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ECONOMIC CRITERIA FOR CHOICE OF TECHNIQUE IN
A SOCIALIST ECONOMY
(THEORETICAL FOUNDATIONS)

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Introduction:

The problem of the choice of technique for producing various products still remains one of the most controversial questions in the theory and practice of economic activity in socialism.

Ever growing amount of investments necessary to achieve an increase in production is being made in all industries. Usually, there exists a possibility to achieve this increase in production by making use of various techniques.

In connexion with this fact the problem arises how to insure that the enterprises (industries) realize in each investment the technique most effective to the national economy and thus insure the maximum effectiveness of investment outlays.⁽¹⁾

The solution to this problem is of a vital importance to the national economy because of the long-term effects of investments being undertaken. Undertaking an investment predetermines the conditions of carrying out economic activity during the period of its exploitation which is sometimes as long as several decades.

(1) This problem is also important for the existing enterprises. Of course, the possibility of the choice of technique in existing enterprises are limited. It usually arises in connexion with the problem whether the required production should be manufactured by means of technique used up to now or rather by means of an improved technique.

In a socialist economy, a number of economic indicators have been in use for several years in making the choice of technique in investments. According to the authors who devised the indicators, they should insure the adoption of investments with the techniques most effective to the national economy by enterprises (industries) and guarantee the maximum effectiveness of investment outlays.

The economic significance of these indicators has not yet been sufficiently clarified. This is certainly the reason which explains differences in some respects among economic indicators for the choice of technique in investments used in various socialist countries.

The aim of the present paper is to clarify theoretical foundations of economic indicators for the choice of techniques in producing various products and to define their economic significance.

The considerations and conclusions contained in this paper have at the same time practical importance. A better insight into the economic essence of the indicators used in practice might, in our opinion, contribute to the creation of indispensable conditions for adoption of the most effective technique of producing various products in enterprises (industries).

In our opinion a solution of the problem of the choice of technique for production requires a close link between the problems of the choice and the problem of constructing the central plan for the national economy.

In a planned socialist economy the choice of technique should be made at two levels:

- 1/ at the central level while formulating the central plan,
- 2/ at operational levels while formulating economic plans on their levels.

In the socialist economy the choice of technique should be made first of all in the process of constructing the central plan. Generally speaking the essence of central planning in the socialist economy consists in formulating economic targets to be attained in the plan period, determining the amounts of the means required to attain these targets and co-ordinating these requirements with the available quantities of these means. The central planning board is, however, unable to balance the requirements for objects of labour with the currently produced quantities of them without deciding upon techniques of production in the national economy. The magnitude of the increase in production of the respective kinds of objects of labour depends in a direct way on the techniques of production adopted in the industries which make use of them.

Balancing the requirements for investment outlays and the labour force with the available amounts can be made by the central planning board only after the choice of production techniques has been made.

In a socialist economy the central planning board alone may know all the techniques of production which exist in the national economy. It also knows future trends in production techniques, although one cannot claim

perfect foresight in this respect.

The central planning board may know better general economic conditions prevailing in the period covered by the plan and in the future period, when the selected techniques will be in operation.

This knowledge enables the central planning board to make a direct choice of the techniques of production which will be most effective in the national economy throughout the whole period of their operation.^{1/}

The most effective techniques of production will be those, which make it possible to produce maximum volume of final products in the national economy under prevailing economic conditions, every year while they are in operation.

The final products include newly produced means of consumption destined for individual and collective consumption, means of production (the size of the productive capacity), circulating means and production for export purposes. All newly produced final products constitute the volume of the gross national income.

The adoption of such a measure of effectiveness of techniques in the whole national economy is compatible with the essence and purpose of production in a socialist society and is in perfect agreement with the basic economic law of

1/ Other economic units on the other hand, constitute only a part of the national economy and know the techniques of only that part of the economy. It is therefore impossible for them to select directly the most efficient technique from the point of view of the national economy. They can do that only indirectly - as will be demonstrated later on.

socialism.^{1/}

The choice of the most effective technique of production in the central plan does not guarantee that these most effective techniques will actually be operated in the national economy in practice. It is only a necessary precondition of their realization but it is not a sufficient one.

Techniques of production are actually put into practice first of all by industries and enterprises. If the techniques embodied in the plan are most efficient, it is necessary to see to it that enterprises and industries should realize to the extent possible, techniques analogous to those used in the central plan.

1/ Strictly speaking the means of production (including circulating means) which constitute a part of the volume of final products are not by their essence the aim of the socialist production. It becomes evident when we consider several periods simultaneously. The aim of the socialist production is to insure a constant increase in consumption of the society. That is why a volume of final products in each period must include also means of production and circulating means in order to create conditions for constant rise of the level of consumption in future periods. Some economists define the aim of production in a different way as a maximization of the volume of means of consumption and insuring an appropriate share of the means of production. This definition of the aim of production in socialism is equivalent to the definition stated above. The maximization of the sum of variable magnitude and a constant magnitude takes place by maximizing the variable magnitude.

There exist two methods of transmitting to the enterprises (industries) the decisions of the central planner with respect to techniques:

1. The method of transmitting technical coefficients of the techniques adopted in the plan (for instance quantity of materials used up, labour force, investment outlays) by way of administrative distribution of the means (direct controls).
2. The method of transmitting the system of economic indicators designed to induce enterprises (industries) to make the decision with respect to technique which would be comparable with the central plan.

The progress of research in the field of economic effectiveness of technique in the socialist economy leads to the conclusion, that the second method - formulating a system of economic indicators - is apt to secure the adoption of the technique most advantageous to the national economy and that this method is more efficient than the first.^{1/}

We intend to demonstrate in the present paper that enterprises (industries) will choose techniques congruent with the decisions made previously in the central plan if in their economic calculations they make use of the system of economic indicators obtained from the process of the choice of technique in the central plan.

1/ We take it as an excuse for omitting the method of transmitting the system of technical indicators from further considerations.

The indicators in question are: prices of the manufactured product, raw materials and intermediates and means of production (equal to the planned, socially necessary outlays on labour) wage rates, depreciation quotas, standard indicator of productivity (equal to the marginal coefficient of effectiveness) and standards for differential rent.

On the basis of these indicators each enterprise (industry) may calculate respective prices of manufacturing the product by means of each technique and choose the technique which will guarantee the production at the lowest individual price (the price will be lower at the same time than the official price of the product).

This will be the most advantageous technique to the national economy because it will make possible the production at the lowest outlays in social labour.

The central planning board may also link the incentives of material interest of enterprises (industries) with lowering of the individual price in comparison to the official price. Under such arrangements, enterprises (industries) will do their best to choose the technique which will be most advantageous to the national economy, because it will be, at the same time, most appropriate to promote their individual material interests.

The analysis of the procedure by which the choice of technique is made in the central plan permits us also to evaluate the present methods of determining the efficiency of techniques (investment outlays) in the socialist economy.

The methods currently in use rectify the existing system of prices in such a way, that the adjusted system of prices warrants the choice of techniques which are most advantageous to the national economy.

However, the adjustment of prices is not carried out in a consistent way and takes place only at the stage of investment planning.

The analysis of the process of the choice of techniques in the central plan permits us to draw the conclusion that under the circumstances when the prices will reflect the socially necessary outlays of labour there will be no necessity to use separate methods of the choice of technique. The choice of technique will then be performed on the basis of this system of prices.

II. The Choice of Technique in the Process of Constructing the Central Plan

1. Premises of the choice of technique

The central planning board decides upon a technique of manufacturing from the whole spectrum of techniques existing at the time of formulating the plan.

The choice is made on the basis of knowledge of the following data:

1. Ultimate targets of the social production.
2. Amount of means available to secure the achievement of the production target.

Final products constitute the ultimate target of the social production.

Only when the kinds and the level (minimum and maximum) of the final products is determined is it possible to make the choice of technique of manufacturing these products. It means that the specific targets concerning the structure and volume of the final products constitute primary data for the problem of the choice of technique.^{1/}

The available means determine the techniques which may be used in the central plan to manufacture the assumed final products.

These means are:

1. The assumed magnitude and structure of the investment fund for investment purposes.
2. The existing previously produced means of production and the amount of circulating means in the national economy at the start of the period.
3. Magnitude and structure (professional qualifications) of the labour force to be employed and the conditions of work (including the duration of the working day). In the socialist economy planned employment is as a rule equal to the total labour force in a given period.
4. The assumed level of the wage fund in the national economy and the assumed system of rewarding individual members of the society for achieving the plan targets (hourly wage rate, daily wage rate, monthly wage rates and salaries).
5. The amount, location and kinds of natural resources which may be tapped for production purposes in the plan period.

^{1/} This assertion does not imply, that the choice of technique has no indirect influence on the magnitude and structure of final products. See page 36.

6. Maximum amounts of respective kinds of products which may be imported.

The choice of technique is also influenced by the estimates of: 1. The social demand and foreign demand for the respective final products in the future. 2. The probable increase in the labour force. 3. The magnitude of the investment fund in the future plan periods. 4. Possibilities of tapping additional natural resources and imports from abroad. 5. Technical progress in the future.

There exist numerous techniques of manufacturing in the national economy compatible with full use of the available amounts of means. Depending on the technique chosen, the volume of the final products may be greater or smaller.

The choice of techniques which warrant the achievement of the maximum volume of final products is accomplished in the process of formulating the central plan by the method of successive improvements of the plan.

That is why, at the first stage of formulating the central plan we assume that there are no additional complications which make the problem all the more complex. It is indispensable to the full clarification of the complex problems of the choice of technique in the plan.

We start the explanation of the problem of the choice of technique in the plan by making the following simplifying assumptions:

1. The planning of production is for the next year after a choice of technique in investments. Every investment is built in a year and begins to operate in the beginning of the next year.
2. The existing natural resources make it possible to extract any required amount of raw materials. We assume that the needed amounts of each raw material are extracted in the identical economic conditions.

These simplifying assumptions we discard in the next stages of process of choice of technique in the central plan taking into account more precise requirements of practice.

Besides we assume the following fixed assumptions:

1. The central planning board has a detailed knowledge of all elements of the national economy and disposes over a technique of computation which enables it to elaborate a detailed central plan for the whole national economy.^{1/}
2. The choice of technique is considered within the model of the so called "pure socialism". We assume therefore that there is only one form of property.
3. Labour force and investment outlays is fully mobile, i.e. they may be transferred to alternative uses in production of other kinds of products.
4. There exists a technical possibility of achieving a desired increase of production in every industry.
5. Foreign trade is omitted from consideration.

Under these assumptions the problem of the choice

1. It is justified by the fact that "however, despite the practical impossibility of carrying through such a scheme to the letter, its presentation and, in particular, the specific knowledge of the data which it may be desirable to have, ... may substantially help and give direction to the practical determination of a plan and its indicators as well as in the understanding of particular economic problems". L.Kantorovich: The Best Use of Economic Resources. London, 1965, Pergamon Press, p. 220.

of techniques is reduced to the problem of determining which of the existing techniques of manufacturing is most effective - it means that techniques which make it possible to produce the given volume of final output at the same time are saving the maximal volume of means. It is an indispensable condition of maximum additional increase in the volume of these products, and at the same time of maximal volume of final output.

In order to determine this, the central planning board may introduce first one of the existing techniques of manufacturing each product and then go on to determine the efficiency of other existing techniques in relation to the techniques previously assumed. On the theoretical plan, the central

planning board may begin the choice by assuming, as a first step, any of the existing techniques of manufacturing.

In practice the planning process will be started with the assumption of the techniques which were in use in the plan for the previous period.^{1/}

The assumption of applying the techniques which was in use in the previous period means that in the investment projects one adopts an analogous technique to the technique used in the investment project in the previous period and that the techniques of the existing means of production remain unchanged.

One assumes therefore, that the existing means of production make it possible to repeat the process of production in the plan period in the same scale as before. In the early phase of elaborating the central plan the central planning board may limit itself to the analysis of the plan of the increase of the volume of final products, which will be attained as a result of making use of the investment fund for investment projects based on the technique used in previous periods.

2. Elaboration of the central plan on the assumption of the techniques in investment projects previously in use and economic indices of this plan

The process of elaborating the central plan on these assumptions will run along the following lines:

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- 1/ The problem of the choice of technique both in the central and for the enterprises (industries) consists always in the problem whether the output should be produced by means of the technique used up to now or by means of a new technique (improved).

1. The central planning board starts its work by formulating the hypothesis concerning qualitative and quantitative structure of the increment in final products which are planned to be produced as a result of putting into operation the investment fund.

The assumed plan of increment in final products may be stated in algebraic terms as follows:

$$\left[\Delta x_1, \Delta x_2, \Delta x_3 \dots \dots \dots \Delta x_m \right]$$

where:

Δx_i - absolute volume of increment in the production of the i - final product

i - /1, 2, 3 m/ kinds of final products, a part of them constitute the consumption means for instance 1, 2, 3 c, a part of them are means of productive e.g. c + 1, c + 2 c + d and a part of them are raw materials and intermediates (e.g. c + d + 1, c + d + 2, c + d + e.

2. The second stage of the process of constructing the central plan is to determine the increment of gross products in each industry.

They are greater than final products by the amount of raw materials and intermediates which must be produced in all phases of the process of production of these products.

The increments of gross products is determined on the basis of knowing the amounts of final products and the planned technical coefficients of production resulting from the adopted techniques.

In the circumstances of mutual interdependence among industries the gross products are calculated on the basis of a set of balance equations:

$$\Delta X_1 = A_{11} \Delta x_1 + A_{12} \Delta x_2 + \dots + A_{1m} \Delta x_m$$

where: ΔX_1 - the volume (in physical units) of the
i - gross product (i = 1, 2, 3, m)

A_{ij} - the coefficient of the cumulative material absorption expressing the volume of the product in the i - product which must be produced in the national economy in order to obtain a unit of the j - product (j = 1, 2, 3, m) and meet the requirements of all phases of the process of producing this product.
(In algebraic terms A_{ij} is an element of a matrix which is the reverse of the matrix of technique of production).

On the basis of balance equations it may be seen that the gross products are determined on the assumptions of the data on final products and the techniques of production in the national economy.

3. Knowing the magnitude of increments in the respective gross products and the planned coefficients of labour-intensity for the applied techniques of production it is possible to determine the requirements of each industry for the labour force:

$$\Delta \pi_0 = \frac{\Delta X_1 a_{01}}{w_1} + \frac{\Delta X_2 a_{02}}{w_2} + \dots + \frac{\Delta X_m a_{0m}}{w_m}$$

where:

$\Delta \pi_0$ - the amount of labour force necessary to produce the given increment in gross output.

a_{0i} - the planned coefficient of labour intensity expressing the number of working hours of concrete labour hours required to produce a unit of the i - product,

w_i - the planned number of working hours of a labourer of the i - industry in a year

4. As a next stage in the process of plan construction the increase in requirements for labour force in all industries must be compared to the increase in labour force available to the national economy.

In the case of a divergence between the requirements and the amount of labour available the central planning board revises the original planned increase in final products in accordance with the targets of the long-term plan. The revision of the planned amount of final products and the appropriate revision of gross products is performed by the central planning board until the requirements for labour in the national economy is equal to the available increase in the labour force, i.e.

$$\Delta L = \Delta V_0$$

where: ΔL - the available amounts of free labour force in the national economy in the given period,

ΔV_0 - the requirements for labour in the revised plan of gross output.

5. Simultaneously with the balance of distribution of the increase in labour force the central planning board divides the wage fund for the newly employed among industries. The size of the increase of the gross products and the planned coefficients of wage provide guideposts for the distribution.

$$\Delta V = \Delta X_1 v_1 + \Delta X_2 v_2 + \dots + \Delta X_m v_m$$

where: ΔV - the wage fund of the newly employed workers in the national economy,

v_1 - the planned coefficient of wage for manufacturing a unit of the increment of 1 - product.

6. The knowledge of the increase in gross products and of the planned coefficients of investment characteristic for the techniques used up to now in investments allows to calculate the requirement for investment fund on the part of all industries of the national economy. It will amount to:

$$Z = \Delta X_1 b_1 + \Delta X_2 b_2 + \dots + \Delta X_n b_n$$

where: Z - investment fund necessary to produce given increments of gross products,

b_1 - investment coefficient reflecting the price of an investment^{1/} (investment outlays) per unit of the increment of production.

7. The last stage of constructing the central plan based on technique previously used by the central planning board is to calculate the requirements for investment outlays. The increases of gross products in each industry and the allocation of outlays (various objects of labour, labour and investment outlays) among these industries necessary in the final outcome to produce the assumed volume of final products were determined in this plan.

The plan which is finally adopted contains the maximum increase of final products which it is possible to produce by applying previous techniques in investments under the conditions of a given increase of the labour force. Under these circumstances it is no longer possible to produce final products. The investments additionally introduced into the plan would stand idle without bringing any productive effect to the national economy on account of shortage of the labour force.

1/ according to the assumptions, only the prices of the products produced by means of the adopted techniques are treated as unknowns. We assume, however, that in the period of investing the prices do exist. These prices are determined in a similar way as those which apply for production in the plan period.

On the basis of the elaborate central plan it is simultaneously possible to compute outlays incurred by the society both in the period of exploitation and in the period of investing in order to attain planned increases of various products.

As is well known, production of each product by means of a given technique requires: a definite amount of objects of labour and outlays of living labour. Furthermore, manufacturing a product involves partial wear of the means of production created as a result of investment. This wear is reflected in the depreciation.

$$l_j = [a_{1j}, a_{0j}, u_j]$$

where: l_j - stands for a unit of increase of the j - product
($j = 1, 2, 3, \dots, m$)

a_{ij} - technical coefficient of production expressing the quantity of the i -object of labour used per a unit of the increase of j - product.

u_j - depreciation per unit.

The raw materials intermediates reflected in the coefficient a_{ij} are also products on which objects of labour, outlays of living labour and depreciation were used. These objects of labour were also produced by using objects of labour, living labour and wearing off the means of production etc.

It means that the only outlays which are incurred by the society in production of each product in the period under consideration are outlays of living labour and depreciation outlays (the latter reflect outlays of labour previously made which are transferred to the product).

The outlays in living labour made in all phases of manufacturing the product by the workers of different professions

and degrees of qualification may be added together after the outlays are reduced to simple labour. In the socialist economy, where human work is rewarded according to the quantity and quality of labour (results of labour) comparative differences in the quality of labour are reflected in the planned wage rates.^{1/} It means that the wage fund is on the one hand a measure of the aggregate demand of the community for means of individual consumption and on the other hand a measure of the planned amount of homogeneous labour (simple labour) / used in the national economy in a given period.

An aggregate computation of the outlays of simple labour for the production of each product is performed on the basis of the equations:

$$K_j = A_j + U_j = a_{1j} / v_1 + u_1 / + a_{2j} + u_2 / + \dots \dots \dots + a_{mj} / v_m + u_m /$$

where: A_j - coefficient of the cumulative outlays in living labour, made in the given period in all phases of the process of producing the j - product
 $j = 1, 2, 3, 4 \dots m /$

U_j - coefficient of cumulated depreciation

K_j - coefficient of cumulated outlays of labour (living labour and depreciation).

Coefficients of cumulated outlays of labour for each product indicate, that the distribution of the means among industries in order to attain an increase of production is strictly speaking a distribution of the living labour used in the given period and of a part of labour used previously (i.e. depreciation). The proportions of this distribution are determined by magnitude of the increase of production

1/ In the socialist economy "weighting" the labour of all kinds of workers is performed on the basis of a properly constructed "system of rates" Oskar Lange "Teoria reprodukcji i akumulacji" (The Theory of Reproduction and Accumulation), Warsaw, 1961, PWN, s.18.

and the adopted techniques of production in investments.

Determining the coefficients of cumulative outlays of labour does not exhaust the whole of the outlays of labour, which are made in the national economy to produce an increase of a product. To achieve a unit of a product requires investing appropriate outlays in investment characterized by the technique used up to now. Outlays of labour incurred in the period of investing are called in practice investment outlays.

In order to attain an increase in each product it is necessary to make investment outlays in all phases of the process of manufacturing. Determining a coefficient of cumulative investment outlays requires knowledge of a coefficient of cumulative material absorption for each product and investments coefficients of these materials. This coefficient may be computed by solving the following equation:

$$J_j = A_{1j}b_1 + A_{2j}b_2 + \dots + A_{mj}b_m$$

where: J_j - coefficient of cumulative investment outlays.

It can be concluded therefore that the production of a unit of increase of the j - product by means of techniques previously used requires of the national economy K_j outlays of labour and J_j investment outlays for producing investment. The above indicators describe the technique of producing the j - product. These indicators exhaust all outlays which are incurred by the national economy to produce a given product.

3. The necessity for selecting a progressive technique in the plan

The foregoing analysis of constructing the central plan and conclusions following from it were based on the assumption that in the investments one applies techniques which were in use previously.

The experience of the economic practices in the socialist countries indicate that such a plan cannot guarantee full use of the investment fund. The amount of increase of the final products in the central plan based on the previous techniques in investments is limited by the existing increase of the labour force and not by the investment fund.

A part of the investment fund not used under the circumstances of planning the investments based on techniques previously in use;

$$\Delta I = I - Z$$

where: I - investment fund in the national economy
will be called here surplus of the investment fund.

A surplus of the investment fund creates objective possibilities of adopting in the plan additional investments making possible a further increase in the volume of final products in comparison with the amount already envisaged by the plan. A necessary condition of materializing these possibilities is to guarantee the labour force needed in these investments. It is possible when new techniques are introduced in place of the previous ones allowing production at lower inputs of labour. These techniques are called progressive techniques^{1/}.

1/ "When the labour force is fully employed, as it is actually in the socialist countries, any increase of the national product requires ... application of progressive methods of manufacturing". O.Lange "Pisma ekonomiczne i spoleczne" ("Economic and Social Papers") 1930-1960, Warszawa, 1961, PWN, s.188.

The needs for introducing progressive techniques arise, therefore, out of the necessity for exploitation of the investment fund in the national economy in order to achieve the greatest volume of final products.^{1/}

4. Indicators of the choice of progressive technique
in the plan

The possibilities to manufacture output while saving the inputs of labour exist both for the planned increases in gross products and for the products to be produced with the existing means of labour.

The progressive techniques^{2/} may be applied in the national economy:

1. as a result of replacing the techniques used up to now in investments,
2. as a result of investments replacing means of labour characterized by obsolete techniques,
3. as a result of improving the techniques in the existing means of production,
4. as a result of introducing new raw materials and intermediates in place of the old ones in the production process.^{3/}

The realization of respective progressive technique involves usually investment outlays of different size than the realization of the previous techniques. The investment,

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- 1/ In this connexion one usually stresses the importance of a progressive technique as one of the mainsprings of economic growth and even as the most important mainsprings of all.
 - 2/ The forms of the progressive techniques in investments may be different. They may consist for inst. in the change in technology of production, in increasing the degree of mechanization, in introducing automation in changing the size of the investment projects, in increasing the degree of vertical and horizontal specialization, etc.
 - 3/ Introducing raw materials and intermediates is directly linked with the choice of technique: 1. there is a problem of the choice of techniques in producing these raw materials and intermediates.

outlays may either be the same or greater or smaller.

Accordingly, progressive techniques are referred to as capital-intensive, capital-neutral, and capital saving.

The existence of a progressive technique enables the central planning board to embark on the next stage in the process of constructing the central plan.

At this stage the progressive technique is introduced into the previously elaborated plan (which encompasses both the existing means of production as well as other investments) in order to create a surplus in the balance of the labour force and the volume of final product in the plan is increased.

The size of the volume of this increase depends upon the size of investment outlays which may be mobilized for that purpose from the surplus of the investment fund.

The size of these outlays depends in turn upon:

1. the magnitude of the up-to-now surplus of the investment fund,
2. changes in the surplus of the investment fund caused by the adoption of progressive techniques saving the needed amounts of the labour force.

There can be no doubt that the central planning board should adopt such progressive techniques, which save the needed amounts of labour force while allowing at the same time the maximum excess of the investment fund to be directed toward increasing the volume of final products. The progressive techniques which meet these requirements are the most effective to the national economy!^{1/}

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- 3/ 2. it influences the degree of obsolescence of the techniques of producing raw materials and intermediates used up to now.
 1. It follows then, that not every progressive technique is effective to the national economy.

They will guarantee the achievement of the maximum volume of final product in the ...

The knowledge of the existing progressive techniques enables the central planning board to determine in a direct way, which of these techniques are most effective to the national economy.

The most effective group of techniques is the capital-saving group. These techniques make possible not only saving of labour outlays but also saving of investment outlays.^{1/} In this way they contribute to an increase of the investment fund surplus.

Economic advantages of the progressive techniques induce the central planning board to adopt all these techniques in place of the old ones.

They are characterized by the following economic indicators

$$K_1 - K_2 > 0 \quad \text{and} \quad J_1 - J_2 > 0$$

where: K_1, J_1 - cumulative outlays of labour and cumulative investment outlays necessary to produce a given output by means of the technique used up to now.

K_2, J_2 - cumulative outlays of labour and cumulative investment outlays indispensable to produce a given output by means of a progressive technique.

1/ It is possible to compute the differences among outlays of labour and differences among investment outlays in investment projects characterized by different techniques of production if the investment projects realize identical targets of the general social nature. As is commonly known, the social task of an investment project does not consist only in producing output. The construction of an investment projects allows to accomplish other tasks outside the production sphere e.g. social targets, health targets, political targets etc.

In the economic practice the identity of general social targets is attained by selecting the investment techniques from among the techniques which warrant the accomplishment of both productive targets and non-productive targets. The techniques which do not meet these requirements are left out of consideration.

As a next stage the central planning board adopts in the plan all the techniques of the capital-neutral type.

They are characterized by the following economic indicators:

$$K_1 - K_2 \geq 0 \quad \text{and} \quad J_1 - J_2 = 0$$

The remaining progressive techniques necessary to save the needed amounts of labour force are selected by the central planning board from among the progressive techniques of the capital-intensive type. The most effective of them will be those, which make it possible to save still needed amounts of the labour force at the lowest investment outlays out of the surplus of the investment fund.

In order to select these techniques the central planning board compares the amounts of the saved labour and the size of the additional investment outlays.

The comparison may be made in two forms:

the first form is the so called indicator of the individual recoupment period.

$$T_1 = \frac{J_2 - J_1}{K_1 - K_2} = \frac{\Delta J}{\Delta K} \quad \text{lub} \quad T_1 = \frac{J_2}{K_3 - K_2} = \frac{J_2}{\Delta K} \quad 1/$$

where: ΔJ - additional cumulative investment outlays

ΔK - the size of the saved cumulative outlays of labour

K_3 - cumulative outlays of labour which would have to be incurred in order to produce output with obsolete means of production to be removed.

The reciprocal of the indicator of individual recoupment period is the individual coefficient of effectiveness of investment outlays

1/ The indicator $\frac{J_2 - J_1}{K_1 - K_2}$ is applied in comparing the investment of various techniques. On the other hand, the indicator $\frac{J_2}{K_3 - K_2}$ is applied above all in the analysis of replacement of the existing means of production characterized by a certain technique of investment.

$$Q = \frac{1}{T_1} = \frac{K_1 - K_2}{J_2 - J_1} = \frac{\Delta K}{\Delta J} \text{ or } Q = \frac{K_3 - K_2}{J_2} = \frac{\Delta K}{J_2}$$

The most effective progressive techniques are those which have the highest individual coefficient of effectiveness. In order to select such techniques the central planning board ranks them according to the magnitude of the individual coefficients of effectiveness of investment outlays from the highest to the lowest.

$$Q_1, Q_2, Q_3, Q_4, \dots, Q_{n-1}, Q_n$$

where: Q_j - the individual coefficient of effectiveness of investment outlays in the j -th progressive technique. In the series the inequality holds:

$$Q_j \geq Q_{j+1}$$

The central planning board ends the choice of the progressive techniques in the series at the moment when the last selected progressive technique - together with those previously selected allows to save the needed amounts of the labour force.

Among the progressive techniques adapted in the plan there are techniques which replace those applied up till now in investments, in the existing means of labour or the removed means of labour. It means that there is a common criterion for selecting techniques in investment projects, removing the productive equipment used up to now and replacing it by new investment projects and improving the existing means of labour.

As a result of such a choice of progressive techniques (independent of the technical form) the central planning

board may devote a maximum part of the surplus of the investment fund to increase the volume of the final products and guarantee thereby production of a maximum volume of these products.^{1/}

The remaining progressive techniques with a lower coefficient of effectiveness than the coefficient of effectiveness of the last progressive technique adopted in the plan will not be introduced into the plan, although they enable some branches to operate at lower total outlays of labour than the techniques adopted in the plan. A possible assumption of additional progressive techniques however, would be disadvantageous to the national economy. It would cause:

1. decrease of the volume of final products as a result of increasing the investment outlays for releasing labour force,
2. emergence of a surplus of unemployed labour as a result of releasing it in the amount surpassing the requirements.

The only condition limiting the scope of application of progressive technique in the socialist economy is then the required magnitude of the labour force to be released. It arises in turn out of the need for producing maximum volume of final products.

1/ Assumption of the maximum volume of final products in the central plan and adopting the most effective techniques create the necessity for balancing a new the products with the existing means. The principles of balancing were outlined above.

III. Economic indicators of the techniques adopted in the central plan.

1. Socially indispensable outlays of labour as an economic indicator of techniques adopted in the investment projects

Let us now characterize the coefficient of effectiveness of the adopted progressive techniques in the investments of the capital-intensive type.

Individual coefficients of effectiveness of the investment outlays for each of these techniques are higher than the coefficient of the effectiveness of investment outlays of each not adopted techniques and they are also higher or equal to the coefficient of effectiveness of investment outlays of the last adopted progressive techniques

$$\begin{array}{c} q_1 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ q_k \end{array} \Bigg| \gg q_k > \begin{array}{c} q_{k+1} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ q_{k+n} \end{array}$$

The coefficient of effectiveness of the investment outlays of the last adopted progressive technique in the central plan is called the limiting coefficient of effectiveness of investment outlays and is described by the symbol q^1 . It expresses the limiting effectiveness (saving of labour outlay) which is the minimum effect of each 1 zloty of investment outlays incurred for adopting a progressive technique in place of the technique previously used independently of

1. The reciprocal of this coefficient is called the limiting recoument period and is described by the symbol T.

the industry in which it was adopted.^{1/}

In all progressive techniques adopted in the investment projects in place of the techniques used up to now, definite investment outlays have effectiveness not smaller than the limiting effectiveness:

$$K_1 - K_2 \gg J_2 - J_1/q$$

The progressive techniques adopted in the plan for investment projects may be characterized not only in relation to the techniques used up to now in the investment projects but also in relation to the techniques ~~in the~~ removed obsolete means of production. This assertion holds true also for the investment projects adopted in the plan with the previously used technique (in the case when the adoption of investment project with progressive technique might be ineffective), and for the investment projects with a progressive technique of the capital-saving type.

In comparing investments with the removed means of production, all investment outlays which have been made guarantee the marginal efficiency at least:

$$K_3 - K_2 \gg J_2 q$$

where: K_2, J_2 - economic indices of investment of effective techniques (in some industries the techniques may be progressive in others - the same as before).

1/ As may be inferred the level of the coefficient q stands in the reversed proportion to the amount of the surplus of investment fund and it is directly proportional to the degree of effectiveness of the progressive technique in comparison to the technique previously used. As was demonstrated, the size of the surplus of the investment fund is in turn directly proportional to the size of the investment fund in the national economy and it is inversely proportional to the size of the increase of the labour force in the economy. These factors then determine the level of q and so they determine the scope of application of progressive technique in the national economy.

It means, that the investment outlays in the central plan are not only instruments to expand production, but they are also means to decrease the outlays of labour in the amount of at least q per each unit of investment outlays.

It may easily be shown, however, that each discarded technique warrants lower efficiency of investment outlays the marginal effectiveness:

$$K_2 - K_4 < (J_4 - J_2) / q$$

where: K_4, J_4 - total outlays of labour and total investment outlays in the discarded progressive technique.

Let us analyze the effects of adoption into an already elaborated central plan of an investment project with ineffective progressive technique. Let us assume, that it has the lowest total outlays of labour in an industry. It requires, however, too large investment outlays and its coefficient of effectiveness is therefore lower than the limiting coefficient. The analysis will permit to look at the essence of the limiting coefficient of effectiveness of investment outlays from a different point of view.

The adoption of an investment project with such a technique creates a possibility of saving outlays of labour in this industry. The application of the technique requires however additional investment outlays. The adoption of the given technique decreases accordingly investment outlays incurred in the plan for different kind of production because the whole investment fund in the plan was already disposed of. As a result of this decrease it is necessary to give up an effective technique of manufacturing adopted in the other

industry, because there is not enough investment outlays and in this case it becomes necessary to produce the output by means of an ineffective technique with higher total outlays of labour.

Decreasing the investment outlays for the other industry by ΔJ and producing the output by means of ineffective technique will cause the rise in total outlays of labour by at least ΔJq . The saving of total outlays of labour, however, as a result of applying the ineffective progressive technique will ex definitione be lower:

$$K_2 - K_4 \Delta J_4 q$$

It follows, that striving toward minimization of outlays of labour in one industry may be incompatible with the realization of maximum saving of labour in the national economy as a whole. As a result of using the investment outlays for an ineffective progressive technique the saving of labour in the industry does not imply saving of labour outlays on the scale of the national economy.

Undertaking the production by means of an ineffective progressive technique is connected not only with total outlays of labour, but also with additional outlays of labour in the other production where a definite amount of investment outlays was given up in order to put it into use in an investment project with an ineffective progressive technique. The sum of these outlays reflects social outlays of labour, which are incurred by the national economy to produce an output in an investment project with an ineffective progressive technique. A part of these social outlays of labour are incurred directly (in the investment project which is

planned to produce the output) and a part of them is indirect (in another industry, as a result of lowering the investment outlays there in connection with the realization of the investment project).

These social outlays of labour are higher in the case of applying an inefficient technique than the cumulated outlays of labour in the case of adoption of effective techniques:

$$K_4 + \Delta J_4 q > K_2$$

For this reason it is indispensable to give up investments with an ineffective technique and adopt investments with an effective technique. In comparison to the state after the adoption of investment with an ineffective technique this causes lowering the investment outlays for the production under consideration and makes it possible to devote them for the other production.

The change in the direction of investment outlays causes also in this case a loss of lowering the outlays of labour (increase in the outlays of labour) in the production where the investment outlays have been cut and a lowering of outlays of labour in the production, where the investment outlays have been increased.

It follows then that also in the case of the adoption of an investment project with an effective technique incurring the investment outlays is connected with the loss of a possibility of decreasing the outlays in the other production and influences the level of the outlays of labour.

However, in the case of adoption of an investment with an effective technique the investment outlays will insure saving of labour, which is higher than the maximum increase of outlays of labour in the other production as a result of not investing the outlays in the ineffective technique of producing the output. The maximum increase of outlays of labour will not surpass $J_0 q$ if the investment outlays are J .

The limiting coefficient of efficiency of investment outlays expresses then on the one hand the maximal (minimum) saving of the outlays of labour which should be yielded by each 1 unit of investment outlays in the effective techniques and on the other hand the limiting (maximum) increase of the outlays of labour in the other production where the investment outlays on ineffective technique have not been incurred.

As a result of adoption of an investment project with an effective technique the social outlays of labour will be:

$$K_2 + J_2 q$$

they are lower than (or in some cases equal to) the social outlays of labour incurred in production of a given output in an investment project with an inefficient technique used up to now:

$$K_2 + J_2 q \leq K_1 + J_1 q$$

in comparison with the social outlays of labour which would have to be incurred.

$$K_2 + J_2 q \leq K_3$$

and they are lower than the social outlays of labour on production in an investment project with an inefficient progressive technique:

$$K_2 + J_2 q \leq K_4 + J_4 q$$

Social outlays of labour in the investment projects with an effective technique are lower than the social outlays of labour in any other investment with a technique which has not been adopted. They are the least then:

$$K + J_j = \text{minimum}$$

This amount of social outlays of labour cannot be decreased because any lowering would exclude the production of the required output. The formula $K + J_j = \text{minimum}$ expresses then the socially indispensable outlays of labour on the production of the required output. In other words, the economic indicator which characterizes the investment projects with an effective technique are the socially indispensable outlays of labour on producing this output.^{1/}

On the other hand, producing an output in investments with ineffective techniques requires outlays which are higher than socially necessary. It implies therefore incurring unnecessary outlays of labour.

1/ Dividing the socially indispensable outlays of labour to produce the required increment of production in the effective investment project by the increment of production yields the socially indispensable outlays of labour of producing a unit of the product.

They will amount to:

$$p_j = k_j + J_j q$$

where: p_j - socially indispensable outlays of labour on the production of a unit of j-product,

k_j - total outlays of labour per unit of j-product,

J_j - total investment outlays per unit of j-product,

The above formula is an aggregated formula. The expanded formula of calculating the socially indispensable outlays of labour per unit of j-product is as follows:

$$p_j = k_j + J_j q = A_{1j} / v_1 + u_1 + b_{1j} q / \dots + A_{mj} / v_m + u_m + b_{mj} q /$$

2. Obsolescence of the techniques of the existing means of labour and socially necessary outlays of labour

In the process of the choice of investments characterized by progressive techniques it may be advantageous to the national economy to scrap a part of the obsolete equipment and replace it by new investment. Only these means of production are removed the operation of which require not lower outlays of social labour (superfluous outlays) than the necessary outlays

$$K_3 \gg K_2 + J_{29}$$

Such means of labour are fully worn out in the economic meaning of the term or they may be technically obsolete from the point of view of operating them.

The greater part of the existing means of labour will remain in the central plan.

Although these means of labour are characterized by a lower standard of technique and are obsolete from the technical point of view (they are no longer produced) and the total outlays of labour are higher, it may have some economic advantages to keep them in operation. The advantages may be that the productive exploitation of such means of production incurs outlays of social labour for production purposes only. It incurs no investment outlays.

That is why it may be advantageous to the national economy to keep them in operation rather than replace them by new investments, which would entail the increase of outlays of social labour as:

$$K_2 + J_{29} \gg K_5$$

where:

K_5 - total outlays of labour for production for each of the means of production remaining in the plan.

It means that replacing the effective means of labour by a new investment project will cause the decrease of the volume of final products which might be produced in the national economy.

Production of the output with the existing means of production remaining in the plan is an indispensable condition of achieving maximum volume of final products.

These obsolete means of labour save outlays of labour in comparison to any other alternative way of producing the given volume of output.

An economically justified period of exploiting the existing means of labour lasts till the moment when they stop yielding savings of labour. During the whole period, however, they are effective to the national economy: the exploitation of each of the existing means of labour bringing savings of outlays of labour is an indispensable condition of achieving the maximum volume of final products in the plans elaborated within the period.

The application of a means of labour which saves outlays of labour in one line of production means giving up the possibility of decreasing the outlays in other lines of production. In the case of effective use of every existing means of labour this loss of saving of outlays of labour will not exceed the saving of outlays of labour which have actually been made:

$$/K_2 + J_2q/ - K_5 \gg R$$

where: R - the maximum amount of the loss of savings of outlays of labour (increase of the outlays of labour) in other lines of production as a result of giving up an inefficient use of the existing means of labour.

It means, that the social outlays of labour incurred in producing with the existing means of production will be lowest:

$$K_1 + R = \text{minimum}$$

At the same time they are equal to the socially indispensable outlays of labour on production the output in the adopted investments:

$$K_1 + R = K_2 + J_{29}$$

In the central plan therefore each required production is insured by making outlays of socially necessary labour^{1/} in every means of labour, both in the new means of production (investment projects) and in the old means of production and independently of the level of accumulated outlays incurred in producing the output.

1/ The above calculation of the socially necessary outlays of labour refers to final products and gross products dependent upon final products. As is known, final products were assumed in the plan as primary data. As a result of adopting effective techniques it may turn out, that the production of a definite final product requires much smaller outlays of social labour in the sector than the production of another equally important from the point of view of general social interests. It means that the calculation of socially indispensable outlays of labour provides the basis for making a correction of the previously assumed final products. The correction therefore constitutes another stage in the process of elaborating the central plan.

The existing means of production turn out product at higher total outlays of labour than a new investment project. They insure thereby correspondingly lower savings of the outlays of labour. The comparison of savings of outlays of labour achieved in manufacturing output by means of the existing means of production to the savings of labour in the investment project indicates the degree of efficiency of the existing means of production (the degree of technical obsolescence) or the degree of "or. l" wear).

A lower degree of efficiency of the existing means of labour in relation to investment projects finds its expression in the price of the existing means of production in the given period in relation to the price of investment (that is the amount of investment outlays).

The existing means of production have as a rule a worse technique than the technique adopted in the investment projects. That is why the price of the existing means of labour must be lower than the price of an investment. It should reflect the differences in the quality of the means of labour and the investment. These differences reduce themselves to the differences in the amount of saving of outlays of labour in manufacturing the output. It is therefore necessary to fix the price in relation to the price of investment proportionally to the achieved savings of outlays of labour.

The formula of pricing the existing means of production is as follows:

$$J_{\text{p}} : J_{\text{a}} = R : J_{\text{a}q}$$

where: J_{B} - the price of the existing means of production to be determined.

After reformulating the above equation we obtain:

$$J_{\text{B}} = \frac{1}{q}$$

The price of the existing means of production is directly proportional to the amount of saved outlays of labour and inversely proportional to the level of the limiting coefficient of effectiveness.^{1/}

As a result of such calculation of the prices of the existing means of production the ratio of savings and prices is the same no matter what is the quality of the means of labour and what is the industry concerned. It is equal to the limiting coefficient of investment outlays, i.e. the magnitude q . Therefore the socially indispensable outlays of labour on production of a given output, no matter whether the means of production are new or obsolete, are computed in all cases according to the formula $K + J_q = \text{minimum}$.

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1. It is also possible to demonstrate that the price of the existing means of production in the given period may also be calculated in another way, by subtracting appreciation for the previous period of exploitation from the price of the means of production at the moment of making the investment. The time factor must also be taken into account. The condition of this calculation is, however, that introducing the progressive technique in the national economy should be compatible with forecasts at the moment of investing.

IV. Economic Conditions of the Choice of Effective Technique
in Enterprises (Industries)

i. Stating the Problem

The elaboration of the central plan is a necessary condition of producing a maximum volume of final products in the national economy, because in the absence of the plan it is impossible to coordinate economic activities of enterprises (industries) and select the most effective techniques - the basic conditions of the maximization. It is not, however, a sufficient condition.

It is necessary furthermore to insure that the economic activities of enterprises (industries) are carried out according to the plan, i.e. that they should produce the required quantities of output and adopt the techniques which are most effective for the national economy. Only then, the achievement of the maximum volume of final products will be carried out smoothly because the requirements of all enterprises (industries) for raw materials and intermediates, investment outlays and labour force will be compatible, balanced with the produced amounts of raw materials and intermediates, with the amount of the investment fund and the magnitude of planned employment. Insuring this compatibility constituted a condition of putting into practice the principle of directiveness of the central plan, its superiority in relation to the plans of enterprises (industries)

The central planning board may attain compatibility of economic plans of enterprises (industries) with the targets of the central plan provided:

1. It transmits to the enterprises (through the intermediary of industries) information on the decisions made in the plan concerning the quantity of the required output and the degree of effectiveness of the techniques of production.
2. It creates material incentives inducing the people who carry out the plan to pursue the targets fixed in the plan.

These are economic conditions of the choice of effective technique in the enterprises (industries)

2. Account of outlays of social labour in enterprises (industries)

The central planning board insures the production of the required output in enterprises (industries) compatible with the decisions of the plan by transmitting them the information in a direct way in the form of an order expressed in terms of physical units.^{1/}

1/ The enterprises are unable to obtain the information in another way. It is not sufficient e.g. to transmit the information on the planned socially necessary outlays of labour. This information indicates the adopted techniques of production only and not the volume of output. No enterprise (industry) can get the information on the planned volume of output for the plan period from other enterprises (industries) because it is unable to place orders for a product until it has information concerning the planned amount of production.

The central planning board can, however, insure the adoption of effective techniques of manufacturing in enterprises (industries) by transmitting them economic indicators of the plan in the form of official norms. These indicators are: the socially necessary outlays of labour on producing each product, wage rates, depreciation rates and the coefficient of limiting efficiency.

The social outlays of labour on production of a given product by means of a technique were computed in the central plan on the basis of the formula:

$$A_{1j}/v_1 + u_1 + b_1q + \dots + A_{mj}/v_m + u_m + b_mq \quad 1/$$

When the socially indispensable outlays of labour necessary to produce all products have been determined in the plan, the social outlays of labour on each product may be calculated in a different way, namely:

$$\sum_{i=1}^m a_{ij} p_i + v_j + u_j + b_jq \quad 2/$$

To compute the social outlays of labour by this method one must know only indicators referring to inputs of objects of labour, labour force and investment outlays for each technique of producing the product and economic indicator referring to the manufactured product.

It means that the computations of the social outlays of labour can be carried out by the enterprises (industries) themselves.

1/ See the formula in the footnote p.

2/ In the linear programming the following hold true:

$$\sum A_{ij} /v_i + u_i + b_iq/ = \sum a_{ij} p_i + v_j + u_j + b_jq$$

/i = j = 1, 2, 3, m/.

They know indicators of inputs of raw materials and intermediates, labour force and investment outlays for each technique and they also know the economic indicators of the central plan which have been communicated to them.

As a result of computations of the social outlays of labour on producing a given output by means of each technique and after comparing them with the indicator of the socially necessary outlays of labour the enterprises (industries) will select the most effective technique for the national economy both in investment projects and in the existing means of production. These will be techniques characterized by the lowest social outlays of labour on producing the given output which do not exceed their necessary planned level:

$$\sum a_{ij}p_i + v_j + u_j + b_jq \leq p_j \quad 1/$$

By the same token the enterprises (industries) will discard all other techniques because they require other than the lowest social outlays of labour.

The central planning board communicates indicator of the planned socially necessary outlays of labour for each product in the form of the planned prices of these products^{2/} which will be in force in the period of carrying out the plan. The prices constitute a form of expression of the

1/ This inequality will often appear in practice. The enterprises (industries) know in detail all techniques of production in the planned investment projects and in the existing means of production and that is why they are able to adopt more effective techniques than those adopted in the central plan.

2/ We mean the prices in the turnover among state enterprises and not retail prices. The latter refer only to the means of consumption. The problem of retail prices is left outside the scope of the present paper.

socially indispensable outlays of labour on manufacturing the product.

On the other hand the coefficient of limiting efficiency is communicated in the form of the normative index of rentability. The coefficient of limiting effectiveness may be computed in the central plan as a difference between the price of a product and the planned unit costs,^{1/} referred to the incurred investment outlays. From the point of view of enterprises (industries) it constitutes the planned (normative) indicator of rentability.

The price of each product reflecting the planned socially necessary outlays of labour may be defined then in the following way:^{2/}

$$P_j = \bar{k}_j + b_j q$$

where:

\bar{k}_j - planned costs of producing a unit of j - product in which the used raw materials and intermediates are priced according to the formula $p = k + bq$

The price of a product fixed on the basis of the above formula is called a socialist price of production. The above considerations dealing with the subject of determining the socially indispensable outlays of labour are essentially identical with the considerations on the subject of fixing the prices in the plan. It means that fixing the prices in the

1/ The sum $\sum a_{ij} + v_j + u_j$ constitutes the planned costs of producing a unit of a given product.

2/ The prices of investment goods produced in the period of investing are priced in a similar way (they are equal to the socially necessary outlays of labour) see p. 16.

socialist economy should be strictly connected with the elaboration of the central plan, with the problem of the choice of technique and with determining the quantity of production in this plan. Determining the prices constitutes the reverse side of the process of elaborating the central plan.

As a result of communicating the prices, the norm of rentability and other economic indicators the computation of the social outlays of labour in enterprises (industries) is carried out in the form of the individual price of product. The enterprises (industries) will select as the most efficient those techniques which insure the production of a unit of product at the lowest individual price of product, which is simultaneously lower than the planned price:

$$K_j + b_j q = \text{minimum } p_j$$

As a result of the application of economic indicators of the central plan the choice of technique in enterprises (industries), carried out by the enterprises (industries) and formally independently of the central plan, is in fact compatible with the targets of this plan.

3. Economic incentives and the calculus of the social outlays of labour

Creating the conditions for calculating outlays of social labour in enterprises (industries) does not suffice to guarantee that the enterprises (industries) will select most effective techniques for the national economy. It is necessary in addition to warrant that such a choice will also

1/

be profitable to the enterprise (industry) at the same time.

This condition will be met if the central planning board will order that the saved outlays of social labours per unit of product (the difference between the official and individual price) as a result of choosing a technique for investment and the existing means of production will increase: the incomes of workers of the enterprises (industries).^{2/}

The necessary precondition of such a system of incentive is introducing a payment for making use of the productive funds (which are the results of the investment outlays) equal to the normative level of rentability.^{3/}

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1. It is true that the economic incentives do not solve by themselves all the problems of the economic activity of enterprises (industries). Non-economic motives of the productive activity have a so great importance. Nevertheless, the thesis that fulfilment of the central plan should be attained not only by non-economic incentives but also by applying economic incentives constitutes one of the basic principles of the socialist economy.
 2. The achieved saving of labour in the planned investment is a result of economic activities of a number of units (industry, investor, projecting bureau, building enterprise). There arises therefore the problem of the distribution of savings of outlays of labour among the units. We omit this problem in the present paper.
 3. Introducing this payment is justified by the fact that the planned rentability of enterprises is proportional to the degree of technical equipment of labour. This equipment required from the society definite outlays of labour on investment. On this ground the planned economic effect obtained as a result of these investment outlays should belong to the society and not to the enterprise. The economic relations of an enterprise (industry) with the whole economy are governed by the principle: for investing equals productive funds equal payment to the account of the society.

Under these conditions the incomes of the workers of the enterprise (industry) from producing a unit of a product in the plan period will be calculated by subtracting the expenditure on replacing the worn out means of production, the depreciation fund and payment for using the productive funds from the revenue (equal to the planned price):

$$v_j = p_j - \left(\sum a_{ij} p_i + u_j + b_j \right) / q_j$$

where : \bar{v}_j - the incomes of the workers per unit of product which the enterprise will get as a result of the choice of technique saving the outlays of labour in relation to the planned price.

It means that the enterprise (industry) will obtain the higher incomes the more it will contribute to the covering of social outlays of labour of producing the given product by improving the technique in relation to the technique adopted in the plan.

Under such principles of sharing the incomes of workers in each enterprise (industry) strong incentives must arise toward selecting technique which will insure the production at the lowest individual cost in the investment projects and the existing means of production.

The choice of such a technique is obviously most profitable to the enterprise (industry) because it guarantees maximum incomes.^{1/}

This technique will also be most profitable to the national economy because it insures the production of the product at the lowest social outlays of labour.

1/In practice, the difference among maximum revenues and wages according to the building wage system would constitute the allowance fund. The level of individual incomes would be regulated by means of the tax on incomes (wages and salaries).

In the economic sector (industry) the utilization of resources is determined by the availability of raw materials, labor force and investment. In the economic sector (industry) the utilization of resources is determined by the availability of raw materials, labor force and investment. In the economic sector (industry) the utilization of resources is determined by the availability of raw materials, labor force and investment.

The economic sector (industry) is characterized by the utilization of resources in the production of goods and services. The economic sector (industry) is characterized by the utilization of resources in the production of goods and services. The economic sector (industry) is characterized by the utilization of resources in the production of goods and services.

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4. The calculus of social outlays of labour and incentives in the period of analysis, the technique.

We have considered up to now the application of the economic indicators of the central plan and introduction of material incentives in the stage of elaborating the plan by the enterprises (industries).

The indicators referred to the period when the output would be produced by means of the adopted techniques. It seems that the enterprises (industries) will use planned economic indicators

in selecting the technique for investments and the existing means of production, which will be in force in the period of starting the production by means of the adopted techniques of production, and not the current economic indicators which are in force in the period when the choice of technique is being made.

The economic indicators constituted as the financial indicators in the period of the choice of technique will become current economic indicators in the period when the production on the adopted technique is new (as a result of investment) and previously existing means of production is started.

The indicators constituted an effective tool of insuring the production in the most efficient way to the national economy in this period.

The enterprises will manufacture the output at the lowest individual price because it is most profitable to do so from the point of view of their material interests. In this way they will get the highest incomes for their workers as a result of manufacturing the required output.

That is why the enterprises will be materially interested in initiating and carrying out all undertakings increasing the incomes of the workers (decreasing the individual cost of the product).

The undertakings may consist in improving the quality of the product, lowering the costs of production or replacing unnecessary machines, keeping the stocks in an indispensable amount, etc. The enterprises will also be materially interested in the maximum exploitation of the adopted

techniques by increasing the production (payment for using the productive fund does not depend on the size of production) if there is a demand on the part of the purchasers.

The enterprise will attain then the highest real revenue, and consequently the highest incomes for its workers.^{1/}

V. The Time Factor in the Choice of Technique

1. Introductory Remarks

The time factor occupies a central place in the choice of technique of production. It is connected with the fact that the respective technique in investments (existing means of production) differ with respect to the time of producing the output, the time of construction and the time of operation.

The socialist economy is interested in adopting the techniques in the investment projects (existing means of production) characterized by such times

of construction and times of operation which guarantee the production of the maximum volume of final products in each year of operation.

This is a condition of maximum increase of the rate of economic development.

It follows that the problem of the time factor is strictly connected with fixing the socially necessary outlays of labour on producing the output, and particularly with fixing the coefficient of normative effectiveness (payment for using the productive fund) In other words the time factor is taken into account in fixing the socially necessary outlays of labour.

1/ On this account the enterprises (industries) will be materially interested to adopt the most effective technique in enterprises (at the moment of selecting the investment) As is well known, the choice of technique is carried out by the projecting organizations. That is why enterprises (industries) having regard to their own material interest, will strictly investigate the investment projects from the point of view of efficiency.

2. The importance of the time of production in the choice of technique

The central planning board selects the time of producing a unit of output while selecting techniques of production. The choice of technique may therefore be considered from the point of view of selecting the time of production. It allows us to define the economic significance of the time of production.

Depending upon the time of production the amount of production in various investments characterized by different techniques are different.

If the time of production of a given investment is n years $/ n \leq 1/$ the amount of annual production in the investment - on the assumption of ceteris paribus $-\frac{1}{n}$ units. Consequently the investment coefficient will be $/$ if investment outlays on the investment project are $I/$:

$$b = nI$$

It follows from the equation that the investment coefficient depends on the amount of investment outlays on the investment projects and on the time of producing output. It expresses the time within which the investment is engaged in producing a unit of output. The formula of the most effective technique $\bar{k} + bXq = \text{minimum}$ may therefore be written down as:

$$\bar{k} + nIq = \text{minimum}$$

The formula expresses the influence of the time of production upon the effectiveness of the technique. Shortening the time of production on the assumption of ceteris paribus is always advantageous because it implies lower the investment coefficient and consequently lowering the social outlays of labour on producing the unit at a given time.

of this formula the problem of the efficiency of technique is also solved for a technique which e.g. shortens the time of production by one day but involves higher investment outlays.

The time of production is also reflected in the prices of products calculated in the central plan. The formula of the price: $p = \bar{k} + bq$ may also be written in the following way:

$$p = \bar{k} + n\bar{l}q$$

If in several industries the costs of products and investment outlays are the same, the level of prices in these industries depends directly on the time of production. The price in the industry with higher time of production will also be higher, because then we have higher normative rentability per each unit of output.

If the product could be produced instantaneously, in a timeless way, its price would equal the cost because the normative rentability would then be zero. In this sense, it may be stated that an amount of rentability appears only then (and coefficient of rentability) when the production requires time.

The prices of all products in the central plan were fixed on the basis of the formula $p = \bar{k} + bq$ ^{1/}. It means, that the time of producing means of labour (investments) is also reflected in its price (constituting the investment outlays to the investor):

$$p_b = \bar{k}_b + b_b q = \bar{k}_b + n_b \bar{l}_b q$$

where: p_b - price of the investment (investment outlays)
 \bar{k}_b - costs of the constructing enterprise
 \bar{l}_b - productive funds of the constructive enterprise engaged in building the investment project
 n_b - time of constructing the investment project

1/ The prices of the means of consumption at which a state enterprise sells them to the state trading organizations are also fixed in this way as was explained earlier. See footnote 2 p. 43.

If two investment projects are adopted in the plan requiring equal costs and engaging equal productive funds on the part of the construction enterprise, the investment with shorter time of production will have lower price.

3. The importance of the time of construction in the choice of technique

In making the choice of an investment with a certain technique the central planning board will simultaneously decide upon the time of building the investment.

As was stated earlier the social outlays of labour on producing an investment may also be determined according to the formula taking into account the time of construction $/n_b \leq 1/$:

$$K_b + n_b I_b q$$

Hence, the formula for the choice of effective technique of producing an output in the central plan:

$$\bar{K} + I_q = \text{minimum}$$

where:

\bar{K} - costs of producing a given amount of output in the investment

I - social outlays of labour on producing the investment

may also be written:

$$\bar{K} + \sqrt{\bar{K}_b} + n_b I_b q/q = \text{minimum}$$

On the basis of the above formula it is possible to determine the connexion between the time of constructing and the efficiency of the given investment in a direct way. It indicates, that shortening the time of construction - on the assumption of ceteris paribus - is always advantageous to the national economy. The economic effect of this shortening is a decrease of social outlays of labour incurred on producing the investment, and consequently a decrease of social outlays of labour incurred on output in this investment.

On the basis of this formula it is possible to calculate:

- the effectiveness of adopting an investment with a higher time of construction and higher investment outlays, but lower costs of production,
- the effectiveness of shortening the time of construction of the given investment if it requires additional costs of construction or concentration of a greater amount of means of labour in the construction.

These technical endeavours (and the times of construction) will be effective if they guarantee maximization of outlays of labour on producing the output in the investment.

The choice of an advantageous time of construction has been analysed on the assumption that in all investment projects under consideration characterized by different techniques they are performed within a year. The investment outlays are incurred within a year.

In practice some investments have long times of construction amounting sometimes to two, three and more years. In such cases outlays are made in successive years.^{1/} A possible adoption of an investment with a multiannual construction time freezes up the investment outlays in the economy for a number of years. It excludes the possibility of applying them in other lines of production and causes the decrease of saving (growth) of the outlays of labour in the other line of production.

1. We have assumed up to now that the planned investment projects will be completed within the year. We now discard this assumption. If the time of constructing the investment project takes several years, only a part of the investment is planned to be done within the year in question. It means that such investment project will be completed in a time period longer than the plan period. On the other hand, within the year some investment projects will be completed on which investment outlays were made in the previous years. As a result of this the conditions for the choice of technique in the plan period may be different than the conditions in the past. Consequently the level of planned prices and the limiting coefficient of effectiveness may be different.

Let us assume that in the i 'th year of a multi-year construction period a part of the investment outlays on an investment is made (I_i)^{1/} It has been shown earlier that incurring investment outlays I on a given investment project, causes an increase of the outlays of labour by I_q within a year. These additional outlays of labour increase the social outlays of labour incurred on the given investment. If investment outlays I_i are frozen up for one year, by the end of the year $(i + 1)$ they increase to:

$$I_i + I_i q = I_i (1+q) \quad 2/$$

If the time of freezing-up amounts to two years they increase by the end of the year $(i + 2)$ to the amount:

$$I_i (1 + q) + I_i (1 + q)q = I_i (1 + q)^2 \quad 3/$$

If in successive years $I_1, I_2, I_3, \dots, I_{n-1}, I_n$ investment outlays have been made (where 1, 2, 3, ..., $n-1, n$ - years of construction) the social outlays of labour on producing an investment (investment outlays) amount to:

$$I = I_1 (1+q)^{n-1} + I_2 (1 + q)^{n-2} + \dots + I_{n-1}(1+q) + I_n$$

The above social outlays of labour on producing an investment determine the planned price of the investment taking into account the time of construction and repartition of investment outlays within the period of construction.

1. Investment outlays on a part of an investment planned for the i 'th year are calculated according to the formula of social outlays of labour:

$$I_i = \bar{K}_b + n_b I_b q$$

2. Investment outlays frozen up for one year equal the amount of the investment outlays which would be available in $(i+1)$ year if the investment outlays were not frozen up and if the saving achieved were also devoted to accumulation.
3. It follows from our considerations that the formula of "compound interest" expresses the simple fact of exploiting the achieved saving for accumulation purposes.

(Economic effects of freezing up the investment outlays in the construction period)^{1/}. The investment outlays determined in this way surpass by far the amount of investment outlays incurred in respective year of construction calculated without taking into account the time factor.

A multi-year construction period influences the choice of technique in a direct way. Such investments will be effective to the national economy if the adopted technique guarantees a much larger decrease of costs of production, than the technique in investment characterized by the same investment outlays but shorter time of construction.

4. The influence of the time of exploitation on the effectiveness of technique

So far, we have considered the problem of the choice of technique in investments (existing means of production) on the assumption that in the costs of producing an output depreciation for replacement was taken into account^{2/}. By the same token we have assumed that the exploitation period in investment projects with different techniques were given. Making these assumptions allows us - as will be shown later - the choice of the effective techniques on the basis of knowing the costs in the first year of exploitation only (the other element of the choice are of course the investment outlays).

We shall consider now the factors influencing the length of the economically justified period of exploitation of the respective techniques.

- 1/ The analogous price of an investment may be computed for the construction enterprise if uncompleted production in successive years of building the investment project is treated as an increase of the productive funds. The price of the investment for the constructing enterprise is composed of the planning costs plus normative levels of rentability (payment for making use of the production funds).
- 2/ Depreciation for replacement purposes will be called here for brevity sake depreciation. As is known the planned capital repairs are also connected with depreciation. We will omit the problem of setting aside funds for capital repairs purposes. They are determined in a similar way as depreciation funds for replacement purposes.

The investment project of today with a certain technique will soon become obsolete as a result of carrying out new investments with ever more progressive techniques in the successive years of its exploitation. It will be reflected in the steady rise of current costs^{1/} in the successive years of exploiting the investment in question in relation to the costs in the investments undertaken in these future successive years.

This constant relative rise of costs causes that in a certain year of its exploitation (e.g. t year) it will become effective to the national economy to give up the exploitation of this investment project and replace it by a new investment.

It will happen at the time when:

$$\bar{K}_{3/t/} = \bar{K}_{2/t/} + I_{2/t/} q/t/$$

where:

$\bar{K}_{3/t/}$ - current costs in the t - year of the investment considered today.

$\bar{K}_{2/t/}$, $I_{2/t/}$ - costs and investment outlays in the t - year of the new investment

$q/t/$ - normative coefficient of rentability (effectiveness) in the t - year.

The formula, on the basis of which the time of exploitation is determined in the investment, is analogous to that which served as a basis to determine the period of exploiting the existing means of production. The above formula allows us to determine the moment of giving up exploitation of the considered investment projects with different techniques.

1. We are trying now to determine the time of exploiting the investment projects. We can't determine depreciation unless we know the time of exploitation. It means that it is necessary to make use of the current costs while determining

It does not serve the purpose of computing when this time will come. However, it contains data which are indispensable to compute it. These data are:

1. Data concerning the current costs of the investment in question in the successive years of its exploitation.
2. Data concerning the costs and investment outlays in new investments carried out in the successive years.
3. Data concerning the level of the limiting coefficient of effectiveness in the successive years of exploiting the investment in question.

While making the choice of the planned investment one analyzes therefore not only the conditions of exploitation in the first year but also in the following successive years of exploitation. In this way it is possible to determine the time of exploitation and consequently - annual depreciation. It means that as a result of determining the depreciation it is formally possible to analyze the conditions in the first year of exploitation only while making the choice of technique.

Of course, it is impossible to get exact data on the conditions of exploitation in the successive years of the investment in question. For this reason the time of exploitation may be determined in an approximate way only.

Let us assume that the current costs in the planned investment are changing in the successive years of exploitation by a definite amount s_1 as a result of changes of prices and physical wear. Similarly, the costs and investment outlays in new investments which will be planned in these years

change in the successive years by definite amounts s_2, s_3 .
Let us assume too, that the level of q does not change in
the respective years. We are assuming therefore that:

$$\bar{K}_3/t/ = \bar{K}_3 + s_1 t; \quad \bar{K}_2/t/ = \bar{K}_2 + s_2 t; \quad I_2/t/ = I_2 + s_3 t$$

where: \bar{K}_3 - current costs in the investment in question in the
beginning period

\bar{K}_2, I_2 - costs and investment outlays in new investments
in the beginning period

s_1 - annual increase \bar{K}_3 /positive and negative/ as a
result of physical wear and changes of prices and
wage rates

s_2 - annual increase \bar{K}_2 /in principle negative/

s_3 - annual increase I_2 /positive and negative/

Substituting this data in the formula determining the time
of giving up the exploitation of the investment in question
we obtain:

$$\begin{aligned} K_3 + s_1 t &= \bar{K}_2 + s_2 t + I_2 + s_3 t/q \quad \text{hence} \\ \bar{K}_2 - \bar{K}_3 + I_2 q & \\ t &= \frac{\bar{K}_2 - \bar{K}_3 + I_2 q}{s_1 - s_2 - s_3} \end{aligned}$$

This formula takes into account all the basic factors in-
fluencing the time of exploiting the investment project with
a definite technique, namely future increase of the labour
force, the magnitude of the investment fund in successive
years, development of technique in the future in the industry
and in the national economy and the character of the progres-
sing physical wear.^{1/}

As a result of determining the time of exploiting the
investment projects with various techniques the central
planning board is capable of determining the magnitude of

1/ A detailed discussion of the influence of each of these
factors on the time of exploitation of investment in
question transgresses the scope of the present paper.

annual depreciation which must be included in the costs of producing an output in these investments. It determines them on such a level at the time of giving up the exploitation of the investment that the depreciation fund should be equal to the amount of investment outlays incurred on the investment project. While computing the annual depreciation the central planning board takes into account the time factor, that is the fact the depreciation in the socialist economy is fully repaid until the time of using it for replacement purposes. It brings savings of labour outlays to the national economy proportional to the magnitude of depreciation and the level of the limiting coefficient of effectiveness.

On the assumption that the depreciation constitutes a linear function of the time of exploitation, the annual depreciation for replacement purposes is:

$$A / (1+q)^{t-1} + A / (1+q)^{t-2} + \dots + A / (1+q)^1 = I$$

where: A - the magnitude of the annual depreciation to be determined.

Hence, the annual depreciation for replacement purposes amounts to:

$$A = I \frac{q}{(1+q)^t - 1} \quad 1/$$

As a final result the length of the time of exploitation influences the level of costs in respective investment projects with various techniques by its influence upon the magnitude of depreciation.

1/ The suggestion of computing the depreciation in the socialist economy in this way was first advanced by a Soviet economist A. Lure. In Poland, this suggestion was advanced by O. Lange - "Teoria reprodukcyj i akumulacji" Warszawa, 1961, PWN p.131-132 /The Theory of Reproduction and Accumulation/. He suggests that the annual depreciation on the assumption of continuity should be computed according to this formula $I \frac{q}{e^{qt} - 1}$ identical with the formula stated above.

It influences therefore the level of social outlays of labour too. This implies that the length of the time of exploitation directly influences the degree of efficiency of techniques in investment outlays (existing means of production) and their choice.

5. The Choice of Technique on the Basis of the Individual Price of the Product and the Choice on the Basis of the Time Structure of outlays and revenues

It is possible to demonstrate in another way that the price of a product determined according to the formula $p = k + bq$ takes into account the time factor. It is possible to demonstrate that the choice on the basis of an individual price of product: $\bar{k} + bq = \text{min} \sum p$ yields identical results as the choice on the basis of methods of analysis of the time structure of combined outlays incurred on production both in the time of construction and exploitation and the time structure of combined revenues obtained within the period of exploitation.

Let us reduce the unit outlays and unit revenues to the moment of the end of the time of exploitation. Let us assume that the current costs and prices (revenues) are unchangeable within the whole period of exploitation.^{1/} In order to abbreviate the computations we substitute r in place of $(1+q)$. Then the choice of the most effective technique by the method of analysis of the time structure is performed on the basis of:

1/ The assumptions are necessary in order to show the compatibility of the choice of technique on the basis of individual price and on the basis of the analysis of the time structure.

$$br^t + \bar{k}_e \frac{r^t - 1}{r - 1} = \text{minimum} \ll p \frac{r^t - 1}{r - 1}$$

where: b - the investment coefficient of the given investment computed with taking into account the time of freeze-up of investment outlays in respective years of the construction period

\bar{k}_e - current unit costs

In order to reduce this formula to a basis of comparability with the formula of the choice on the basis of an individual price of product $\bar{k} + bq = \text{minimum}$ where depreciation is included, it is necessary to transform it into another form. As was stated above, the sum of the unit depreciation within the period of exploitation is equal to the coefficient of effectiveness. This formula will be unchanged if we add the magnitude $u \frac{r^t - 1}{r - 1}$ and subtract the magnitude equal b. We obtain then

$$br^t + \bar{k}_e \frac{r^t - 1}{r - 1} + u \frac{r^t - 1}{r - 1} - b = \text{minimum} \ll p \frac{r^t - 1}{r - 1}$$

After the transformation has been made:

$$b(r^t - 1) + (\bar{k}_e + u) \frac{r^t - 1}{r - 1} = \text{minimum} \ll p \frac{r^t - 1}{r - 1}$$

let us substitute k (costs) in place of $(\bar{k}_e + u)$ and let us get $\frac{r^t - 1}{r - 1}$ before the brackets, we obtain then:

$$(\bar{k} + bq) \frac{r^t - 1}{r - 1} = \text{minimum} \ll p \frac{r^t - 1}{r - 1}$$

After reduction of both sides of the inequality by $\frac{r^t - 1}{r - 1}$

we obtain finally $\bar{k} + bq = \text{minimum} \ll p$.

In this way we have demonstrated the identity of both methods of the choice of technique. We have proved then, that the method of the choice on the basis of individual price for

one year takes into account the time structure of the outlays and revenues.

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X

As a result of combining the economic incentives with the minimization of the individual price in relation to the official price the enterprises (industries) will be interested in shortening the time of production, the time of construction and improving the time structure of the investment outlays. It will be advantageous from the point of view of their material interests because it contributes - on the ceteris paribus assumption - to diminishing the individual price and in this way to increasing the incomes of workers of the enterprises (industries).

VI. The importance of the natural factors in the choice of technique

1. Introductory remarks

The above considerations were based on the simplifying assumptions: 1/ that the existing natural resources make it possible to extract any required amount of raw materials which is necessary in the final effect to manufacture final products, 2/ that the needed amounts of each raw material are extracted in the identical, optimal economic conditions, 3/ that the respective locations of investments are equally advantageous.

The central plan elaborated in these conditions prescribed the amounts of each raw material to be produced which arose out of the needs of producing the remaining products in the

national economy. To produce these products one assumed such raw materials (and in connexion with this the technique) which - in relation to other possible substitutes - insured any diminishing of the social outlays of labour. Simultaneously the extraction of respective raw materials in each investment project was insured in the plan at the socially indispensable outlays of labour equal to $\bar{k} + bq = \text{minimum}$.

Now we discard these assumptions. In reality the possibilities of producing the majority of raw materials in the optimum economic conditions are limited. In this connection the central planning board, in order to balance the requirement for the raw materials, will have to plan the extraction of them in relatively worse conditions. Similarly the possibilities of producing the best substitutes are limited and for this reason the board will have to plan the extraction of relatively worse substitutes. Furthermore, the best locations are limited and in connexion with this fact it is necessary to plan the locations of the majority of investment projects in relatively worse conditions.^{1/}

As a result of worse conditions of extracting the raw materials and location of the investment projects the central planning board will have to choose other techniques of production and will achieve smaller volume of final products in the plan, than in the circumstances of only optimal conditions of extracting the raw material and of location of the investment projects.

1/ We omit this problem. It was treated in a paper "Choice of Location in Industrial Projects Evaluation" by Z. Zajda and S. Zawadzki.

2. The influence of different conditions in which natural resources are present on the choice of technique in the central plan.

The choice of technique in the central plan is **simultaneously** the choice of the kind and quantity of raw materials which are to be used in these techniques in order to produce eventually the assumed amounts of final products. The choice of technique may therefore be considered from the point of view of the choice of raw materials (natural resources).

If a definite raw material appears in different economic conditions the central planning board will first exploit in the plan those amounts of the raw material which appear in the best economic conditions. In further stages it exploits successively these amounts of the raw material which appear in the worse economic conditions.

In the relatively worst economic conditions are the amounts of the raw material which are introduced into the central plan at the moment of completing the elaboration of the plan!/^{1/}

The central plan elaborated in this way and the adopted

1. It follows from the above considerations that the factors determining which are the worst assumed conditions of extracting the raw material are : 1/ the requirements for the raw material, 2/ the amounts of raw material extracted in the economically better conditions. Usually, greater quantities of each raw material are planned to be extracted in the period under consideration than in the past period. This increase of raw material may be extracted in better economic conditions than in the previous period. It means that the thesis - that the ever greater quantity of raw material must allegedly be extracted in ever worse conditions - has no economic justification if the problem is considered dynamically.

techniques^{2/} insure the production of the maximum volume of final products which is possible at the given investment fund, the given amount of labour force and the given conditions in which natural resources are present.

Let us characterize in the central plan the economic coefficients of using a unit of raw material extracted in relatively better economic conditions (in comparison to a unit of the raw material extracted in the worst conditions adopted in the plan).

Each unit of such raw material will insure in the adopted techniques a saving of the social outlays of labour to the amount of:

$$h_1 = \sqrt{\bar{k}_3 + b_3q} - \sqrt{\bar{k}_1 + b_1q}$$

where: $\bar{k}_3 + b_3q$ - the social outlays of labour on extracting a unit of raw material in relatively worse conditions

$\bar{k}_1 + b_1q$ - the social outlays of labour on extracting raw materials in relatively better economic conditions (measured according to the previously used formula).

The coefficient h_1 will be called the coefficient of effectiveness of the raw material extracted in relatively better economic conditions.^{2/} In each discussed technique, however, a unit of the raw material insures a smaller saving of outlays of labour than the magnitude h_1 .

1. New, relatively worse conditions of elaborating the plan in comparison to the previously assumed conditions influence the scope of application of the respective technique adopted in the plan. They therefore influence the level of the limiting coefficient of effectiveness of investment outlays and - as will be shown - the price level. In the present paper we omit the mathematical aspects of elaborating the central plan and determining in the plan the economic coefficients in the new conditions.
2. This coefficient expresses therefore the decrease of outlays of labour extracting a unit of raw material in relatively worse economic conditions in relation to the outlays on the extraction in better economic conditions.

The coefficient of effectiveness h_1 performs similar functions to the functions of the limiting coefficient of effectiveness of investment outlays q . It implies that the coefficient expresses at the same time the maximum amount of the lost saving (increase) of the outlays of labour in other lines of production in which using a unit of raw material extracted in relatively better conditions is ineffective.

The indispensable outlays of labour which are incurred in the national economy as a result of using in the adopted techniques of a unit of raw material extracted in better conditions are:

$$\bar{k}_1 + b_1 q + h_1$$

They are equal to the socially indispensable outlays of labour incurred in extracting the raw material in relatively worse economic conditions:

$$\bar{k}_1 + b_1 q + h_1 = \bar{k}_3 + b_3 q$$

Using a unit of a given raw material involves therefore the identical (indispensable) social outlays of labour, independently of the conditions in which it is extracted.

It follows from the above formula that in extracting raw materials in different conditions the socially indispensable outlays of labour are computed according to the previously used formula $\bar{k} + bq$ only for a unit of raw material extracted in relatively worse conditions.

Similarly using a unit of a better substitute in the adopted techniques is effective in relation to the relatively worse substitute (e.g. using gas instead of coal) It brings

the savings of outlays equal at least to h_2 :

$$\sqrt{\bar{k}_3 + b_3q} - \sqrt{\bar{k}_2 + b_2q} \geq h_2$$

where: $\bar{k}_3 + b_3q$ - social outlays of labour on extracting the relatively worse substitute in the amount equal, from the technical point of view, a unit of a better substitute.

$\bar{k}_2 + b_2q$ - social outlays of labour on extracting relatively better substitute (calculated according to the previous formula).

The coefficient h_2 will be called here the limiting coefficient of effectiveness of a relatively better substitute. It expresses a condition of effective use of this substitute. In order to use better substitutes then there it is not sufficient to get any saving of outlays of labour - as was pointed out under the above assumptions - but it is necessary to achieve saving equal to at least h_2 .

On the basis of the considerations similar to the above reasoning it is possible to reach the conclusion that the use of a unit of a better substitute causes a total social outlays of labour to the amount:

$$\bar{k}_3 + b_3q + h_2$$

and that they are equal to the socially necessary outlays of labour on production of a relatively worse substitute!

On the basis of such reasoning of the raw materials which are substituted, each technique in the central plan in which a better substitute has been applied, insures the production of an output at the lowest social outlays of labour.

It means that using another substitute in these techniques would cause a rise of social outlays of labour above the minimum level. Similarly, the application of a better substitute

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1. If a unit of a better substitute in an industry, insuring the limiting effectiveness replaces e.g. two units of the relatively worse substitute, the social outlays of labour on a unit of a better substitute will be twice as high as outlays on a unit of the relatively worse substitute.

priced in this way in the techniques in which worse substitutes were applied in the central plan would cause a rise of social outlays of labour on producing the output. It means that in these techniques using a worse substitute ensures production of an output at the lowest social outlays of labour.

3. The choice of technique in enterprises (industries) taking into account the natural conditions

The central planning board may insure the choice of the most effective techniques in enterprises (industries) which will take into account the limitations in extracting the raw materials if it communicates them economic indicators of the definitely elaborated plan.

The indicators are above all - as was stated earlier - the prices of products and indicators allow to calculate social outlays of labour in each technique: prices of the raw materials and intermediates, wage rates, depreciation rates and the normative indicator of rentability (payment for using the productive funds).

As a result of taking into account the natural conditions it is in addition necessary to communicate to enterprises (industries) which will extract the better substitutes the levels of the limiting annual saving of the outlays of labour H_2 on this account. It is similarly reasonable to communicate to enterprises (industries) extracting the raw material in relatively better conditions the level of the annual saving of labour H_1 .

1. The enterprises which extract a better substitute in relatively better conditions should set a combined indicator of annual saving and outlays of labour on this account from the central planning board. It is: $H_3 = H_1 + H_2$

The central planning board communicates these magnitudes in the form of the norm of the differential rent.

This norm in conjunction with the other economic indicators enables the enterprises to calculate the social outlays of labour on a unit of raw material and compare them with the fixed prices:

$$\bar{k}_j + b_j q + \frac{H_j}{X_j} \leq p_j$$

The annual norm of the differential rent determines the obligatory annual payment to the society on the account of making use of the layers of resources, or better substitute or a given raw material extracted in relatively better economic conditions.^{1/}

The central planning board may fix the annual payment in another way, namely in the form of payment on the planned price of the layer of raw materials.^{2/} The price of the layer is fixed in the amount of "capitalized" annual differential rents (limiting levels of annual savings of outlays of labour)

$$p_z = \frac{H}{q}$$

where; p_z - the price of the layer of raw material appearing in relatively better economic conditions or the price of the layer of a better substitute.

It means that the level of the price of the layer in the central plan depends on the magnitude of the annual saving

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1. At the given price the revenue equal to the norm of the differential rent arises because of extracting the raw material in better conditions (extracting a better substitute) and therefore it is not an effect achieved on account of a better work of those employed in extracting the raw material.
 2. we apply the term "price of the layer" and not "price of the ground" because fixing the latter requires making the choice of the most effective location in addition.

of outlays of labour which it is possible to achieve on this layer,^{3/} the coefficient of rentability being treated as given. It has therefore a close link with the outlays of labour.

It follows from the above formula that the annual norm of the differential rent (payment for using the layer) may be calculated through multiplying the price of the layer by the normative indicator of rentability:

$$H = p_2 q$$

If the price of the layer is included in the planned production funds of the enterprise which will extract the raw material it would be possible then in the central plan to calculate the price of each raw material according to a uniform formula concerning each product:

$$\frac{\bar{K} + Iq}{X} = \bar{k} + bq = p$$

where: I - production funds of the enterprise extracting the raw material in better conditions (or better substitutes). They encompass fixed funds, circulating funds and the price of the layer.

As a result of fixing the prices of all raw materials and products on the basis of the socially indispensable outlays of labour the enterprises (industries) will select techniques in which raw materials are used according to the precepts of the central plan. Better substitutes will therefore be used in the techniques in which they are most effective to the national economy.

3/ Similarly on the basis of the magnitude of annual saving of outlays of labour and the coefficient of rentability it is possible to calculate the price of the obsolete means of production left in the central plan. See p. 38.

The enterprises (industries) strive for the maximization of their incomes (minimization of the variable costs in relation to the fixed price) and hence naturally are inclined in adopting improved techniques, than those accepted in the central plan. In particular, they will strive at saving of the effective raw material costs (substitute). Saving of this raw material will bring higher savings of the outlays of labour than it could be under the assumption of extracting the raw materials only in the best economic conditions.

VII. Concluding Remarks

In this paper we have tried to demonstrate that the problem of the choice of technique in the socialist economy should be considered first of all in the process of elaborating the central plan. Considering the problem in the process of elaborating the plan allows us to assess the importance of the technique as a means of speeding up of the economic development, to indicate the scope of applying the progressive technique in the socialist economy and factors which determine this scope.

In particular, on the basis of analysis of the choice of technique in the central plan it is possible to demonstrate that a condition of achieving maximum effects in the socialist economy is the choice of such technique which will ensure full employment of all members of the society.

The analysis of the choice of technique in the central plan has a basic importance for other reasons as well. In making the choice one simultaneously determines economic indicators (above all prices of the products) and a system

of incentives. On this basis the enterprises (industries) will choose the most effective techniques to the national economy, compatible with the earlier decisions of the central plan.

On the basis of these economic indicators of the central plan the enterprises (industries) may calculate the social outlays of labour which are required by each technique to produce a needed output. On the other hand, the system of incentives will force the enterprises (industries) in an economic way to adopt techniques which will insure the production of an output at the lowest real social outlays of labour. The choice of such technique will be most advantageous from the point of view of their material interests because it will guarantee the maximization of incomes of the employed.

In the paper we have presented the methods of the choice of technique in the central plan under a number of assumptions. We have omitted the analysis of some important elements of the choice. Despite this, however, the process of the choice of technique in the central plan is a very complex one.

However, it is indispensable to economic practice to devote ever more attention to the problem of the choice of technique first of all in the process of elaborating the central plan and determining as a result of this process economic indicators (above all prices) for enterprises (industries). It is then a basic way of increasing the efficiency of economic activity in socialism.

Of course, the elaboration of a detailed central plan is not a realistic task. In practice, the central planning board may elaborate a plan in aggregate terms. In connection with this fact the basic indicators of the plan, the volume of output, technique of production, economic indicators, will be approximate magnitudes.

It seems however, that even such economic indicators may be an effective instrument of guaranteeing, that the enterprises (industries) should choose the technique which are most efficient to the national economy.

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