultural machinery. Some countries do not indicate outlays of machine-building products in agriculture at all.

One should take special note of the indices for the chemical industry. They show that the Soviet Union is definitely behind in supplying chemical industry products. The index for outlays of chemical products in Soviet agriculture in 1959 was one-third of the U.S. index for 1947. The lag is still more pronounced when one compares the Soviet index with those of countries with intensive farming methods.

The data in Table 6 support the conclusion that Soviet agriculture needs considerably larger quantities of industrial products, notably chemicals. This is a crucial factor in the drive for greater agricultural output.

* * *

Analysis of the structure of material outlays gives an idea about the level of technical development and the nature of production ties between individual branches. It should be supplemented by an analysis of the structure of the use of products of the branches. A combination of the two elements of analysis provides a more comprehensive view of the structural features of the economy as a whole and of its various branches.

The relationship between current production consumption and the final product is a synthetic index that reflects the effect of a number of factors:

1) the level of industrial processing of products of a number of branches; thus, the portion of farm output used in production depends less on the internal agricultural turnover than on the level of development of its industrial processing;

2) the level of technical development of the consuming branches; for example, the distribution of electric power and chemicals among production branches depends on the level of electrification and the extent of application of chemical processes in these branches;

3) the extent of the social division of labor; thus, the level of specialization and cooperation in the machine-building industry affects the share of current production consumption in the given branch (the share of supplies for outfitting [komplektatsiia] and cooperation);

4) the specific features of the branch structure of industry and the entire material production in the country; for example, the absence or insufficient development of a branch affects the relationship between products going for production consumption and into the final product.

There is a distinct trend now toward making a progressively greater part of the production of heavy industry available for personal and public consumption, and channeling it into the consumption fund, while allocating a greater part of the light industry product for production consumption (into the fund for replacing current outlays). It may be recalled that in industrially developed countries a substantial part of the machine-building, chemical and electric power output consists of consumer items — automobiles, television sets, plastic goods, etc., which have become established features of everyday life. At the same time, some of the light and food industries turn out semifinished products which require further industrial processing. This applies to the textile, fish, flour-grinding and other industries, which now largely produce objects of labor rather than consumer goods. Thus, textiles and flour, which were formerly reworked in the household, now go to sewing factories and bakeries. The production of factory-made clothing and ready-made food products has grown substantially in recent

decades. All these changes stem from technical progress, the growing differentiation of production, and the elimination of many labor-consuming operations in housekeeping.

The same is true of agriculture. Formerly, only industrial crops (sugar beet, cotton, flax, etc.) were subject to industrial processing. Now such products as milk, meat, vegetables, and fruits are also processed industrially in great quantities.

Tables of interindustry ties characterize the relation between products currently consumed in production and products channeled to the consumption and accumulation funds by branches of industry and agriculture. The data in the tables make it possible to determine the relation between the means of production and the products consumed in the branches concerned, and thus enable us to calculate the relationship between subdivisions I to II in the production of the social product. The relationship between the current production consumption (without covering wear and tear and the general overhaul of fixed assets) of the product of a branch and its total consumption in the country will be referred to below as the coefficient of production consumption. This relationship is given for eight countries in Table 7.

It may be seen from Table 7 that a relatively high production consumption is typical for countries with developed industry and diversified economies. Export figures are not taken into account in the table. The coefficient of production consumption depends to some degree on the amount of goods exported, although the latter is not related to the level of technical development and division of labor, which are reflected in the coefficient. Suppose 70% of the textiles are consumed in production, while 30% go to the consumption and accumulation funds. This unquestionably reflects the level of development of the sewing industry in the given country. However, if a certain amount of textiles is exported, inclusion of the amount in the final product would distort the coefficient of production consumption. The share of production consumption in the aggregate product consumed, including exports, will be less, especially for countries with big exports. The coefficient of production consumption would then be 37.7 for Great Britain instead of 43.2 and 30.4 for Norway instead of 37.4, etc. When the coefficient of production consumption is calculated, therefore, export data should be omitted.

Table 7

	Production consumption*	Final product**
Japan	48.4	51.6
USA	47.3	52.7
USSR	44.3	55.7
Great Britain	43.2	56.8
Italy	42.5	57.5
Hungary	42.4	57.6
France	41.5	58.5
Norway	37.4	62.6

*The sum of outlays in construction is excluded to make data comparable. The entire production of the construction industry is referred to the accumulation fund. The figures for Italy and Great Britain were taken from interindustry balance sheets calculated in consumption prices, while producers' prices were taken in the case of other countries.

**The final product includes nonproductive consumption, accumulation, the covering of wear and tear and general overhaul of fixed assets.

* * *

Let us examine in Table 8 the coefficient of production consumption for products of the key branches (in producers' prices).

Analysis of indices characterizing the share of production consumption by branches enables us to draw the following conclusions. The coefficient of production consumption is high for branches of heavy industry that manufacture mainly objects of labor (elements of circulating assets). This applies, first of all, to ferrous and nonferrous metallurgy and the fuel and chemical industries. The production consumption coefficient for these industries largely reflects the share of means of production.

The branches of heavy industry manufacturing

Table 8

	Ferrous and non-ferrous metallurgy	Fuel industry	Chemical industry	Machine-building	Electric power	Textile industry	Agriculture
USSR	81.8	76.4	75.7	31.4	62.8	58.5	63.5
USA	76.1	70.3	66.4	32.4	59.3	70.1	71.3
Great Britain*	81.8	80.0	70.6	47.7	57.0	49.1	50.1
Hungary	80.8	88.8	63.8	45.6	56.0	61.1	54.6
Italy*	88.6	88.0	72.6	14.6	58.0	67.2	72.7
Norway	59.1	82.4	67.8	8.3	40.0	46.0	61.7
Japan	80.0	93.1	71.1	26.8	58.7	59.1	73.5
Yugoslavia	82.1	82.0	63.6	30.1	81.4	38.3	45.2

*Figures obtained from tables based on consumption prices.

Table 9

	Ferrous and non-ferrous metals	Fuel industry	Chemical industry	Machine-building	Electric power	Textile industry	Agriculture
USSR	94.4	79.6	79.1	39.4	68.3	58.5	63.5
Great Britain	92.0	95.6	71.3	50.1	58.8	49.1	50.1
Hungary	85.3	83.4	66.9	51.2	57.6	61.1	54.6

instruments of labor and other elements of fixed assets direct their production primarily into the accumulation fund. This applies first of all to the machine-building and construction industries. The production consumption coefficient reflects chiefly the internal production ties (e.g., cooperative deliveries within machine-building). This index does not give an idea of the share of the production of means of production in the given branches, because their products chiefly go into capital construction. For the first group of industries, the coefficient of production consumption is 70 to 90, and for the second — 10 to 45.

The light industries may also be divided into two groups in terms of the share of products turned out for production consumption: production of semifinished products, chiefly for further processing, and production directly for consumption. The textile industry, for example, belongs to the first group, and has a production consumption coefficient of 40 to 70; the clothing industry belongs to the second group, and has a coefficient of 3 to 20.

The above figures do not cover outlays of products in construction (building and assembly). This item is quite big in countries where there is a great deal of construction. Inclusion of "construction" in the first quadrant would substantially increase the coefficient of production consumption. Production consumption coefficients, inclusive of construction outlays, are given in Table 9 for the USSR, Great Britain, and Hungary (in % of the aggregate product).

On the whole, the Soviet production consumption coefficient for all branches of heavy industry just about equals that of the most economically developed capitalist countries, and is higher than that of the United States as regards ferrous metallurgy, fuel, electric power, and the timber industry. This relationship between the coefficients is due to a set of reasons, and chiefly the high rates of expanded reproduction in the USSR. Relatively more products of oil refining, electric power and chemicals go into the final product in the USA than in the USSR.

In some light and food industries, and in agriculture, the Soviet coefficient of production consumption is less than that of the USA. It is 58.5 for the Soviet textile industry, and 70.1 for the textile industry of the USA; 61.3 and 76.6 respectively for flour-grinding; 34 and 48.3 for the fish industry; and 63.5 and 71.3 for agriculture. It should be borne in mind that the coefficient for the light and food industries in the Soviet Union is somewhat understated because, in a number of cases, the prices of goods used for nonproduction consumption are higher in our country (they include the turnover tax) than prices of goods used for production purposes.

Nevertheless, the lower (as compared with the USA) production consumption coefficient for textiles, fish and flour reflects, to some extent, the fact that the processing of these products in our industry proceeds on a somewhat smaller scale than in the United States.

The production consumption index for agricultural output is of particular interest. A progressively greater portion of agricultural output is being processed industrially as a result of technical progress and greater division of labor. Great progress has been made in this field in all industrially developed countries in the past few decades. The coefficient of production consumption for agricultural products is affected by the index of their use in agriculture itself. The portion of agricultural output retained in farming for its own production needs was 36.9% in Yugoslavia, 32.6% in Hungary, 26.6% in the USA, 23.6% in the USSR, 14.8% in Norway, 14.4% in Italy, and 2.9% in Japan. In the first four countries, the large amount of consumption within agriculture was due to the large output of animal husbandry, which involves a considerable consumption of the output of crop cultivation. In Norway, Italy and Japan, the level of development of animal husbandry is considerably lower, and the turnover of agricultural products within the agrarian sector is consequently low.

Comparison of data on the production consumption coefficient for agricultural production with the indices on the consumption of this output within agriculture gives a more accurate idea of the scale of industrial processing of agricultural products. Soviet industry processes somewhat lesser quantities of agricultural products than does U. S. industry.

Information on the branch structure of the distribution of output of individual branches is of great interest. Table 10 presents figures on the distribution of ferrous and nonferrous metals, fuel, electric power, and chemicals for current production needs in 12 key branches of material production in 4 countries (in % of total).

It should be borne in mind when analyzing the branch structure of the distribution of the various products that it is influenced by many factors and, first of all, by the branch structure of production.

The similarity of the production structures of the USSR and the USA is revealed more or less distinctly in the table showing the distribution of products. Large-scale production and a high degree of economic integration are characteristic of the two countries. Foreign trade is of far less importance in their economies than in the economies of Japan and Great Britain. Figures for the consumption of metals in the Soviet and American machine-building industries, and of fuel in metallurgy, are quite close. The consumption of chemical products in the machine-building and light industries of the USSR is very high. But the output of the chemical industry is still inadequate, and, consequently, the actual extent of application of chemical processes in these branches cannot be considered satisfactory.

* * *

Table 10*

	Ferrous and nonferrous metals	Fuel industry	Electric power	Machine-building	Chemical industry	Timber, woodworking and paper industry	Nonmetallic mineral products	Light industry	Food industry	Agriculture and forestry	Transport and communications	Other branches, trade, services, and public catering
Ferrous and nonferrous metals												
Great Britain	-	2.7	0.1	90.8	2.4	0.6	0.4	0.1	0.2	-	1.1	1.6
USSR	-	1.3	0.2	77.2	4.6	2.1	6.1	0.7	2.1	0.4	2.1	3.2
USA	-	1.4	0.6	72.5	4.9	2.3	1.4	0.2	5.7	0.8	2.5	7.7
Japan	-	3.2	1.8	63.9	11.2	1.1	2.5	0.4	3.6	0.7	5.8	5.8
Fuel												
Great Britain	11.3	-	12.3	5.9	12.2	3.0	4.3	4.0	7.6	5.3	21.1	13.0
USSR	22.0	-	16.3	5.2	3.0	5.0	5.5	1.6	4.8	13.0	21.3	2.3
USA	22.3	-	10.1	3.4	7.1	3.9	3.7	1.0	2.6	9.3	25.5	11.1
Japan	29.2	-	13.1	2.7	8.2	2.7	8.4	3.2	6.2	0.7	22.7	2.9
Electric power												
Great Britain	16.5	11.2	-	20.4	11.0	3.6	6.1	9.1	6.8	-	8.6	6.7
USSR	18.1	15.3	-	15.9	8.8	4.1	11.2	7.3	5.1	4.0	6.8	3.4
USA	16.5	5.2	-	13.9	6.7	4.6	4.4	6.1	5.8	3.3	6.8	26.7
Japan	20.1	10.0	-	5.4	16.8	8.1	4.0	6.9	7.6	3.0	7.4	10.7
Chemical products												
Great Britain	1.7	11.5	0.8	18.4	-	3.2	3.1	15.0	6.9	20.9	12.4	6.1
USSR	3.8	2.7	0.2	31.2	-	4.8	1.8	16.4	2.1	11.5	11.5	14.0
USA	4.1	3.5	-	22.1	-	4.2	2.0	14.2	21.4	14.0	2.7	11.8
Japan	2.2	1.9	0.3	7.7	-	3.0	2.2	31.6	6.5	28.2	3.3	13.1

* Data on intrabranch consumption of products is omitted because it is impossible to render these indices comparable.

Comparison of national tables of interindustry ties enables us to compare and analyze the following aspects of the economic structure of various countries:

a) branch structure of national production;
b) branch structure of national consumption;
c) branch structure of exports and imports;
d) branch structure of accumulation and consumption funds;
e) structure of material outlays by branches;
f) structure of distribution of products within the branches between the replacement, accumulation, and consumption funds;
g) structure of distribution of products of the various branches for production needs in the various branches of material production.

The coefficients of full outlays enable us to determine the volume of gross product corresponding to the different elements of the final product (consumption fund, accumulation fund, replacement and general overhaul of fixed assets, and exports). This interconnection of the final and gross products reflects the structural features of the economies of the various countries. This is a very incomplete list of the possible lines of analysis of economic structure based on data obtained in interindustry investigations. The present article deals with the structural features of only some of the above lines of analysis.

Comparisons of production structures based on national interindustry balance sheets enables us to ascertain important features in the production structures of different countries — features that are mainly dependent on the level of technical development and the social division of labor — and to establish the progressive features of these structures in order to draw practical conclusions useful for our own long-term planning.

The data reviewed show that the structure of social production in the USSR is on the level of that of the highly developed industrial countries. At the same time, they give a general idea of some of its shortcomings — the insufficient development of the chemical industry, the poor use of metals in industry, the unsatisfactory processing of agricultural products, the imperfect cooperation in the machine-building industry, etc.

It should be emphasized that the possibilities for analyzing the production structure on the basis of tables of interindustry ties are still limited because, first, the statistics available for the national tables are generally not reliable enough; second, in most countries these tables are compiled for one year only, and therefore the data describing trends in the development of the production structure are lacking; and, third, the tables are compiled by very different methods in each country. Naturally, the elaboration of interindustry balance sheets by one method and for a fixed term in capitalist and socialist countries is practically impossible, but it is quite feasible within the framework of the socialist economic system.

Methodological and practical work is being carried out in the socialist countries to compare the levels of economic development in the member-countries of the Council for Mutual Economic Assistance. Cooperation of scholars of the various countries will make this job easier. Joint elaboration of a single methodology for making report and projected interindustry balance sheets will afford good opportunities for determining the most rational production structure, improving the international division of labor, and increasing the efficiency of foreign trade between countries of the world socialist economic system.

Footnotes

1) Interindustry balance sheets were also drawn up in Poland, Yugoslavia, France, the Federal Republic of Germany, Denmark, India, Israel, New Zealand, the Netherlands, Puerto Rico, the South African Republic, British Guiana, Colombia, the Congo (capital in Leopoldville), Cyprus, Mexico, Peru, etc.

2) See Narodnoe khoziaistvo SSSR v 1960 g. Statisticheskii ezhegodnik, Gosstatizdat, 1961, pp. 103-51.

3) The results of this interindustry study of the U.S. economy for 1947 were first published in Review of Economics and Statistics, 1952, No. 2, Vol. 34, pp. 37-142.

4) E. S. Kirschen, et al., La structure de l'economie Europeenne en 1953, Paris, 1958. This book furnishes data for the FRG, Austria, Belgium, Denmark, France, Greece, Ireland, Iceland, Italy, Luxemberg, Norway, the Netherlands, Portugal, Britain, Sweden, Switzerland and Turkey.

5) See Vestnik statistiki, 1961, No. 4, pp. 33-37.

6) The British interindustry balance sheet figures for 1948 are from a table in I. G. Stewart, "Input-Output Table for the United Kingdom," The Times Review of Industry, Dec. 1958, pp. VII-IX.

7) Figures for Japan, Italy, and Norway are from H. B. Chenery and P. G. Clark, Interindustry Economics, London, 1959.

8) Les Comptes de la Nation, Vol. 11, Paris, 1960, p. 60.

9) Medusobni Odnosi Privredih Delatnosti Jugoslavija v 1955 godini, Zaverni Zavod za Statistiku, Beograd, July 1957.

10) Comparability of data is also complicated by the different conceptions of the sphere of services. The interindustry balances of Norway, Italy and Japan refer water supply, steam heating and automobile repairs to the sphere of services. The balance of the Western European countries refer water supply and steam heating to "other branches of production" and automobile repairs to machine-building. The sector "other branches of production" also differs quite substantially in composition from country to country.

11) In the USSR and, to a large extent, in Japan the tables mirror the streams between the "pure" industries. In most of the other countries the tables show the ties between existing branches of industry in which the basic product comprises the bulk of the output of the enterprises belonging to the given branch and only a small portion does not conform to the basic line in the branch.

12) In view of the fact that production in Britain and Italy is quoted in consumption prices, the shares of the various industries and agriculture are somewhat higher (for the value of output includes distribution and transportation expenses). In the case of the United States, these figures are somewhat lower than they should be because the share of trade and services is exaggerated as compared with their actual participation in material production. This applies to some extent to the other countries represented in the tables as well.

13) The full exports of a product are computed with the help of coefficients of full outlays by the following formula:

$$X_i = \sum A_{ij} Y_j,$$

with X_i being the amount of product i required in the production of exported goods, inclusive of all indirect outlays in the national economy, A_{ij} being the coefficients of the full outlays of product i in the manufacture of a unit of product j, and Y_i being the amount of exported product N_j.

* * *