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SOME PROBLEMS OF CONSTRUCTING
THE LONG-TERM PROJECTION
IN CZECHOSLOVAKIA

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Introduction

The necessity of constructing the long-term projections and plans has been felt almost in all the countries of the world. It is quite understandable because successful solution of present economic problems can't be in many fields reached without at least rough ideas about the economic development in the next 10-20 years. Nevertheless the practical experiences in working out the long-term plans and projections are relatively small because of the great difficulties which must be overcome, in particular as regards the solid information basis. The mathematical methods and mathematico-economic models are promising in this field of observation, analysis and planning. The majority of models described in literature has the theoretico-study character and it is necessary to come to the working models which are to be elaborated on the basis of local conditions, needs, objectives which are given to these models, information basis etc. . From the view point of practical application of these models it is clear that they must be constructed as structural and dynamic models of the national economy.

The history of long-term planning in the socialist countries (centrally planned economies) is relatively short. It is due to the fact that the annual and perspective plans for 3-7 years were sufficient for solution of most economic problems at the present stage of economic development, when the problems of effective structure of the national economy, international division of labour and coordination of plans among the socialist countries are solved, the construction of long-term plans represents a necessity in most of the socialist countries. The significance of long-term planning is also greater in the socialist countries where the government decides about the future economic development of a country. Some experiences of Czechoslovakia must be therefore comprehended as the first and initial practical steps in this not fully explored field of planning.

1. Necessity of Drawing up the Long-Term Projection.

By the long-term projection we mean the projection of the future development of the national economy as a whole for the period longer than 10 years. The terminology in this field is not yet clear. Sometimes we speak about long-term plans, long-term prognosis, studies. I use in this paper the term long-term projection to differentiate a little between the character of long-term plans in comparison with the short-term and middle-term plans.

There are many reasons why the long-term projections are to be elaborated. Many economic processes themselves have the long-term character, namely:

Labour forces planning where the process of training qualified personnel lasts many years and the decision about the number and structure of students in secondary schools and universities at present needs certain knowledges about the future needs and demands for the amount and structure of labour forces. These future requirements for labour forces will be given by future structure of the national economy (both by the structure of productive and non-productive branches in the national economy) technical and scientific progress and other factors.

Planning of capacities, fixed capital and investments.

Gestation period of the majority of investments is from 3 to 8 years. The expected life of new capacities and fixed assets created by investments may be in the range from 10 to 30 years. It means that the decision about a new investment project needs certain ideas about required production on these new capacities in the next 10-30 years. Of course some calculations about the future demand for the commodities produced by new investments are always made in investment projects

in connection with separate investments. But this is not enough. Individual branches in the national economy are mutually connected with many interdependencies which must be respected to avoid significant imbalances in the national economy. For example decision making about a new motor-car plant with a certain capacity needs simultaneously a certain decision about the deliveries for motor-car production (from import or from domestic production) from metallurgical, chemical, oil, energy, engineering and other branches of the national economy. It means that simultaneously with the decision about the new motor-car factory we must decide about the necessary investments in delivering branches (if we don't want to increase imports). These delivering branches are also linked up with other branches, and so on.

From that follows that the long-term projection and plans are also to be constructed as comprehensive, over-all plans including all the spheres of reproduction (production, distribution, consumption and accumulation), the main proportions in the reproduction process (between production and consumption, accumulation and consumption, production of the means of production and consumer goods, proportions among the main branches in the national economy) and respecting the mutual relationships among the branches, between production, labour forces, investments and consumption. On the other hand in the process of constructing the long-term plans it is necessary to use all available detail information from investment projects, sectoral and other projections and plans.

It means that the approach to the elaboration of long-term plan, may be generally viewed upon from two main sides:

- a) from the view point of the national economy as a whole (from the national point)

b) from the sectoral point of view. These two approaches may of course differ and it is necessary in a iterative way to seek for an optimal solution simultaneously with the ensurance of a balance state in the national economy.

It is of course not an easy matter to reach this objective and we shall later on discuss some possible methods which may be used in the solution of that target.

Continuity in planning is another significant reason for constructing the long-term projections. As it is difficult to construct annual plan without perspective plan, in the same way it is difficult to work out perspective plan without long-term projection.

2. Specific Features of Long-Term Plans and their Relationship with the Short and Middle-Term Plans.

The long-term plans and projections are characterized by some specific features in relation to the short and middle-term plans. Among these features we can mention the following:

a) The data and figures comprised in long-term plans are not obligatory for ministries, enterprises, trade and other economic units in the national economy, are not given as directives, but they have only an orientation character and are given for information about the future possible long-term economic development of a country. This follows from the hypothetical character of long-term projections - they are practically prognoses and their accuracy becomes less with the length of the given period.

b) The data and figures in long-term projections are in more aggregative form than in annual and perspective plans. In many cases the quantitative figures can't be even given and only some directions, tendencies of future development may be foreseen (for example the living style after 20 years, the character of urban and rural areas, transportation, recreation, culture, education etc.). Very often the long-term projections are constructed as macro-economic models and only some aggregative economic figures are derived from these or outside these models (national income, labour forces, fixed capital, investments, consumption, savings). In the case of structural breakdown of the national economy only the major branches (sectors) in an aggregative form are taken into account. When the long-term projections are based on the input-output tables, the number of branches may be somewhere between 10 to 30 branches.

c) As regards the applied classifications of production and other economic activities, the pure commodity or branch approach in contradistinction to organizational or institutional

approach is only recommendable. It is due to the fact that the organizational structure is changeable especially during a long period. It means that the data are collected and foreseen for pure commodity or service branches irrespective of organizational structure.

Nevertheless, the time series of statistical data are necessary for deriving some parameters, for analyses, extrapolations, comparisons of past development with the anticipated economic development. Very often these time series are available according to the organizational structure of the national economy. In this case the compromise is necessary and the structural breakdown of the national economy within the long-term projection must be consistent with these time series.

Very important principle which is to be applied in constructing the long-term projections is the principle of connection between the long-term projection and the middle-term plans. Practically the main purpose of the long-term projection is to give the necessary framework for constructing the five-year plans, to outline the main targets and tendencies of the long-term economic development of a country, which are to be respected and concretized within the framework of five year plans. On the other hand the long-term projections must respect the planned targets determined by the five year or annual plans. It means that mutual exchange of information between the five year plans and long-term projection takes place. In this way the continuity of planning is safeguarded.

3. Methodology of Working Out the Long-Term Projection.

The approach to the elaboration of long-term plans and projections may be different in different countries. It depends inter alia on the targets and objectives which are given to the long-term planning, on the possibilities, information basis and so forth. In the socialist countries the role and significance of the long-term planning has been increasing since the problems of efficiency, structural changes, international division of labour, construction of middle-term plans e.c. can't be successfully solved without the ideas and conceptions about long-term economic and social development of a country. One from the main targets of the State Planning Commission according to the new system of management and planning in Czechoslovakia is therefore to organize, co-ordinate and elaborate the long-term plan up to the year 1980. On the following pages I shall try to describe the approach to long-term planning which is applied at present in Czechoslovakia.

Generally we can say that the works on the long-term plan are organized according to the two basic lines:

- a) elaboration of economic and technico-economic studies and projects according to the main branches of the national economy and according to the fundamental problems of the economic development.
- b) construction of a comprehensive over-all macro-economic projection in the form of a dynamic structural model of the national economy.

In an iterative way by means of mutual exchange of information between the detailed economic and technico-economic studies on the one hand and global macro-economic projection on the other hand we want to reach:

- a) balanced
- b) realistic
- c) relatively efficient

long-term plan.

Now we can describe in greater detail the individual components of long-term plan. We shall begin with the economic and technico-economic studies (or conceptions).

The main objectives of economic and technico-economic studies are:

- to clear and qualify the main technical and economic problems of future long-term development of the appropriate branch or field of national economy.
- to elaborate alternative solutions of future economic development and recommend the most efficient one according to the chosen criterium
- to give necessary information for constructing the global macro-economic dynamic and structural model of the national economy.

The technico-economic studies will be elaborated for about 25 branches of the national economy.

The economic studies are to be carried out for the following fields:

- Living standards
- Foreign economic relations
- Productivity of labour and distribution of labour forces
- Development of the structure of qualified personnel
- Reproduction of fixed capital and investments

- Regional aspects of economic development.
- Economic problems of defence
- Reserves.

The technico-economic conceptions (studies) will contain the following main sections:

- A. Major directions of scientific and economic development.
- B. Research and evolution.
- C. Foreign relations.
- D. Productivity of labour and qualification of labourers.
- E. Reproduction of fixed capital.
- F. Regional aspects of long-term economic development of a branch.

A. Major directions of scientific and economic development.

Within the framework of this section of technico-economic conception the realization of significant technical arrangements will be observed and quantified as:

- Acquisition of new capacities with higher parameters and equipments with new production principles.
- Realization of progressive technological production processes.
- Significant directions of developing automation and computation technique.
- Structural changes in the raw material basis of production.
- Significant investments.
- Significant arrangements in replacement, modernization and reconstruction of production basis of a branch.

B. Research and evolution

In the draft of this section of the technico-economic conceptions the following problems will be observed:

- Fundamental directions and objectives of research works which are to be primarily secured.
- Directions of technical development which are to be secured by international scientific and technical cooperation or by import.
- Directions of research which will be gradually limited
- Fundamental research problems.

Together with the above mentioned problems of research works the analysis of past development and international comparisons of research basis in a branch are to be prepared. In a special table the envisaged number of labourers, investments and an amount of foreign currency for purchase of licences will be calculated.

C. Foreign relations.

In this section of the technico-economic conception the following problems will be studied:

- Technical and economic development in the world, prognosis of trends of production and consumption in the world and the possibilities of sales of our products on the world markets.
- International division of labour and optimal inclusion of our economy into the world economy, in particular as regards the integration with the economies of socialist countries.
- Calculations of the effectiveness of commodity and territorial structure of the foreign trade.
- Prognosis of price trends.

D. Productivity of labour and qualification of labourers.

Analysis of the increase of productivity of labour must take-into account all the decisive factors effecting the growth of productivity of labour. The close connection of this section of the technical-economic conception with the other sections is apparent.

In the conception of employment the number of workers, specialists with secondary and university education (according to the study specializations) will be determined.

E. Reproduction of fixed capital.

The following questions are to be answered in this section:

- Necessary investments for further development of a branch.
- Influence of these investments on the fixed capital
- Repercussions in ratios: fixed capital-output, capital to labour ratio, productivity of labour, costs of production.
- Possibilities of development by means of non-investment factors.

F. Regional aspects are to be elaborated in the form of regional requirements for capacities, labour forces, energy and water supply, housing and other facilities necessary for labourers. The unified methodological guidelines for constructing the technico-economic conceptions were elaborated by the State Planning Commission. According to these methodical instructions every organization responsible for preparation of the technico-economic conception must give the required data in the form of prescribed system of indicators, forms and tables to the State Planning Commission. On the basis of the above mentioned and other information the global conception about the social and economic development of a country will be built up.

Macro-economic long-term projection of the national economy.

The construction of the macro-economic projection represents the second main line of works on the long-term plan. It is apparent that this macro-economic projection must be worked out by the central planning authority.

We may distinguish up to now two main stages in connection with the elaboration of macro-economic projection:

Research stage where some production functions were investigated in relation to the Czechoslovak national economy. In particular the application of the Cobb-Douglas production function was provided according to which the national income is the function of fixed capital and employment in the productive sphere of the national economy. Four sector model was elaborated and in relation to agriculture there was applied a specific production function. Two sets of variants were calculated with different effectiveness of production factors.

The results of this research stage can be summed up into the following conclusions:

a) It is not sufficient to provide analyses and projections by means of one function including aggregative magnitudes of the national economy. Diversification of production functions must be made.

b) It is necessary to construct a structural model which will include about 20-30 branches of the national economy.

c) It is necessary to distinguish production (output) and capacities and introduce the coefficient of utilization of capacities (output to capacity ratio).

d) Besides production functions it is necessary to formulate the cost functions according to which the material costs of production (material inputs) will be calculated.

Second stage may be characterized by building up the working dynamic structural model of Czechoslovak national economy which will be practically used in elaborating the long-term plan up to the year 1980. At present the works on building up and filling in the working dynamic structural model are provided and therefore we can only outline some problems and approaches to this macro-economic model. The specific feature of this stage is the linkage between the technical-economic and economic conceptions on the one hand and the macro-economic projection on the other hand.

In constructing the working dynamic structural model of the Czechoslovak national economy the disaggregation will be done on about 25-30 branches of the national economy, input-output tables will be used and production and cost functions will be applied. The model must enable to give many variants of long-term economic development of the country. The optimization is not required for the model and the effectiveness of individual variants will be judged by special expert analyses.

It is understandable that the precision of results will be decreasing with the increase of the length of the period. It is therefore envisaged that relatively good results may be obtained for the period of 10 years. With the increase of the length of the period the aggregation must be done. As regards the prognosis on 15 years and more only national income and some main indicators of economic development will be estimated.

Conception of production and other functions in the model

It is anticipated that the production and other functions will be constructed according to the individual branches of the national economy.

The following formulation of the econometric functions is given only as an example first of all for the manufacturing industries.

We have these magnitudes:

X ... gross output

N ... material costs of production (material inputs)

P ... number of labourers.

F_m ... fixed capital of engineering character (machines and equipment)

F_{st} ... Fixed capital of construction character (buildings and structures)

E ... consumption of energy

Q ... capacity of production

u ... utilization of capacity (output to capacity ratio)

N_o ... material inputs on the average level of rationalization.

The formulation of the production function is the following:

$$X = u \cdot Q$$

$$Q = a \cdot P + b \cdot F_m + c$$

$$u = k \cdot \frac{E}{F_m} + q$$

The coefficients a, b, c, k, q are empirical coefficients of regression functions.

The cost function is as follows:

$$N = \frac{1}{1+r} \cdot N_0$$

$$N_0 = m_0 + m_1 \cdot \frac{X+Q}{2} \cdot \left(\frac{X+Q}{2}\right)$$

$$r = S \cdot \left\{ \frac{F_m}{P} - \left(\frac{F_m}{P}\right)_0 \right\}$$

m_0, m_1, m_2 are empirical coefficients.

Other production functions may also be used. For examples:

$$Q = a \cdot F_m^{m_1} \cdot P^{m_2}$$

or $Q = a \cdot F_m^{m_1} \cdot P^{1-m_1}$

This is practically the Cobb-Douglas production function where the coefficients m_1 and m_2 are the coefficients of capital and labour elasticity of the growth of national income. The coefficients a and m_1 must be empirically ascertained for example on the basis of statistical time series.

As regards the ascertainment of empirical coefficients it is supposed that the statistical time series will not be the only source of information because the statistical data can be in many cases misleading for extrapolation. Besides the statistical time series and the application of regression functions the coefficients are to be estimated on the basis of special branch technical-economic studies.

The global construction of macro-economic model

The time interval of the long-term projection will be decomposed into partial periods of one or more years long. Within the individual periods the branches will be linked up by means of input-output tables.

In the transition from one to the another period it is supposed that the final consumption, capacities and material inputs will be changed. It is the purpose of econometric functions to estimate these changes.

It is possible for example to construct a four-stages model, where the time period of 12 years will be divided into four three years intervals.

The dynamic elements of the model are the followings:

- estimates of stock of capacities by means of production functions
- estimates of changes in material inputs through cost functions
- dynamization of input coefficients in the input-output tables on the basis of information taken from technical economic conceptions.
- estimates of changes in empirical coefficients in econometric functions
- utilization of consumption functions in estimating the final consumption

The first rough algorithm of structural macro-economic model will be approximately like this:

- a) determination of final consumption
- b) calculations of gross outputs by means of input-output table
- c) application of production and cost functions which will lead to the necessary material inputs, investments, labour forces

- d) confrontation of these results with input-output tables, necessary adjustments and a repetition of the whole process

It means that in an iterative way it will be possible to reach :

- equilibrium in the national economy
- realistic estimates about the future economic development
- relatively efficient solution of the future development of the national economy.

As it is clear from the above mentioned facts, many problems of dynamic, structural macro-economic model of the Czechoslovak economy have not been fully solved up to now (for example international division of labour and foreign trade etc.). It is anticipated that these problems will be gradually, step by step solved in the process of practical working out of the model. Probably in this process many assumptions will be changed, many adjustments will be done, but it is believed that only through the practical work and exercises progress can be reached in the application of mathematical methods in planning.

4. Input-Output Tables in the Long-Term Projection.

Almost in all cases when the model of national economy is built up as structural, input-output tables and coefficients computed on their basis are used for linking up the different sections of this model (especially final demand with production according to the chosen branch structure of the national economy).

Input-output tables constructed for the purposes of long-term projections have some specific features:

a) the number of branches included in the input-output tables is relatively small with relatively great aggregation of production (in my opinion the number of branches can fluctuate from 10 to 50 branches). Apparently, the longer the period in question, the smaller the number of branches. As it was said before, the Czechoslovak input-output table applied in long-term projection will include about 25 branches.

b) Very often it is not necessary to construct the whole input-output table in absolute figures with all quadrants and it is possible to calculate only the input coefficients which are first of all used in the model.

c) Several matrices of input coefficients must be constructed. It depends on the length of long-term projection and its time subdivision. Say that we are constructing the long-term projection for 12 years with the subdivision into four three-year intervals. In this case it is necessary to dispose of four matrices of input-coefficients (or four input-output tables) which reflect say the final year of the period in question. In this case we suppose that the input coefficients are changeable and that the changes during the three year period are of such an importance that they must be taken into account. Naturally we can assume that the input-coefficients are stable

and in this case only one matrix of coefficients is sufficient. But this assumption is not realistic.

It is clear that many difficult problems must be solved to construct input-output tables which are suitable for long-term projections. We can mention some of these problems:

a) Dynamization of input coefficients and necessary information for this dynamization. In Czechoslovakia we suppose that the new dynamized input coefficients will be calculated on the basis of the information taken from technico-economic conceptions and on the basis of cost functions. In the methodical guidelines for elaborating the technico-economic conceptions are prescribed the coefficients which must be calculated within the framework of technico-economic conceptions. These coefficients are prescribed according to individual branches included in the input-output table and in many cases only the key coefficients of decisive significance are to be calculated.

b) Information about final consumption.

We suppose that this information will be prepared exogenously outside the input-output table by means of different methods. In the sphere of personal consumption the consumption functions will be used, normative method (norms of consumption of foodstuffs, clothes, shoes a.c.) will be applied, international comparisons and other analyses will be made use of.

In the sphere of collective consumption other methods must be used because of different factors influencing this component of final demand. The calculations will be done according to the individual non-productive branches (education, health, administration, science and research, defence a.c.).

Stocks will be calculated in the form of norms (these norms are to reflect a desirable level of stocks in the branches).

c) Investments.

Investments represent one of the most difficult problem in long-term projections and input-output tables. The difficulties lie in the following:

How to calculate necessary investments for production? Investments can not be determined without previous determination of output because the required investments in the planned period are given by the planned volume of output and investment intensity of this output. In this way primary are outputs and secondary are investments. Here the short-cut is done because on the basis of planned output we calculate the necessary capacities and through the value of fixed assets which will cover these capacities we can come to investments (some of these problems are explained in another memorandum No. 636 PART IV dealing with the balance of fixed capital and labour resources).

Nevertheless the assumption of input-output technique is contradictory. We must determine the required investments as the component of final consumption if we want to calculate the necessary outputs.

Even in case when we estimate the future outputs according to the individual branches of the national economy we shall face great difficulties in calculating the necessary investments because of a time lag between investments and outputs. It is possible to calculate the investments at the beginning of long-term projection according to the planned outputs at the end of the period taking into consideration the average time lag between investments and output in the branch. But how to calculate necessary investments at the end of long-term projection? This is a very difficult problem which must be solved.

Another difficult problem in linking up the investments with production is the calculation of investment to output ratios. It is supposed that these ratios will be calculated on the basis of technico-economic conceptions and individual investment projects.

It seems reasonable to begin calculations by means of input-output tables with roughly estimated investments in final consumption and repeat several times the calculations and by an iterative way to link up investments and outputs.

d) Foreign trade.

The first problem is how to treat foreign trade (imports and exports) in input-output tables for the purposes of long-term projection. In the case of Czechoslovak economy this problem is very serious because of a significant role of foreign trade in economic development. In my opinion it is necessary to differentiate inside the input-output table the consumption of local production on the one hand and the consumption of imported production on the other hand. Inside imported production it is necessary to differentiate competitive and complementary imports. This treatment of foreign trade is necessary for elaborating many variants in relation to the structure of imports and exports and their influence on the national economy as a whole. By this way it will be possible to solve partially the problem of substitution of domestic production for imports and on the contrary and to seek the most effective (but realistic) alternative of foreign trade in the future long-term economic development. Criteria for the most effective structure of foreign trade may be different. Undoubtedly one criterium must be the equilibrium in the balance of payments, but beside this criterium it will be possible to apply the other criteria: repercussions of the structure of foreign trade on investments, labour forces, material inputs, final consumption.

The second problem is where to receive the necessary information about imports and their utilization in different branches and about exports, in this long-term period. Main sources of information will be the following:

- Technico-economic conceptions where will be contained the specifications of imports and exports according to the individual branches.
- Economic conception of international division of labour and foreign trade where the long-term agreements and cooperation with the socialist countries and studies of foreign markets and prices will be contained.

5. Organization of Works on the Long-Term Projection.

The constructing of the long-term projection will be the subject of great number of economists, planners, technicians and mathematicians on all levels of management and planning (state level, ministry level, enterprise level). Practically thousands of officials of the planning staff will take part in this work. Inside the State Planning Commission special department of long-term projection was created with the aim to coordinate and methodically direct the work on long-term projection. The Academy of Science, and their different departments together with Universities and University colleges will also participate in constructing the long-term projection. Significant role will be played by the sectoral research institutes which together with ministries, associations and enterprises will prepare the technico-economic conceptions of development for the appropriate branches of the national economy. It means that the working out of the long-term projection will be not the matter of a limited group of people, an academic matter, but the instrument by which thousands of practical planners and research workers will be involved into the solution of pressing economic problems within the framework of the long-term projection. It is also supposed that the works on the long-term projection will be organized as team works.

