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Planning the Volume of Investment in the Long-run Period

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Problems of finding the most suitable method for the determination of the volume of investment in the long-run period have not yot been sufficiently solved. The theoretical studies and concepts presented by a number of authors do not go beyond an econometrical-model approach based on capital: output ratios et cet, zhich cannot be applied in the planning processThis is so particularly because of the "model-character" of such approaches; even the most sophisticated model is an extreme over-simplification as compared zith the actual life and problems of the national economy.

Many failures of such theoretical concepts, in my oppinion, are a logical conclusion of an inproper principal approach to the formulation of the problem itself. As a rule, many authors deal zith investment process as an independent category: planning and calculating the volume and rate of grozth of investment is taken as a primary category. As a matter of fact, the plan of investment can be only derived from the general concept of economic development. The aim of investment is to provide new capacities at an amount and structure pre-determined by the long term plan of production and services.

Which is, then, the specific duty and "field of activity" for investment planners and investment planning methodology itself?

As far as the long-run is concerned, two main aspects should be distinguished:

1/ Fixing the material sources of investment/supply side/; i.e.:

- construction capacities,
- capacities of the construction material producers, significantly modyfying the construction capacities;
- capacities of engineering industries
- import limitations.

For the five-year plan, this sources/input/side is almost fixed. For the long run/say, 15 years/, a number of measures can be taken to adjust the capacities available to the volume and structure of investment required, regarding other limitations of a basically macroeconomic substance (maximal rate of investment and other macroeconomic proportions determined by the central political and economic authorities).

2/ Finding the objective criteria and methods of determination of investment required.

The investment planning methodology should develop specific objective criteria and methods by means of which it is possible:

- to determine the volume of investment that must be necessarily spent if the targets formulated in the plan are to be met and - simoultaneously - to offer other alternative solutions if the plan targets are changed,
- to verify the necessity of investment volume, as it is claimed by subordinated authorities in the process of plan preparation,
- to fix some kind of upper limits of investment with regard to the pattern of economic effects that are to be achieved in the respective branche or sector.

Replacement and development investment differ in this methodological respect significantly. Therefore, they will be dealt with separately.

Planning the repacement investment

There are two methods of planning replacement that were widely used by our planners in the past. Unfortunately, they are far from any scientific approach - they are rather remnants of our "planning folklore".

1/ Method Based On Depreciation Rates

The depreciation approach is an typical "folklore inheritance". According to it, the annual volume of replacement investment is identical to the reproduction value of the written-off fixed assets within the planned period.

The annual depreciation rate a /it should be noted, that the straight-line method of depreciation is used/ is an inverse of the estimated service life T_i/assuming the liquidation value is zero/

/1/ $$a_i = \frac{1}{T_i}$$ i = i-th group of the fixed assets

By means of the group depreciation rates a_i; the average service life of the fixed assets is determined:

/2/ $$\bar{T} = \frac{\sum_{1}^{n} F_i}{\sum_{1}^{n} \frac{F_i}{T_i}}$$

F_i = value of the fixed assets in the i-th group

The average "depreciation service-life" is taken as identical with the planned service life in the long run. Thus, the volume of replacement investment equals the reproduction value of the T_i years old fixed assets in the i-th group.

Which are the disadvantages of such a method? The criticism concentrates to the function of depreciation rates.

a/ Depreciation rates and depereciation service life are taken as identical with the planned service life. Consequently, there is no space for alternative solutions, there is no planning in the proper sens of the word, since everything is pre-determined by the depreciation rates. The depreciation rates are, as a rule, fixed for a rather long period/ in the CSSR, the current rates have been effective since 1967 and are expected to be used until 1980, at least/.

Therefore, the identification of the depreciation rates with the plan of replacement is a basically misleading idea for the long-term horizon, where alternative solutions and their comparisons are the essence of planning.

b/ The depreciation rates are an instrument of the current economic policy. The financial and fiscal aspects dominate when the rates are elaborated by the central authorities. In the CSSR, e.g., the current depreciation rates have been significantly affected by the situation in 1967. High profits and inflationary financial resources in the hands of industrial firms were the background that lead to a policy of high depreciation rates. High rates were to reduce firm's disposable profits and thus to contribute to the "tight money policy". The actual service life of the fixed assets/of machines and equipment namely/ are longer than the depreciation rates anticipated. Prevailing fiscal criteria embodied in the depreciation rates make them useless for long-term planning.

2/ Replacement Planned By Means of the Fixed Assets Turnover Period - Static Approach

The essence of replacement planning, according to this method, lies on comparing a series of service-life alternatives and calculating the volume of replacement investment for the respective alternatives. Such an approach, so far, is quite correct. The criticism arises if the methods of calculation of the service life alternatives are analysed.

The average service life ex-post calculated from the statistical data is defined as:

$$/3/ \qquad \bar{T}_t = \frac{F_t}{L_t}$$

F_t = value of the fixed assets in the t-th year

L_t = reproduction value of the fixed assets liquidated in the t-th year.

The meaning of $\bar{T}_t$ calls for further precision. As a matter of fact, $\bar{T}$ is not the actual service life of the liquidated assets; it is merely the turnover period of the fixed assets in the t-th year. Only if the F:L ratio becomes permanent for a long period, the $\bar{T}$ would become the actual ser of liquidated assets.

In the long run, the essence of planning replacement lies in the determination of alternative magnitudes of $\bar{T}$; from which the volumes of replacement investment for the respective alternatives are derived:

$$/4/ \qquad L' = \frac{F}{\bar{T}'}$$

The lower T', the higher L' and vice versa.

Formula /4/ reflects the essence of replacement planning: to confront alternatives of more or less intensive replacement in order to find the most suitable solution for the long run with respect to the limitation. The solution adopted must be consistent with the entire economic plan - this goes beyond the specific field of investment planning.

However, the method lacks dynamic approach. Consequently, the alternative magnitudes of L' - when calculated by means of form /4/ are not consistent to T'. Moreover, the turnover period T defined by equation /3/ is ill formulated, too.

The calculated values of L' as a function of an independent variable T would lead/ in the long run/ to the liquidation of fixed assets at the age of T years only in case of stagnation, i.e. if the volume of fixed assets F remains stable in the long run. In marxist terms, the forms /3/ and /4/ are adequate for the case of simple reproduction only. This, obviously, contradicts the real conditions and even the essence of planning/ the aim of planning is to achieve growth, not stagnation/ and makes the method described, despite its advantages as compared with the "depreciation approach", useless. It is simply another example of surviving approaches inherited from the pioneering times, another example of our "Planning Folklore".

3/ <u>Replacement Planned By Means of the Average Turnover Period - Dynamic Approach.</u>

The drawback of the static approach is offset if the growth factor is included into the formulae. Domar's dynamic models of the depreciation:replacement and replacement:investment ratios can be applied also for a long term projection of replacement investment as a function of variable turnover periods T' as alternative solutions.

Let us briefly develope the dynamic formula of T and L.

If the annual rate of growth of gross investment/1+r/ is given, the volume of gross investment of the t-th year G_t as compared with the original volume of G at the time point 0 is

$$/5/ \qquad G_t = G_o/1+r/^t$$

Gross investment of the year "t" are a composition of replacement L_t(equal to the value of fixed assets liquidated) and of development investment I_t/ equal to the net increment of the stock of fixed assets/:

$$/6/ \qquad G_t = L_t + I_t$$

From /6/; the replacement ratio a_t can be derived

$$/7/ \qquad a_t = \frac{I_t}{L_t}$$

Let us assume a given service life T for all the fixed assets. The volume of fixed assets liquidated in the t-th year is, by definition, given by gross investment/ identical with gross fixed assets increment/ spent T years ago:

$$/8/ \qquad L_t = G_{t-T}$$

Since, by definition, the investment grow at an annual rate /1+r/, the gross investment G_t:

/9/ $$G_t = G_{(t-T)}/1+r/^T$$

Hence, the ratio

/10/ $$\frac{G_t}{L_t} = \frac{G_{t-T}/1+r/^T}{G_{t-T}} = /1+r/^T$$

Introducing the replacement ratio a_t, we obtain

/11/ $$\frac{G_t}{L_t} = \frac{L_t + I_t}{L_t} = /1+a_t/$$

Combining /10/ and /11/:

/12/ $$/1+a_t/ = /1+r/^T$$

The average turnover period of the fixed assets, if formula /12/ is used, equals

/13/ $$T = \frac{\log/1+a/}{\log/1+r/}$$

T is now a function of the replacement ratio "a" and of the rate of growth /1+r/. Compared with the "static" formula /4/ the advantages of the dynamic approach reflected by /13/ can be easily seen.

The volume of replacement investment within a time interval of "t" years equals

/14/ $$L_t = F_o \frac{/1+r/^t - 1}{/1+r/^T - 1}$$

Formula /14/ explicitely defines the volume of replacement investment as a function of two variables: of the rate of growth /1+r/ and of the replacement intensity reflected by means of the average turnover period of the fixed assets T. The magnitude T becomes an actual service life of the liquidated assets if the variables /1+r/ and T/ which is a function of "a"/ remain stable for a rather long period. In other words: The turnover period T says, that the chosen rate of growth of investment and the chosen replacement intensity / measured by means of "a"/ as a long term trend can be achieved only if the fixed assets are liquidated after T years of their service life.

Some experience has been collected in the CSSR in this respect. In metallurgical industries, the analysis of the past development in 1950-70 gave the following results / machinery and equipment/:

Period	Replacement ratio "a"	Turnover period T
1951-55	6.243	31.4
56-60	7.528	26.7
61-65	4.423	19.7
66-70	3.076	28.2
1951-70	4.421	24.2

Varying values of T reflect high fluctuations of the replacement during the last two decades in Czechoslovak metallurgy.

Several alternatives were calculated as a first approximation for the long term perspective 1975-1990, for example:

Alternative 1: The proportions of the most intensive replacement period 1961-65 / i.e. with T = 19.7 and r = 8.95%/ were extended over the next 15 years. This lead to the total volume of replacement investment higher than 30 mld crowns and total liquidation of all the machinery and equipment operating in 1970 by the end of the planned period would be a result of such an alternative.

Alternative 2: The proportions of the entire two decades 1950-70 were extended, i.e. T= 24.2 and r = 7,23%. The total volume of replacement is by one third lower than in the first alternative and approximately 70% out of the assets working in 1970 would be replaced by 1990.

At the present, we intend to use this method for an analysis of the long term trends in the replacement in all the productive branches in the CSSR during last 20 years as a first step to the preparation of the long term replacement projection.

4/ Aplication of demographical methods /vintage approach/

Further refinement of the abovementioned method can be achieved by means some methodological instruments widely used in the demographical statistics.

The stock of fixed assets and its development behave in a manner very similar to that of the population: we deal with such categories as age structure of the assets, procurement, liquidation, age composition of the assets liquidated et cet.

To use the demographical approach, the folowing data must be available:

a/ The composition of the fixed assets with respect to their age in homogeneous groups. For this reason, the asets must be arranged into the groups according to their technical parameters so that in each group only the assets with the same durability and average service life are included.

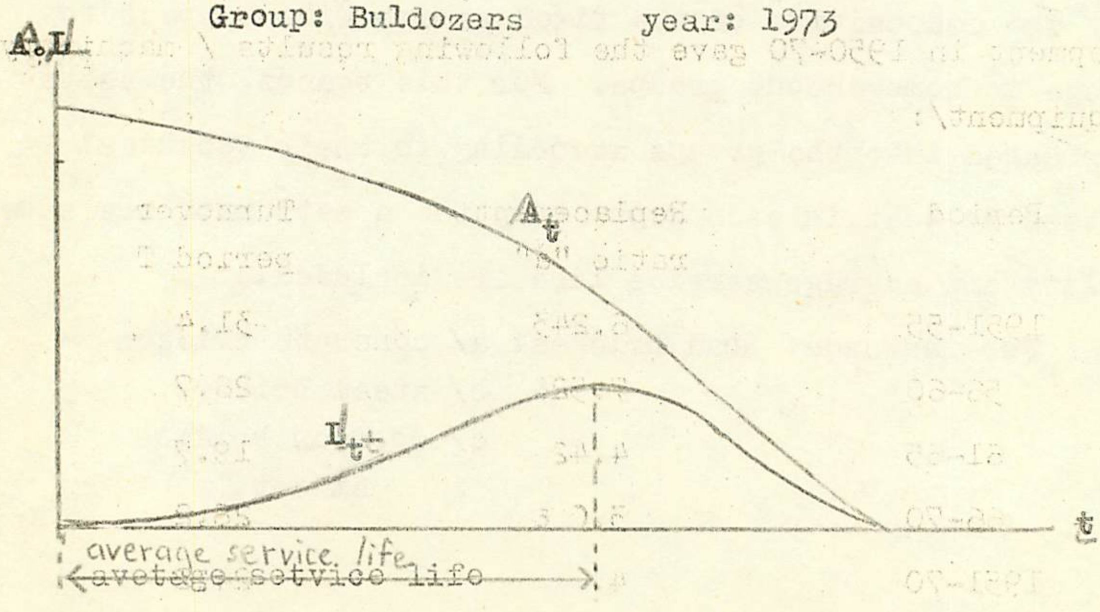
For instance: Road bridges: a/ concrete bridges
b/ steel bridges
c/ woodden bridges
et cet.

In each group, the number of the units and values for every age group are recorded: For machinery and equipment /where the service life does not exceed 10 years/ the yearly groups are recorded, for the machinery and equipment serving more than 10 years the 3-years' groups are sufficient. Structures are usually recorded in five-year age groups.

b/ The distribution of the liquideted asets in each group according to their age.

From the statistical records /or by means of random sampling/, the number of units liquidated in each group is obtained. The distribution of the liquidated assets can be depicted by the following chart:

Group: Buldozers year: 1973



A = number of units operating

L = number of units liquidated

t = age group

c/ The liquidation coefficients

defined as

$$r^h_t = \frac{L^h_t}{A^h_t}$$

h = symbol of the homogeneous group of assets

By means of the coefficient "r", the volume of the assets liquidated in the "h" group of the assets equals

$$L^h = \sum_{t=1}^{t=g} r^h_t A^h_t$$

Provided A and L are expressed in value terms /prices/ the total sum of replacement investment in an industrial or other sector is given by summing L with respect to "h", i.e.:

$$L = \sum_{h=1}^{h=p} \sum_{t=1}^{t=g} r^h_t A^h_t$$

The precision of these calculations highly depends on the availability and reliability of the statistical information.

The essence of planning the future replacement in the long run is then identical with comparing diferent alternatives of the values of r_t^h .

The subsequent alternatives of r_t^h as a token of replacement alternatives can be considered, e.g.:

- reduction of the avarage age of the assets liquidated by means of an uniform increase of r_t^h for each age group,
- total liquidation of old age assets accompanied by reducing the r_t^h for low age groups; this policy may lead to an increase of the average age of the assets liquidated, but- at the same time-the average age of the operating assets may fall.
- substantial increase of the r_t^h for high age groups, but the r_t^h for low age groups is left unchanged.

Planning the development investment

At thepresent, a new approach to the problem of planning the volume of development investment required has been developed in the CSSR.

The following part of my lecture is devoted to a short explanation of this very interesting method.

Five subsequent functions of development investment in a branch are distinguished according to the method:

- securing the increment of production required,
- to achieve the necessary saving of labour force by means of substitution,
- securing the necessary saving/or substitution/ of material inputs /power, fuels, raw materials/,
- to compensate the impact on living conditions by means of additional investment,
- to compensate the deteriorating natural conditions, particularly in mining industries.

The main idea of the method can be formulated as follows: in each branch the aim of investment activity is not to secure new productive capacities /in order to make the increase of output possible/ only. More or less, the other effects mentioned above are expected from investment, as well. The essence of the method is to calculate the amount necessary to achieve the respective effects separately. The more effects /functions/ are required, the more investment can be spent in the branch and vice versa. In such a way, there is a possibility to calculate an upper limit of investment in every branche as it is justified by the effects /functions/ expected and required. The calculation is based on macroeconomic figures and made by the central planning body.

The results obtained are confronted with the plan drafts submitted by branch planning bodies, whose calculations are - as a rule - made "from below", i.e. they are a summary of individual projects, feasibility studies et cet. By means of such a confrontation the plan drafts can be verified and - moreover - some upper limits of investment as a guideline for the branch planners in the first stages of the plan preparations can be fixed.

The volume of investment, as we have said above, is broken down into separate functions. Volumes of investment necessary to achieve each effect are calculated separately.

a/ <u>Investment necessary for output increment.</u>

The total output increment Q is atributed to two factors:

- one portion of ΔQ can be achieved by means of non-investment factors -denoted by ΔQ_{nf}

- provided the total ΔQ required exceeds ΔQ_{nf}, the rest is to be covered by investment factors/ΔQ_{if}/.

Hence,

$$\Delta Q = \Delta Q_{nf} + \Delta Q_{if}$$

Q_{nf} can be achived on theoperating assets after exclusion of permanently idle standing capacities/ assets/. Idle assets are, as a rule a consequence of the shifts in product mix, techneology or co-operation.

By means of mobilizing the non-investment factors/better utilization of operating capacities, be better organization et cet,/ the output-capital ratio will change. Provided the original ratio is

$$/1/ \quad K_o = \frac{F_o}{Q_o} \qquad F_o = \text{value of fixed assets in operation}$$

It can be improved in the plan period: the volume of output increases by ΔQ_{nf}, the stock of assets can by reduced by retiring the idle assets F_n.

The capital: output ratio of the assets operating, that can be achieved in the planned period K_d equals

$$/2/ \qquad K_d = \frac{F_o - F_n}{Q_o + Q_{nf}}$$

Let us call K_d= cap.:outp. attainable.

The investment necessary for securing the second part of output increment ΔQ_{if} is based on the following assumption: The cap.: output ratio of the newly built and invested assets must be as low as the ratio K_d attainable on the operating assets.

Consequently, the fixed assets increment ΔF_1 induced by the increased output is

/3/ $$\Delta F_1 = Q_{nf} \cdot K_d = I_1$$

A short example demonstrates the method

	1975 stat.	1980 plan
1. Output	44 339	55 227
2. Fixed assets	46 778	
3. Idle f. assets	100	100
4. Δ Q planned: total		10 888
5. - non invest. factors		5 988
6. -- /higher capacity load/		/1 100 /
7. -- /higher shifts coef./		/3 788 /
8. -- /new co-operation/		/1 100 /
9. - investment factors /4-5/		4 900
10. Capital-output ratio attainable /2-3/ : /1+5/	0.90	
11. New assets induced for ΔQ_{if} /9x10/		4 410

The volume of output increment achieved by means of non-investment factors can be estimated through expert oppinion. The three main sources of achieving ΔQ_{nf} are shown in the table.

b/ Investment necessary for labour force substitution

As a starting point, the upper limit of labour force to be employed in the branch is given with regard to the general limited labour force resources, L_p.

If the productivity PP_o does not change, the total number of employees necessary for the planned production L_p^* equal

$$/4/ \quad L_p^* = /Q + \Delta Q/ : PP_o$$

Since the upper limit of labour force planned

$$L_p < L_p^*$$

The differnce $L_p^* - L_p$ /a negative increment/ is a relative labour force saving, that must be covered by means of raising the productivity.

The productivity consistent with output and labour force planned PP_p equals

$$/5/ \quad PP_p = \frac{Q + \Delta Q}{L_p} = \frac{Q_p}{L_p}$$

It is possible to raise the productivity by means of non-investment factors and investment factors/ such a breakdown is only partly identical with investment and non-investment factors raising the output/.

After having analysed the non-investment sources raising productivity it is possible to determine the volume of output ΔQ_{np} achieved without any increase of labour force and hence the relative saving of labour without investment/ ΔL_{np}/:

$$/6/ \quad \Delta L_{np} = \frac{Q_{np}}{pp_o}$$

As a rule, the ΔL_{np} is not sufficient/ $\Delta L_p^* > \Delta L_{np}$/. The difference must be covered by means of labour force substitution, i.e. by means of investment:

$$/7/ \quad \Delta L_{ip} = \Delta L_p^* - \Delta L_{np}$$

The volume of investment used for the labour force substitution is based on normative/ marginal/ investment cost per unit of labour force I_{sub} :

$$/8/ \quad I_2 = \Delta L_{ip} \cdot I_{sub}$$

Our short numerical example /continued/ demonstrates the calculation:

	1975	1980
12. Number of employees /thous./	435.6	432.6
13. Productivity	103.1	129.0
14. $L_p^{`}$ /1 : 13 - 1975/		541.5
15. Relative labour saving/14-12/		108.9
16. - non-investment fact.		59.9
17. - investment/subst./		49.0
18. Rate of growth of productivity by non-invest. factors 14: /12+ 17/ %		113.8
19 Marginal subst. cost/thous./		135.-
20. Substitution investment /19x17/		6 615.-

The example reflects the reality of many Czechoslovak industries: the absolute number of employees decreases in the log run and investment spent for labur force substitution exceed that necessary for increased production (compare 11 and 20).

c/ Material inputs saving investment.

Intensive economic development is impossible without a conscious economic policy leading to better use of all the material inputs in the production. Therefore, the plan requires some material saving particularly of imported or genrally deficit materials. As we have demonstrated in the preceding paragraph, in case of material saving the investment and non-investment factors are distinguished.

Material consumption is measured by means of the material coefficient defined as/for original period/

$$/9/ \quad MM_o = \frac{M_o}{Q_o} \qquad M_o = \text{total material consumption}$$

The plan fixes a new progressive ratio

$$/10/ \quad MM_p = \frac{M_p}{Q_p}$$

The total volume of relative material saving to be achieved is

$$/11/ \quad \Delta M_p^* = Q_p \cdot MM_o - Q_p \cdot MM_p$$

The material saving achieved by non-investment factors M_{np}^* is estimated by expert oppinion, the rest /to be covered by means of material saving investment ΔM_{ip}^* equals

$$M_{ip}^* = \Delta M_p^* - \Delta M_{np}^*$$

Given the marginal /normative/ investment cost per unit of material saving, I_{msav}, the volume of investment induced by material saving is

$$I_3 = M_{ip}^* \cdot I_{msub}$$

Short example continues with the material saving investment:

	1975	1980
21. Material coefficient	.58	.55
22. Total mat. consumption	26 057	30 774
23. Total consumption at MM_o	-"-	32 280
24. Relative mater. saving /23-22/		1 606
25. - non investment fact.		1 416
26. - investment fact.		190
27. Marginal per unit investment		5.60
28. Material saving investment total/27x26/		1 064

d/ <u>Investment induced by deteriorating natural conditions</u>

In mining industries, the deteriorating natural conditions are demonstrated by two trends:

- it is necessary to mine in worse condition /geological factor/,
- it is necessary to shift to less favourable ores.

Both trends are not necessarily fully offset by improved technology. Therefore, the per unit investment increases in the course of time.

The exact estimate of the investment induced by both trends can be made by expert analysis only.

e/ Investment induced by the necessity to prevent the deterioration of living environment.

The problem of calculating these investment is, again, dependend on expert oppinion. However, it is possible to elaborate a set of normative techno- economic indicators as guidelinesfor plan estimates. E.g., investment cost for smoke-cleaning per 100MW capacity in the electrical plants et cet.

To sum up the method, the total investment calculated in our exaple can be summarized:

	1975	1980
Fixed assets increment:		
29. for output increment/11/		4 410
30. Labour forces subst./20/		6 615
31. Material saving /28/		1 064
32. Deter. natural cond.		0
33. Living environment		431
34. Total net increment of the assets		12 520
35. Total stock of fixed assets	46 778	59 298
36. Capital: output ratio/35:1/	1.04	1.07

It should be noted, that the capital: output ratio increases in our example despite high efficiency of investment /only efficinet substitution investments are anticipitaded, the utilization of the capacities increases/ only because of high share of substitution investment that do not give capacity effect.

The example shows clearly the main idea of the method described: the more separate effects are attributed to the investment in an industry, the more investment is justified there, and vice versa. In such a way, it is possible to formulate the upper limits of investment in the branche:

- serving as a guideline for the authorities in the respective branches when working on their own draft of investment plan .
- giving some guarantes that the investment calculated will be efficient.