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The Influence of the Time Factor on the Efficiency of Investments

For investments as well as for the other sectors of economic and social life, time is a factor of particular importance.

The process of allocation of investments and of the recovery of the consumed funds is taking place in time, a fact which confers a dynamic character on investments. Thus, the useful effects of investments and, consequently, the economic efficiency of investments will be powerfully influenced by the time factor. In essence, investments represent an action implying certain risks. But, the fact is certain that an important volume of material and human means is consumed, in exchange, the hope exists only that once set in motion, the investment will yield the envisaged effects. It is time that will confirm or invalidate the arguments which were at the basis of the decision of making the investment or will corroborate or deny the economic efficiency expected upon the adoption of that decision.

Undoubtedly, there are a number of possibilities based on calculations for foreseeing what will happen after the investment is put into commission. It should be mentioned, however, that these calculations must refer to various fields of investigation. Thus, it is insufficient to calculate the dimensions and the resistance of the mechanisms and installations, for within the established terms the planned product will be achieved in the envisaged quantities and qualitative conditions but, at the same time, calculations should be made on how the goods will be received on the home market and for export and which are the shifting tendencies of the customers' demands in the foreseeable future.

The relation between investment and time, however, is manifested on multiple planes. The direct effect of investments is the increase of social labour productivity which is materialized in the obtaining of a certain volume of social product with important savings of labour or in the obtaining of a volume of production in a shorter time. It results thereof *that investments*

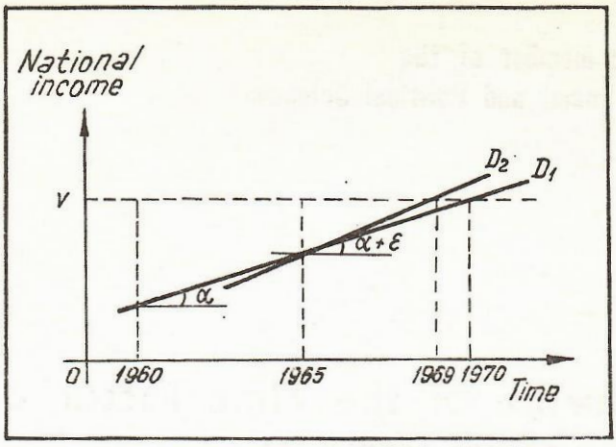


Figure 1

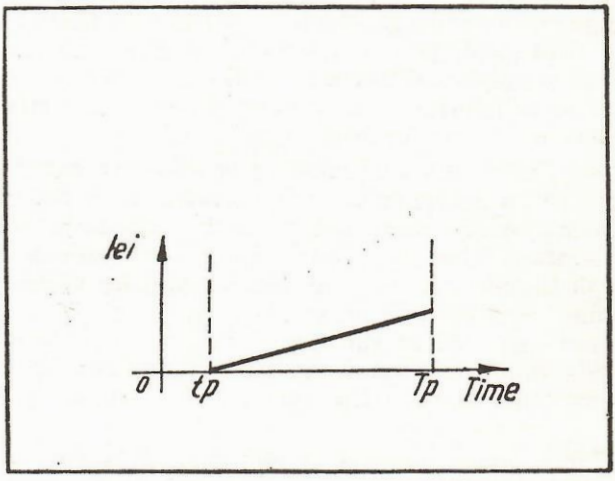


Figure 2
t_p = starting term of designing activity
T_p = finishing term of this activity

mean, in fact, savings of time or, inversely, that time may lead to important savings of investments.

The effects of investments are gradually growing with the increase of time so that in the end *time acts as a multiplier* of the effects of investments.

The achievement of a production capacity in a branch determines the obtaining of a supplementary quantity of production, the bigger as the efficient length of functioning of the respective capacity is longer. On the other hand, the production surplus has effects on the connected branches which, in their turn, determine new supplementary quantities of production in other branches.

As it is known, a certain amount of money invested today is not equivalent to the amount of the same size to be obtained in the future, at a fixed or spaced out date. *The respective amount of money is covering at present bigger costs than in the future.* This is extremely important when the consumed investment funds are compared to the profits resulting from the putting into commission of a fixed asset.

Because of the process of moral wear, the value of a product gradually decreases in the course of time, even if it is not used. Under these conditions, it is supposed that a certain term existed over which the newly created fixed asset no longer achieves products in conditions of efficiency, it is worn morally and consequently, it must be taken out of work, although from the physical point of view, it could still function. Technical progress is rapidly acting in our days, a fact which causes the functioning period in conditions of efficiency to be much smaller than the period of physical existence of a production capacity.

So, it is time that achieves the connection with the general progress of society. The rapid technical progress of the contemporary society makes it necessary to shorten the periods of immobilization of the material assets (in the period of the allocation of the investment and in the period of exploitation of the functioning fixed assets) to the maximum possible.

Investments and time are the elements directly acting on economic growth. The close connection between the two elements and their influence on economic growth can be revealed by a simple and equally suggestive example. Suppose that for the whole of economy, as a result of the investments made, the national income obtained in the 1960—1965 period had a linear variation, represented through the diagram below. By extrapolation, the level V of the national income was to be attained in 1970. The dynamics of the national income for the entire 1960—1970 period is represented by the straight line D_1. Consider tg α the angular coefficient of this straight line.

Let us suppose, however, that beginning with 1965, bigger investment funds could be alloted to the economy. Consequently, the national income had an increase represented by the straight line D_2. Consider tg $(\alpha + \varepsilon)$ the angular coefficient of the straight line D_2. In this case, the level V of the national income was achieved one year earlier, that is in 1969.

Undoubtedly, the analysis of investments can be made also for a certain sequence, but this aspect is only a particular case of the investment and production process which is not taking place instantaneously. Therefore, we admit that the approach to the phenomena of investments may be statical or dynamic. In the first case, we exclude the time factor because in the ana-

lysis of simple economic models, this convention may lead to satisfactory results. A general solution, however, is offered by the analysis in dynamics of the investment phenomena, a fact which implies the taking of the time factor into consideration.

A category of economic calculations refers to the programming of investments so that for the obtaining of the effects expected a minimum volume of means should be consumed or, inversely, maximum economic effects should be obtained on the basis of the ensured volume of means. In this connection, an aspect which should be underlined is *the immobilization of funds, as a first effect of investments.* In their period of allocation, investments entail important fund expenses materialized in material and human assets taken away from the economic circuit and immobilized on building sites. Immobilizations represent losses for economy and they acquire increased proportions to the extent to which the time of immobilization is longer. This phenomenon may be noticed even in the period after the commissioning of the respective investment through the incomplete use of the new production capacities. Indeed, the unused capacity represents an investment without effect, similar to the unfinished investments and determine considerable losses for economy to the effect that the recuperation of the invested funds is not taking place.

In this connection, if we try to divide into periods the examined process, we distinguish:

1. The period in which the material and human means are consumed;
2. The period in which the investment is achieving useful effects (after commissioning).

In this article, we propose to examine thoroughly the effects of the immobilization of funds in the first period. To the same purpose, the influence of four more important elements on the economic efficiency of investments will have to be analysed, namely:

1. the necessary time for the designing of investments;
2. the length of execution of work on the building sites;
3. the way in which the investment funds were spaced out;
4. the effects of the partly commissioning of certain production capacities.

1. THE NECESSARY TIME FOR THE DESIGNING OF INVESTMENTS

At this stage, the immobilized material means do not represent big sums as compared to the human means taken away from productive activity (engineers, specialists, designers with secondary training, etc.). But, what is characteristic is time (the length of execution).

The designing activity which is most often conjugated with the research activity requires a relatively long period of time. In the chain of activities, designing occupies the first place, being the activity with which each investment starts. In all cases, no other activities can be carried out simultaneously with the designing activity, which means that, logically, any prolongation of this activity entails the automatic shifting of all following activities and, finally, they determine a delay in the commissioning of investments and implicitely a delay in the delivery of the finished articles on the market. Therefore, there are many cases when the finished products turned out by the new capacity are practically taken out of competition — being outmoded — already

before their appearance on the market or shortly after the commissioning of the respective capacity. The prolongation of the designing period thus creates profound implications on the economic efficiency of investments.

Without failing too much, it may be admitted that the variation of the immobilization of funds at this stage is lineary, and it can be represented as follows:

2. THE LENGTH OF EXECUTION ON BUILDING SITES

The characteristic feature of this stage are the big funds which are gradually immobilized on the building sites, the entire investment fund being finally immobilized in fixed assets liable to tests and verifications before their commissioning.

Operational research has revealed a number of modern methods for conducting this activity and possibilities for reducing the execution period by a scientific programming of the operations taking place on the building sites.

Of particular importance is the way in which the investment funds are planned on years (and within them, on quarters and months), an element which, as a matter of fact, conditions even the programming of operations on sites. The planning of investments on stages or the spacing out of investments determines direct implications on economic efficiency, a fact which we propose to examine in the following.

3. THE SPREADING OUT OF INVESTMENT FUNDS

Consider the execution duration of an industrial unit. It may be demonstrated that the economic efficiency of investments is the higher as the annual investment funds are smaller in the first years of execution and bigger in the last years.

Suppose we have three variants of spreading out on years of the investment funds I_1, I_2, and I_3:

In this case, variant I_3 is more efficient because it immobilizes, to a smaller extent, the site funds, as can be seen from those expounded further on.

Usually, the calculations made in this respect are based on the formula of compound interest. For the estimation of immobilizations and the determination of more efficient investments, we describe below a relatively simple and conclusive method.

Since we have in view the determination of immobilizations which depend both on the volume of the invested funds and on their duration of immobilization, we propose to operate with the product

$$\text{investments} \cdot \text{time}$$

Time may be expressed in years, quarters, months, decades, weeks or even days. Taking into account the fact that the investments are achieved

(physically) and are recuperated (as funds) in periods of the order of years, we shall operate with the product:

lei · years

Considered in this way, two investments of equal values, having the same — quantitative or qualitative — results and the same execution period, still differ through the immobilized funds, balanced with the immobilization time.

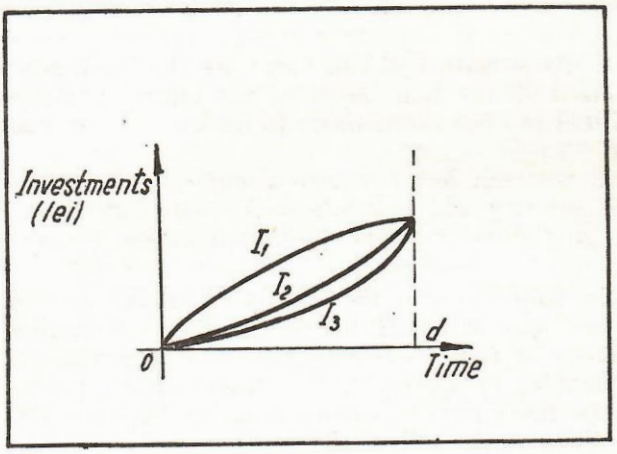


Figure 3

For the estimation of immobilizations, the total investments are decomposed into annual investments (or even in investments on quarters, months, etc.) which are to be introduced into calculation as many times as many years have passed from their incorporation into the physically carried out work to the commissioning of the respective object; the result is related to the execution period, *an average annual value of the immobilizations* being obtained.

To establish the general formula after which the annual immobilizations may be calculated, we note:

i = the number of the variant;
h = the number of years of fund immobilizations;
a_h = annual investments;
d = the duration of execution of the investments (in years);
M_i = the average annual value of immobilizations.

If a fund a_1 was invested in the first year, it means that this value has remained immobilized in each of the following years to the end of the execution period. Correspondingly, investment a_2 in the second year represents another value immobilized in each year (except for the first year). Investment a_{d-1} made in the last but one year of the execution period will remain immobilized only in the last two years, and investment a_d made in the last year represents funds immobilized only in a single year (the last).

In this case, the following matrix can be drawn up:

years	1	2	3	.....	$d-1$	d
investments	a_1	a_1	a_1	.....	a_1	a_1
		a_2	a_2	.....	a_2	a_2
			a_3	.....	a_3	a_3
				.....	.....	.....
					a_{d-1}	a_{d-1}
						a_d

In this case, the annual average of immobilizations is determined with the formula:

$$M_i = \frac{da_1 + (d-1)\,a_2 + (d-2)\,a_3 + \ldots + 2a_{d-1} + a_d}{d}.$$

$$M_i = \frac{\sum_{h=1}^{d} (d-h+1)\,a_h}{d}.$$

Examples:

Let us try to apply this method in the case of two examples. Suppose we have to analyse two variants of investments for which the total volumes of investments and the execution periods are the same, that is:

$$I_1 = I_2 = 1000 \text{ thousand lei}$$

$$d_1 = d_2 = 2.5 \text{ years}$$

where: I_i = the total volumes of investments; d_i = the execution durations; i = variant.

In this case, we examine the spreading out of investments on quarters:

Table 1

(in thousand of lei)

Variant	Year 1				Year 2				Year 3		Total
	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	
1	50	60	70	80	90	110	120	130	140	150	1000
2	30	40	60	80	100	100	120	140	160	170	1000

Practically, it is not necessary to draw up matrices for the two variants. It suffices to number the periods (in our case the quarters) in the table in a

decreasing order, going to calculate the product between the respective investment and the order number of the period inscribed in the column in which that investment is, as follows:

Table 2

Variant	Order number of periods										Total
	10	9	8	7	6	5	4	3	2	1	
1	50	60	70	80	90	110	120	130	140	150	1000
2	30	40	60	80	100	100	120	140	160	170	1000

In continuation, the immobilized average values can be easily calculated:

$$M_1 = \frac{50 \cdot 10 + 60 \cdot 9 + 70 \cdot 8 + 80 \cdot 7 + 90 \cdot 6 + 110 \cdot 5 + 120 \cdot 4 + 130 \cdot 3 + 140 \cdot 2 + 150}{10} =$$

$$= 455 \text{ thousand lei}$$

$$M_2 = \frac{30 \cdot 10 + 40 \cdot 9 + 60 \cdot 8 + 80 \cdot 7 + 100 \cdot 6 + 100 \cdot 5 + 120 \cdot 4 + 140 \cdot 3 + 160 \cdot 2 + 170}{10} =$$

$$= 419 \text{ thousand lei}$$

It results that although the total effort materialized in the investment funds is the same (one million lei) in both variants, the fund immobilizations are different.

As $M_1 > M_2$, the second variant is more efficient.

The economic significance of M_i is that in each period (the quarter, in our case) investment funds of 455 thousand lei, respectively 419 thousand lei were immobilized on an average during the execution period (2.5 years). Let us take the case of investment I_2. Funds of 30 thousand lei were immobilized in the first quarter; in the following quarter, besides them, new investment funds of 40 thousand lei were also immobilized, thus 70 thousand lei in all; in the third quarter, the immobilized funds total 70 + 60 = 130 thousand lei, a.s.o. According to this reasoning, the following investment funds have quarter by quarter been immobilized on the site:

Table 3

(in thousand of lei)

Variant	Year 1				Year 2				Year 3		Quarterly average of immobilizations
	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	
1	50	110	180	260	350	460	580	710	850	1000	455
2	30	70	130	210	310	410	530	670	830	1000	419

It results that the first variant has immobilized, on an average, in each quarter, investment funds totalling 455 thousand lei and in the second 419 thousand lei. Consequently, although it might seem that the two variants are equally efficient, having equal investments (1 000 thousand lei), equal execution periods (2.5 years) as well as equal quantitative or qualitative parameters, the second variant is more efficient because during the making of investments, it envisages immobilizations of smaller funds.

The quarterly variation of the immobilization of investments in the two variants is represented graphically in Figure 4.

It results that the variants in which the spacing out of investments represents a convex curve are more efficient from this point of view, the variant in which the convexity is more pronounced being preferred.

It results from those shown above that in the case of two variants which envisage the same investment funds and the same final effects (the parameters of the fixed assets put into commission), the envisaged execution period is being examined. For economic reasons, the variant envisaging a shorter execution period is preferred. In case that both variants envisage an identical execution period, the average value of immobilizations is calculated, the variant which has M_i = minimum being chosen.

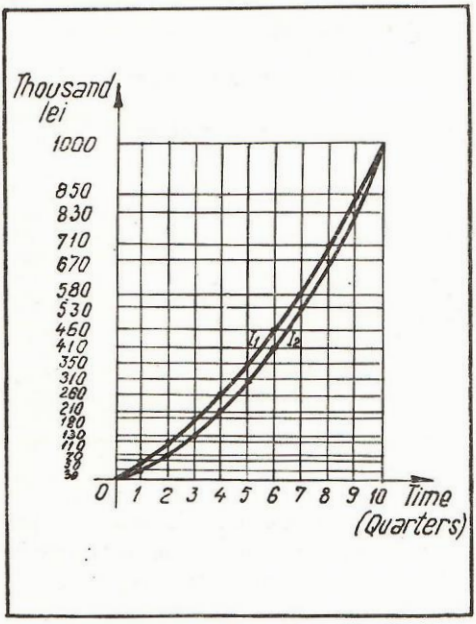


Figure 4

Worth mentioning is that the bigger the investments made are towards the end of the execution period, the more efficient the variant is, the immobilizations being smaller. This easily results also from the examination of the two series of data presented before.

4. THE EFFECTS OF THE PARTLY COMMISSIONING OF CERTAIN PRODUCTION CAPACITIES

In case that before the expiration of the execution period (thus, before the commissioning of the entire objective), certain capacities start producing, it is necessary to make certain changes in the spacing out of investments on quarters, from the examples shown at paragraph 3.

In this case, the sums recuperated through the ahead of term commissioning of certain production capacities are subtracted from the value of the quarterly investments.

Consider a capacity which is commissioned in quarter d-l. Suppose that the following data are known:

q = the quantity of products achieved quarterly;

p = the unitary selling price of products q;

c = the unitary cost of products q.

In this case, the difference (b) between the quarterly value production and the total cost price of this production will be:

$$b = qp - qc = q(p - c)$$

The quarterly investments a_{d-1} and $a_d$will have to be diminished by b. Consider this difference $a'_{d-1}$and a'_d:

$$a'_{d-1} = a_{d-1} - b \text{ and } a'_d = a_d - b$$

Then, the value of M_i is determined as follows;:

$$M_i = \frac{da_1 + (d-1)\,a_2 + (d-2)\,a_3 + \ldots + 2a'_{d-1} + a'_d}{d}.$$

In the general case, when the commissioning of capacity q is taking place in the period j, we shall have:

$$M_i = \frac{\sum_{h=1}^{j-1} (n-h+1)\,a_h + \sum_{h=j}^{n} (n-h+1)\,a'_h}{n}$$

where: ah = the investments of the period; h = the period (year, quarter); j = the year or quarter of the commissioning of the partly capacity q; $n = d$ = the execution period of the whole objective.

*

It has been considered above that the investment variants envisage the same volume of investments (and, in the examples the same execution periods). But, the question may arise what happens when for the building of an industrial objective, the variants envisage different investment funds? In this case, the problem lies not only under the incidence of time factor because apart from this, other factors (the volume of investments, the volume of accu-

mulations, etc.) also intervene, which make that a variant should be preferred to another. In these cases, the recuperation term indicator is used.

In conclusion of the consideration on the spacing out of investments, we should like to underline the fact that as the technical and human means for the achievement of investments are limited, a uniform allocation of investment funds is indicated in practical activity, a fact which allows the easier overcoming of unforeseen difficulties and avoids irregular work characteristic of the months at the end of the year.

INFLUENCE DU FACTEUR "TEMPS" SUR L'EFFICACITÉ DES INVESTISSEMENTS

Les investissements et le temps sont des éléments qui exercent une influence directe sur l'accroissement économique.

L'auteur relève cette relation par l'immobilisation des fonds en tant que premier effet des investissements. Ensuite, on fait l'analyse des effets pendant la période de la comsommation des moyens matériels et humains pour la réalisation des investissements.

L'auteur analyse l'influence des investissements sur l'efficacité économique à l'aide de quatre éléments: le temps nécessaire pour projeter les investissements; la durée d'exécution sur les chantiers de constructions; la façon d'échalonner les fonds d'investissements; les effets de la mise partielle en fonction des capacités de production.

L'auteur recommande la répartition uniforme, en temps, des fonds d'investissements.

ВЛИЯНИЕ ФАКТОРА ВРЕМЕНИ НА ЭФФЕКТИВНОСТЬ КАПИТАЛЬНЫХ ВЛОЖЕНИЙ

Капитальные вложения и время являются элементами, оказывающими непосредственное влияние на экономический рост.

Автор выявляет эту связь при помощи замораживания фондов в качестве первого эффекта капитальных вложений. Далее рассматриваются эффекты в течение периода потребления материальных и людских средств для осуществления капитальных вложений.

Автор подвергает анализу влияние, оказываемое на экономическую эффективность капитальных вложений, при помощи четырех элементов:
время, необходимое для проектирования капитальных вложений; продолжительность выполнения на стройках; способ эшелонирования фондов капитальных вложений; эффекты частичного ввода в действие производственных мощностей.

Автор рекомендует равномерное распределение во времени фондов капитальных вложений.