VOLUME XXX NUMBER 1

Kyoto University Economic Review

MEMOIRS OF THE FACULTY OF ECONOMICS
IN THE KYOTO UNIVERSITY

APRIL • 1960

PUBLISHED BY THE FACULTY OF ECONOMICS
KYOTO UNIVERSITY • KYOTO, JAPAN

ECONOMICS OF DEPRECIATION FINANCING

By

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(1)

The relation between depreciation and equipment investment——which can be formularized
as

Gross equipment investment − Depreciation allowances = Net equipment investment

or

Gross equipment investment = Net equipment investment + Depreciation allowances

Econometric studies on this subject have become very popular after the war, and there is a tremendous volume of literatures that would take us a considerable time for more hurried reading. Reading some of them will reveal that there is a diametrical difference of analytical methods (the objects, forms and procedures of analysis) and results thereof between the writers of West Germany (more broadly, the writers of countries on the Continent, if we include their adherents) and those of America (more broadly, British and American writers if we include their adherents). If we, for convenience' sake, label the former "the German (or Continental) type theory of depreciation financing" and the latter "the American (or Anglo-American) type theory of depreciation financing", and group their studies dealing with this subject in accordance with the above classification, we shall have the following list.

German (Continental) type theory of depreciation financing

West Germany

M. Lohmann, Abschreibung, was sie sind und was sie nicht sind, *Der Wirtschaftsprüfer* 1949, S. 353–357. (vgl. K. Hagest, *Selbstfinanzierung des Betriebes*, Stuttgart 1952, S. 61–62.)

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H. Neubert, Anlagenfinanzierung aus Abschreibungen, *ZfhF* 1951, S. 367--383, 415–423.
H. Langen, Die Kapazitätsausweitung durch Reinvestitionen liquider Mittel aus Abschreibung, *ZfhF* 1953, S. 49–70.
R. Ruchti, *Die Abschreibung*, Stuttgart 1953.
K.H. Forster, *Finanzierung durch Abschreibungen*, Stuttgart 1953.
E. Gutenberg, Der Stand der wissenschaftlichen Forschung auf dem Gebiet der betrieblichen Investitionsplanung, *ZfhF* 1954, S. 557–574.
E. Schäfer, Anmerkungen zum ,Lohmann-Ruchti-Effekt', *ZfhF* 1955, S. 137–140.
K. Hax, Weitere Anmerkungen zum ,Lohmann-Ruchti-Effekt', *ZfhF* 1955, 141–147.
E. Kosiol, *Anlagenrechnung*, Wiesbaden 1955.
K. Hax, *Die Substanzerhaltung der Betriebe*, Höln und Opladen 1957.
K. Hax, Karl Marx und Friedrich Engels über den ,Kapazitätserweiterungs-Effekt', *ZfhF* 1958, S. 222–226.
K. Hax, Die Bedeutung der betrieblichen Abschreibungs-und Investitionspolitik für das wirtschaftliche Wachstum der modernen Industriestaaten,' *ZfhF* 1958, S. 247–257.
F.W. Hardach u. K. Hax, Der Geltungsbereich des Kapazitätserweiterungs-Effektes (Eine Diskussion), *ZfhF* 1958, S. 530–545.

East Germany

O. Kratsch, Zu einigen Abschreibungsproblemen, *Wirtschaftswissenschaft* 1957, S. 551–565.
S. Tannhäuser u. K. Matterne, *Die Grundmittel in sozialistischen Industrie der DDR, Berlin*, 1959, S. 223–232.

France

G. Marechal, Notes sur l'amortissement, *Economie et Politique* 1956, pp. 192–199.

Soviet

С. Борисов, А, Букин, Г. Солюс, Амортизация основного капитала в промышленности капиталистических стран, (Научно-исследовательский финансовый институт, Амортизация в Промышленности СССР, Москва 1956) стр. 213–214.

American (Anglo-American) type theory of depreciation financing

America

R. Eisner, Accelerated Amortization, Growth and Net Profits, *The Quarterly Journal of Economics* 1952, pp. 533–544.
R. Eisner, Depreciation Allowances, Replacement Requirements and Growth, *The American Economic Review* 1952, pp. 820-831.
E.D. Domar, Depreciation, Replacement and Growth, *The Economic Journal* 1953, pp. 1–32.
E.D. Domar, The Case for Accelerated Depreciation, *The Quarterly Journal of Economics* 1953, pp. 493–519.

R. Eisner, Conventional Depreciation Allowances versus Replacement Cost, *The Controller* 1953, pp. 513–514, 533.

E. Schiff, A Note on Depreciation, Replacement and Growth, *The Review of Economics and Statistics* 1954, pp. 47–56.

R. Eisner, Depreciation under the New Tax Law, *Harvard Business Review* 1955, pp. 66–74.

H. Neisser, Depreciation, Replacement and Regular Growth, *The Economic Journal* 1955, pp. 159–161.

R. Goode, Accelerated Depreciation Allowances as a Stimulus to Investment, *The Quarterly Journal of Economics* 1955, pp. 191–220.

S. Davidson, Depreciation, Income Taxes and Growth, *Accounting Research* 1957, pp. 191–205.

England

B. Horvat, The Depreciation Multiplier and A Generalized Theory of Fixed Capital Costs, *The Manchester School of Economic and Social Studies* 1958, pp. 136–159.

Australia

W. Hogan, The Equality of Replacement and Depreciation, *The Economic Record* 1959, pp. 196–208.

In this paper, therefore, the author will examine the structures of the German type and the American type theory of depreciation financing as classified above from the two different angles of the analytical methods employed by each and the results thereof, and will try to clarify the contrast of both types that the former is a theory of enterprise depreciation financing preconditioned by *single equipment investment* whereas the latter is a theory of national economic=enterprise depreciation financing premised by *a constant flow of gross equipment investment.* Assisted by this knowledge of the American type theory of depreciation financing, the auther then hopes to build a theory of national economic = enterprise depreciation financing to be based on a constant flow of gross exuipment investment. Thus this paper is intended to bridge between national economics and enterprise economics through the medium of depreciation financing. However, particularly due to the limitation of space, the author wishes to call the attention of his readers that he will not go any further than presenting the basic scheme of "economics of depreciation financing" as he omits the following phenomena referred to in the above-mentioned studies from his consideration.

(i) Technological progress in equipment production department, which lowers the replacement cost of equipment but promotes replacement by attenuating the economic value of equipment at the same time.

(ii) Rising price levels that elevate replacement cost on the contrary.

(iii) Accelerated depreciation that makes the understatement of profits

possible, especially, accelerated tax depreciation which has an effect of reducing taxes.

(2)

The German type theory of depreciation financing takes as the object of analysis a phenomenon generally called "the Lohmann-Ruchti Effect", that is, when depreciation fund (liquid fund from depreciation) is reinvested in equipment, the period production capacity expands without any change what-so-ever in the total production capacity of equipment.

The author borrowed the terminology of West German scholars which might sound unfamiliar to his readers, but they may as well interpret that the period production capacity of equipment is a concept expressing the quantity of production it can turn out during a certain period of time, say one year, while the total production capacity a concept denoting the quantity of production it can turn out before the existing equipment will be disused. But when we take into consideration the fact that Heubert stated that the total production capacity is a concept denoting value rather than the quantity of delivery, and is the essential basis of the valuation of equipment on a balance sheet[1] and that Hax related that the substance of an enterprise cannot be equated to the period production capacity, but obviously to the total production capacity[2], it might be more appropriate to interpret that the period production capacity is a concept very close to the idea of the use form of means of labor which is the material bearer of fixed capital, while the total production capacity a concept corresponding to the idea of the use value of means of labor.

Now, let us assume an asset, costing $ 1 million and lasting ten years. If the quantity of production the asset can turn out before its useful life terminates amounts to 100 delivery units, the total production capacity will be 100 delivery units, and the annual production capacity will be 10 delivery units. Even at the end of the first year of its service, the annual production capacity will remain at the same level of 10 delivery units whereas the total production capacity at this point of time will be lowered to 90 delivery units. When we write off depreciation allowance of $ 100,000, the book value of equipment by the direct method will be reduced to $ 900, 000 in proportion to the lowering of the total production capacity. If the (liquid) fund of $ 100,000 from the above depreciation is reinvested in a new asset with an assumed life of ten years, the total production capacity

1) Neubert, *a.a.O.*, S. 368.
2) Hax, *Die Substanzerhaltung der Betriebe*, 1957, S. 238.

as well as the book value by the direct method will be increased automatically by 10 delivery units or $ 100,000 respectively, thus resuming their original levels. The annual production capacity on the other hand will rise up to 11 delivery units as a result of the new addition of one delivery unit to the original 10 delivery units. Of course, "such an expanding effect of the period production capacity does not mean any increase in the substance of an enterprise"[3]. It is because "the total production capacity of an enterprise will not be least affected by such a reinvestment policy"[4]. "It is extremely important to note that in this instance, the expansion of the (period) production capacity is not due to self-financing from stated reserve funds or secret reserve funds"[5].

As we have seen above, "the German type theory of depreciation financing" takes as the object of analysis the phenomenon that the period production capacity of equipment will be expanded solely by dint of depreciation financing, and consequently its analytical scheme is based on the following assumptions.

(i) New capital to be invested in equipment will flow into the firm.
(ii) All units of equipment have the same durability.
(iii) Earnings to be realized from the product turned out thereby will at least pay off the original cost of equipment. That is, depreciation allowances will be recovered without fail.
(iv) Depreciation allowance of a certain year will be reinvested automatically at the end of that year in assets of the same kind.
(v) All equipment is divisible into small parts. In other words, depreciation allowances can be reinvested in divisible parts of equipment.

The analysis based on the foregoing assumptions, according to Langen and Kosiol, demonstrated that the period production capacity of equipment would follow the following pattern of expansion.

Assuming that the period production capacity begins at unity, and that the durability of all units of equipment is 10 years, the period production capacity will reach to $2.358=\left(1+\frac{1}{10}\right)^9$ at the end of the 9th year. Then going through ups and downs thereafter, it will gradually be converged to end at $1.818=\frac{2}{1+1/10}$ (Table 1). In general terms, assuming that the period production capacity begins at unity and that the durability of all

3) Hax, *a.a.O.*, S. 238.
4) Kosiol, *a.a.O.*, S. 128.
5) Kosiol, *a.a.O.*, S. 128.

Table I

Year	Period production capacity $n=10$
1	1.0000
2	1.1000
3	1.2100
4	1.3310
5	1.4641
6	1.6105
7	1.7716
8	1.9488
9	2.1437
10	2.3580
11	1.5938
12	1.6532
13	1.7085
14	1.7584
15	1.8011
16	1.8348
17	1.8572
18	1.8657
19	1.8574
20	1.8287

Langen, *a.a.O.*, S. 61.

Table II The Expansion Multiplier=The Limit of Expansion

2	1	3	5	8	10	15	20	30	50	100
$\frac{2}{1+1/n}$	1	1.5	1.67	1.78	1.82	1.89	1.9	1.94	1.96	1.98

Kosiol, *a.a.O.*, S. 129.

units of equipment is n years. it will reach the maximum magnitude of $\left(1+\frac{1}{n}\right)^{n-1}$ at the end of the $(n-1)$ year period. From this point on, it will go through ups and downs and gradually be converged to attain "the expansion multiplier" $=\frac{2}{1+1/n}$ (Table II).

These analytical findings will prove useful for practical application, only if and when all of the foregoing assumptions are satisfied. As Hax has properly stated, "the practical value of a finding from theoretical study depends upon the extent of proximity to reality of the premise upon which it is based"[6], and therefore, should any one of these assumptions be incorrect even partly, the analytical findings therefrom should be modified accordingly.

Following the steps of Hax, Langen and Hardach who realized such problems, the author will consider the proximity to reality of the assumptions upon which the analysis of the German type theory is based, and will explore to what extent are its analytical findings applicable, in hopes to make some modification whereever necessary.

The first and most obvious point to be noted is that the foregoing assumptions missed the corresponding increase of liquid assets that would follow any increase in the period production capacity. The expansion of the period production capacity necessitates a corresponding increase of liquid assets, and if liquid assets in need are not to be acquired with either internal or external capital, a part of depreciation allowances shall be expended for their acquisition. The logical consequence of this will be that the part of depreciation fund that goes to equipment investment will be reduced that much and the expanding effect of the period production capacity will

6) Hardach u. Hax, *a.a.O.*, S. 533.

become weaker. Of course, in this case the object of reinvestment divides into equipment and liquid assets, but what is important for us to note is that the liquid assets in which a part of depreciation fund was reinvested may partly be liberalized n years later for investment in equipment. According to Langen who took this point into consideration, the period production capacity will shift in such a manner as illustrated in Table III, when it is assumed that the period production capacity begins at unity, that the ratio of equipment reinvestment to the total reinvestment is 50%, and that all units of equipment last 5 years. To put it in general terms, assuming that the period production capacity is unity at the outset, that the ratio of equipment reinvestment to the total reinvestment outlays is a, and that all units of equipment last n years, the period production capacity will reach the maximum in the $(n-1)$th year. From this point on, it will go through many changes and gradually be converged to attain the expansion multiplier (the limit of expansion)$=\frac{200n}{200n+a-an}$. Table IV shows the expansion multiplier for a case where n is 5 years and only a varies.

Table III

Year	Period production capacity $n=5$ $a=50$
1	1.0000
2	1.1000
3	1.2100
4	1.3310
5	1.4641
6	1.1105
7	1.1716
8	1.2338
9	1.2967
10	1.3598
11	1.1726
12	1.2092
13	1.2440
14	1.2765
15	1.3061
16	1.2071
17	1.2289
18	1.2483
19	1.2649
20	1.2785
21	1.2263

Langen, *a.a.O.*, S. 67.

Table IV

a	$\frac{200n}{200n+a-an}$
0	1.000
5	1.020
10	1.042
15	1.064
20	1.087
25	1.111
30	1.136
35	1.163
40	1.190
45	1.220
50	1.250
55	1.282
60	1.316
65	1.351
70	1.389
75	1.429
80	1.471
85	1.515
90	1.563
95	1.613
100	1.666

Langen, *a.a.O.*, S. 68.

In the second place, let us examine the point that when equipment is procured with outside capital, it often happens that depreciation and repayment of loans are connected together. In this case, depreciation fund cannot be applied to equiment reinvestment, and quitely naturally no expansion effect will be resulted. However, if the fund recovered by a bank should be loand to another firm, the expansion effect will arise in that firm. But we should remember that the expansion effect moved from the firm that made depreciation allowances to another firm. The same thing will

happen when depreciation allowances of an asset procured with internal capital are invested in an outside business in the form of loan. Thus, whether an unit of equipment is procured with internal or external capital does not make any difference as to the expansion effect from the view-point of the entire economy of a nation.

Thirdly, let us consider the problem that the larger the division of original investment in several pieces of equipment, the greater will become the difficulty of reinvesting depreciation fund in divisible parts of equipment, hence, the greater number of odds left over because they are not large enough to be invested in a piece of equipment. In this case, the longer the period of keeping these odds in the form of liquid assets in relation to the durability before the sums grow large enough to be invested in a piece of equipment, the weaker will become the expansion effect of the period production capacity of equipment or the number of pieces of equipment. Even in this case, it hardly needs to say that the gradual convergence of the period production capacity or the number of pieces of equipment to the expansion multiplier (the limit of expansion) will not be least affect by it. The only but very little change will take place in the way they are converged. That is, they pass lower points than the preceding case, and reach the expansion multiplier, getting rid of odds much faster than we expect. And the age distribution of assets will be, as Hax has made clear, in equilibrium, with $1/n$ pieces of 0 to 1 year old, $1/n$ pieces of 1 to 2 year old, $1/n$ pieces of 2 to 3 year old$\cdots\cdots 1/n$ pieces of $n-1$ to n year old. Here, the number of disused pieces will become exactly equal to that of newly acquired pieces. In other words, replacement of equipment will be done merely.

Lastly, and in connection with what have been said above, we should not overlook the possibility of causing a loss in sales under certain business conditions if the expansion of the short period production capacity acts towards increasing products for sale. In this case, the feasibility of depreciation financing will be restricted by both the difficulty of recovering depreciation charges and the reduced demand for equipment investment.

So far, the author has presented the analytical results drawn from the approximation to reality of the assumptions laid as an analytical scheme just as Hax, Langen and Hardach did. But, excepting the last problem, the analytical results after modification do not differ in essence from those before modification. It is clearly shown as was before that the period production capacity of equipment and the number of assets would continue to grow larger, and would reach to the expansion multiplier that entirely depends upon their durability and the ratio of equipment reinvestment to the total reinvestment. And these analytical results certify the proposition of the

"German type theory of depreciation financing" to be true; that is, the expansion of the period production capacity of equipment or of the number of assets can be effected by depreciation financing. But we must not overlook that this proposition is missing an important premise. In order to bring it to light, let us examine the first assumption, "new capital to be invested in equipment will flow into the firm"[7]. When Hax says "the first assumption means that new capital to be invested in a new machine flows into the firm from outside"[8], it is not clearly shown whether the capital that flows into the firm from outside means only that capital formed from outside by capital stock financing or borrowing, or does it include the capital formed within the firm by self-financing as well. In any case, it is infallibly based on the indispensable premise that the newly formed capital will be applied to net equipment investment first. Therefore, it seems better to rewrite the proposition of "the German type theory of depreciation financing" as follows: Once the newly formed capital is applied to net equipment investment, the said firm can expect merely from depreciation financing the expansion of the period production capacity of equipment or of the number of assets, and the larger the net equipment, the greater the expansion will become.

Extending the scope of validity of the above-said proposition to the national economy, Hax deduced "the macroeconomic effect"[9] as follows.

The expansion effect of the period production capacity by depreciation financing will be brought about in a newly established firm or a firm which is expanded markedly with the assistance of newly supplied capital. Whether an expansion of individual firms such as this may step in the realm of a national economy depends upon how large a percentage of a national economy do new such firms occupy. In highly developed industrial countries such as the United States and England, new firms and markedly expanded firms are only a small percentage of the entire economy. Therefore, an expanding tendency such firms show at the beginning of their existence can produce only insignificant effect as a whole. (Here, a portion of equipment almost equal in value to depreciation allowances will be discharged.) On the other hand, in a relatively young industrial country like Soviet Russia, which (overcoming the deficiency of money capital by forced saving,) has an enormous volume of newly constructed equipment, an expanding tendency (of the period production capacity) generated by continuous reinvestment of

7) Hax, *a.a.O.*, S. 236.
8) Hax, Die Bedeutung der betrieblichen Abschreibungs-und Investitionspolitik für das wirtschaftliche Wachstum der modernen Industriestaaten, *ZfhF* 1958, S. 255.
9) Hax, *a.a.O.*, S. 257.

depreciation allowances will act on the entire economy. (Here, depreciation allowances will be larger than the replacement cost of the portion of equipment discharged from the production line.) But this does not serve as an evidence that the delivery (output) capacity of the Soviet economic system is larger, but only shows that the stage of industrial progress of Soviet Russia is different. The rapid growth (of the period production capacity) during the construction period (of an industrial country) is an once-for-ever phenomenon that will come to an end when the entire economy is visited by the equilibrium stage that is attainable ultimately in case of individual firms.

The foregoing is a faithful representation of the so-called "macro-economic effect" deduced by Hax from his "micro-economic study of the expansion effect". (The complements in the brackets are the words chosen by the author from the original thesis in his attempt to clarify Hax's points or arguments.) In this we can see that there are such parts which witness Hax's correct insight founded on an extremely sharp, though intuitive, reasoning, but interwoven in them are several other parts demonstrating wrong recognition of facts due to his neglect of the limitations of "the German type theory of depreciation financing."

A good example of his correct insight can be found in that part where, maintaining that the way how the expansion effect manifests itself in the entire national economy depends upon how heavy is the weight that large net equipment investors carry in the national economy. Hax ascribed the real cause of the different manifestation of the expansion effect in the United States and Soviet Russia to the different sizes of net equipment investment in both countries. It is because the larger the net equipment investment of a national economy, the greater will be the expansion effect. But it may not be concluded from this that the difference of the stages of industrial progress of the United States and Soviet Russia is responsible for the difference in the sizes of their net equipment investment. It should rather be interpreted this way; the difference of their economic systems brought about the difference in the sizes of their net equipment investment, hence caused different manifestation of the expansion effect. Besides, we cannot say that the expansion effect in Soviet is a phenomenon that happens once for ever. Such mistake originates from his disregard of the limitations of "the micro-economic study of the expansion effect" which is primarily for the case where merely the equipment reinvestment of depreciation fund takes place after a single net equipment investment is effected. No matter how many times it is multiplied, it would never apply to any national economy or firm where net equipment investment is carried on continually. But this was neglected by him. In an actual economy or firm where net equipment

investment is carried on continually, the expansion effect is not an once-for-ever phenomenon, but a continuous phenomenon.

"The German type theory of depreciation financing" becomes utterly powerless before the actuality as we have seen above, and it can hardly be justified logically. If we have to admit that the actuality cannot be altered at all, then we cannot help to say that there must be something wrong with the reasoning which brings to light only one side of the actuality. The defect of the reasoning, as you may easily gather from what have been said already, can be traced back to its failure to build up as a form of analysis an economic model of an actual national economy or firm with continuous flow of net equipment investment. Sharing the fate of other theories developod by managerial economists, "the German type theory of depreciation financing" was captivated by the phenomenon that appeared in "newly established firms or those firms which were expanded markedly with the assistance of newly supplied capital", and consequently could not organize "the micro-economic study of the expansion effect" in such a manner as otherwise might have been incorporated usefully into the proposed theory on "the macro-economic effect". Therefore, we might as well it an one-sided conclusion arrived at by managerial economists who, because the German type theory of depreciation financing did nothing more than presenting a standard example preconditioned by single net equipment investment, were led astray into an impasse like process 'a single net equipment investment at a cortain point of time→depreciation financing→the expansion effect→its discontinuance', and consequently failed to consider the spiral process of 'continued net equipment investment from year to year→depreciation financing→the expansion effect→its continuance'.

On the other hand, "the American type theory of depreciation financing" to be taken up in Chapter (4) did successfully overcome such defect at the very beginning as it happened to be developed by national economists very fortunately.

(3)

Meanwhile, it has been suggested recently by Hax of West Germany that "the Lohmann-Ruchti Effect" might more properly be called the "Marx-Engels Effect". Referring to three letters, one from Marx to Engels dated August 24, 1867, two answers from Engels to Marx, all of which had been unknown to the managerial economists of West Germany, Hax wrote as follows: "Encouraged by the intelligent insight of Karl Marx at this, Friedrich Engels had already studied to the fullest extent the problem (regarding the expansion effect), which was rediscovered by the managerial

economists (of West Germany) for the first time in these ten years"[10]. "In (West) Germany, the (expansion) phenomenon was studied especially by Professor Lohmann of Freiburg University and Professor Ruchti of Würzburg University after the war. From this reason, it became known by the name of "the Lohmann-Ruchti Effect". Since it was ascertained that such phenomenon had been recognized as early as in 1867 by Karl Marx and Friedrich Engels, the credit should be claimed for them. It is proper to call it "the Marx-Engels Effect"[11].

Letter from Marx to Engels, August 24, 1867

"I must once more apply to you for help concerning a point, as I did four years ago. Fixed capital has to be replaced in its natural form only after, say, 10 years. In the mean time, its value returns partially and gradually as the commodities produced by it are sold. This gradual return is not needed for the replacement of the fixed capital (leaving repairs and the like out of consideration) until it has ceased to exist in its material form, for instance that of a machine. *In the interval*, the capitalist has these gradual returns on hand.

Four years ago[12], I wrote you that thus apparently such *an accumulation fund* was forming, for the capitalist was naturally employing the returned money *in the interval* elapsing before he replaced the fixed capital with it. In one letter[13], you argued somewhat superficially *against this*. Later I found that McCulloch represented this depreciation fund as an *accumulation fund*[14]. Convinced that no idea of McCulloch could ever be right, I *dropped the matter*……

You as a manufacturer must know what you do with the returns of the fixed capital before it has to be replaced in its natural form. And you must give me an answer on this point (without theory, purely as a matter of practice)."

Letter from Engels to Marx, August 26, 1867

"As to your question on a replacement fund, I will give you a detailed explanation along with a statement of accounts……(If we assume that a machine wears away in ten years.) there is no doubt that a manufacturer

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10) Hax, Karl Marx und Friedrich Engels über den ‚Kapazitätserweiterungs-Effekt', *ZfhF* 1958, S. 225.

11) Hax, Die Bedeutung der betrieblichen Abschreibungs-und Investitionspolitik für das wirtschaftliche Wachstum der modernen Industriestaaten, *ZfhF* 1958, S. 253.

12) cf. *Letter from Marx to Engels*, August 20, 1862.

13) cf. *Letter from Engels to Marx*, September 9, 1862.

14) vgl. K. Marx, *Theorien über den Mehrwert. Aus dem nachgelassenen Manuskript Zur Kritik der politischen Ökonomie*, hrsg. von Karl Kautsky, 2. Teil, Verlag von J.H.W. Dietz, Berlin 1923, S. 247-248.

is able to employ profitably or at least dispose of the replacement fund for an average period of four years and a half before the machine has been worn out……

At any rate, I will send on to you a statement of accounts."

Letter from Engels to Marx, August 27, 1867

"I enclose here two statements of accounts concerning a machine, which I hope will account for the point to your satisfaction. It is a general rule to write off usually 7.5% of the original price every year, but in order to simplify the calculation, let the rate be 10%. It is not too large for most machines……

……In the statement No. 2, it is assumed that a manufacturer immediately invests the returned money in a new machine every year. In the last column is given the value of all acquisition (machines) at the close of a ten year period. As is shown in this column, his machine then is not, of course, worth more than £1,000. (And in fact, he is unable to have any more than that, as he has been investing as much value as the machine was worn away, so that the whole value of a machine cannot grow any larger through such a process.) However, he is enlarging his shop every year, and running a machine that has costed him an average of £1,449 through eleven years for equipment. Therefore, he is producing and gaining considerably more than he did with the initial £1,000. He is a cotton spinner, and if we assume that £1 represents a spindle and machine for pre-spinning process, he spun with an average of 1,449 instead of 1,000 spindles, and after the initial 1,000 spindles have been worn out, that is, on January 1, 1866, the new year begins with 1,357 spindles that were acquired in the interval plus 236 (spindles or pounds) which is to be written off for the year 1865, or an aggregate of 1,593 spindles. Hence, he could *increase* the machine by 60% by means of depreciation financing from what it was, that is, without investing a penny out of *his proper profits* in a new equipment.

In both statements, repair was left out of consideration. With a 10% depreciation, a machine must pay its own repair cost. In other words, the repair cost should be included in it. It will come to the same thing whether the repair cost is included in that 10% or the durability of the machine is extended by repair. It would not change the situation at all."

Marx, *The Capital*, Vol. II

"With regard to the gradual extension of the business in the course of the partial renewal, we make the following remarks: Although we have seen that the fixed capital continues to perform its functions in the process of production in its natural state, a certain part of its value, proportionate to the average wear and tear, has circulated with the product, has been

II Replaccment fund will be invested in a new machine every year

			New investment	The rate of wear and tear.	The value on Jan. 1. 1866
January 1, 1856 a newly acquired machine			£ 1,000	100%	£ —
January 1, 1857 a 10% depreciation; new investment			£ 100	90%	£ 10
January 1, 1858 a 10% depreciation	£ 1,000	£ 100			
	£ 100	£ 10	£ 110	80%	£ 22
			£ 210		
January 1, 1859 a 10% depreciation	£ 1,000	£ 100			
	£ 210	£ 21	£ 121	70%	£ 36
			£ 331		
January 1, 1860 a 10% depreciation	£ 1,000	£ 100			
	£ 331	£ 33	£ 133	60%	£ 53
			£ 464		
January 1, 1861 a 10% depreciation	£ 1,000	£ 100			
	£ 464	£ 46	£ 146	50%	£ 73
			£ 610		
January 1, 1862 a 10% depreciation	£ 1,000	£ 100			
	£ 610	£ 61	£ 161	40%	£ 97
			£ 771		
January 1, 1863 a 10% depreciation	£ 1,000	£ 100			
	£ 771	£ 77	£ 177	30%	£ 124
			£ 948		
January 1, 1864 a 10% depreciation	£ 1,000	£ 100			
	£ 948	£ 95	£ 195	20%	£ 156
			£ 1143		
January 1, 1865 a 10% depreciation	£ 1,000	£ 100			
	£ 1,143	£ 114	£ 214	10%	£ 193
			£ 1357		
Jaunary 1, 1866 a 10% depreciation	£ 1,000	£ 100			
	£ 1,357	£ 136	£ 236	0%	£ 236
Nominal value of new machine			£ 1,593		
Real value of new machine					£ 1,000

The number of spindles put to work by the manufacturer, assuming 1 spindle represents 1 pound

1856	1,000
1857	1,100
1858	1,210
1859	1,331
1860	1,464
1861	1,610
1862	1,771
1863	1,948
1864	2,143
1865	2,357
Total of 11 years	15,934

1449 on the average

And the year 1866 will begin with 1357+236=1593 spindles."[15]

15) *Der Briefwechsel zwischen Friedrich Engels und Karl Marx*, 1844 bis 1883, hrsg. von A. Bebel und Ed. Bernstein, Bd. III, Verlag von J.H.W. Dietz, Stuttgart 1913, S. 395-400.

converted into money, and forms an element in the money reserve fund intended for the replacement of the capital pending its reproduction in the natural form. This part of the value of fixed capital transformed into money may serve to extend the business or to make improvements in machinery with a view to increasing the efficiency of the latter. Thus reproduction takes place in larger or smaller pericd of time, and this is, from the standpoint of society, reproduction on an enlarged scale. It is extensive expansion, if the field of production is extended; it is intensive expansion, if the means of production is made more effective. This reproduction on an extended scale does not result from accumulation——the transformation of the surplus-value into capital——but from the reconversion of the value which has branched off, and detached itself in the form of money from the body of the fixed capital into new additional, or at least of more efficient, fixed capital of the same kind."[16]

The excerpta from the correspondence of Marx and Engels quoted above and the description in Volume II of "the Capital" which seems to have been written under the influence of Engels' statement of accounts No. 2 prove positively that the phenomenon discussed by the name of "the Lohmann-Ruchti Effect" among West German scholars after the war had already been studied by Marx and Engels jointly in the eighteen-sixties. To do justice to the originators, we may have to call it, as Hax suggested, "the Marx-Engels Effect" instead of "the Lohmann-Ruchti Effect". But it is wrong to conclude that they were nothing but the forerunners of the "German type theory of depreciation financing". It is true that so far as the above-mentioned quotations are concerned, their method of analysis and the results thereof, primitive as they are, are exactly same as those of "the German type theory of depreciation financing". But as will be discussed later, in Chapter 20 "Simple Reproduction" in Vol. II of "the Capital", they employed an analytical method similar to that of "the American type theory of depreciation financing", and although they left their study unfinished, they did obtain an analytical result which is quite within the bounds of possibility to develop towards the same goal from a logical point of view. When we look upon the matter this way, it seems proper to interpret it that in their description of the subject matter are mingled together both the bud of "the German type theory of depreciation financing" and that of "the American type theory of depreciation financing", that what they tried to make it bloom was the bud of the latter, and that the portion quoted above, in which they made the same description as in the former was nothing more

16) K. Marx, *Das Kapital*, Bd. II, Dietz Verlag, Berlin 1951, S. 166–167.

than a preliminary observation for the latter. Therefore, nothing could be more unfair than to indulge in only that portion quoted from Vol II of "the Capital", and with this as the grounds of argument, to discuss the possibility of extended reproduction of fixed capital through reconversion of depreciation fund into fixed capital or the possibility of the expansion of production capacity of equipment, as Kratsch, Tannhäuser, Matterne and Marechal did.

(4)

As was pointed out already, "the American type theory of depreciation financing" which uses the method of analysis preconditioned by a constant flow of investment instead of a single investment, takes as the object of its analysis the quantative relations between the annual grosss equipment investment, depreciation charges, and replacement costs in a national economy or in an individual firm which is a component part of the national economy, and focuses its attention on the phenomenon that depreciation charges exceed replacement costs in a growing economy or firm with increasing annual gross equipment investment.

As "an attemp to assign the principal role to net rather than to gross investment did not pay for the ensuing complications"[17], it was avoided here, but the method of analysis adopted is based on an indispensable condition that net equipment investment must continue every year. Because, in order

Table V

Year	Annual gross equipment investment G_t	Gross equipment investment in the past ten years $K_t=\sum G_t-\sum R_t$	Replacement cost = Gross equipment investment of ten years ago $R_t=G_{t-n}$	Depreciation charges $D_t=\frac{K_t}{n}$
1	100			
2	110			
3	120			
4	130			
5	140			
6	150			
7	160			
8	170			
9	180			
10	190			
11	200	1,450	100	145
12	210	1,550	110	155
13	220	1,650	120	165
14	230	1,750	130	175
15	240	1,850	140	185

Eisner, Conventional Depreciation Allowances versus Replacement Cost, *The Controller* 1933, p. 514.

17) E.D. Domar, *Essays in the Theory of Economic Growth*, New York, 1957, p. 156.

that the flow of equipment may grow larger from year to year, an additional net equipment investment is absolutely necessary in addition to the reinvestment of depreciation fund, and without this, the gross equipment investment would never be able to expand.

Let us assume a national economy where the gross equipment investment grow in arithmetical progression by $ 100,000 each year, and the durability of all sets of equipment is ten years. In this case, as is shown in Table V, the gross equipment investment will exceed the depreciation charges by $ 550,000 each year, while the depreciation charges too will exceed the replacement costs by $ 450,000 each year. This means on one hand that the gross equipment investment growing from year to year consists of the net equipment investment and the reinvestment from the depreciation fund, and on the other hand that the portion of depreciation charges over the replacement costs is employed for the expansion of equipment.

Thus, " the American type theory of depreciation financing " takes as the object of its analysis the quantitative relations between the gross equipment investment, depreciation charges, and replacement costs in a national economy or in an individual firm which is a component part of the national economy, where the annual equipment investment consists of net investment and reinvestment, and therefore, it is right to expect that it should stand on the following assumptions.

(i) The gross equipment investment grows at a certain rate of growth.
(ii) Every set of equipment has the same durability.
(iii) The firm can recover the depreciation charges.
(iv) The depreciation fund of a certain year will be reinvested in equipment at the beginning of the following year.

After having stipulated the above assumptions, and analysed the case in accordance with the prescribed procedure, Domar and Eisner demonstrated that depreciation charges would exceed replacement expenditures according as the rate of growth of the gross equipment invesment and the durability became larger respectively.

Then, through what analytical procedure did they go to get the result that the higher the rate of growth of the gross equipment investment, the more the depreciation charges will exceed the replacement expenditures, and also in the case of a growing economy or a growing firm, the longer the durability, the larger the depreciation charges in excess of the replacement expenditures will become?

Following Domar, let us represent annual gross equipment investment, replacement costs, depreciation charges, durability, gross equipment capital (the book value of equipment by the indirect method), and the rate of growth

of gross equipment by G, R, D, m, K, and r, respectively, and let G_1 in the first year equal 1. The quantitative relations between G_t, R_t, and D_t in any given year after m years have passed may be expressed in the following differentiable continuous function formulas:

When $t \geqq m$

$$G_t=(1+r)^t=e^{rt} \quad \cdots\cdots(1)$$

$$R_t=G_{t-m}=e^{r(t-m)} \quad \cdots\cdots(2)$$

$$K_t=\int_{t-m}^{t} Gdt=\frac{e^{rt}(1-e^{-rm})}{r} \quad \cdots\cdots(3)$$

$$D_t=\frac{K_t}{m}=\frac{e^{rt}(1-e^{-rm})}{rm} \quad \cdots\cdots(4)$$

$$\frac{D_t}{G_t}=\frac{1-e^{-rm}}{rm} \quad \cdots\cdots(5)$$

$$\frac{R_t}{G_t}=e^{-rm} \quad \cdots\cdots(6)$$

$$\frac{R_t}{D_t}=\frac{rm}{e^{rm}-1} \quad \cdots\cdots(7)$$

Then, by differentiating (5), (6), and (7), it can be easily demonstrated as

$$\operatorname*{Lim}_{rm\to 0}\left(\frac{D}{G}\right)=\operatorname*{Lim}_{rm\to 0}\left(\frac{R}{G}\right)=\operatorname*{Lim}_{rm\to 0}\left(\frac{R}{D}\right)=1 \quad \cdots\cdots(8)$$

$$\operatorname*{Lim}_{rm\to \infty}\left(\frac{D}{G}\right)=\operatorname*{Lim}_{rm\to \infty}\left(\frac{R}{G}\right)=\operatorname*{Lim}_{rm\to \infty}\left(\frac{R}{D}\right)=0 \quad \cdots\cdots(9)$$

Also, the quantitative relations between G_t, R_t, and D_t at $t \geqq m$ as shown above may be expressed in the following compound interest formulas, if the gross equipment investment stands at 1 m years ago. In order to show these relations in a less abstract way, Domar gave the Table VI.

$$G_t=(1+r)^m \quad \cdots\cdots(1)$$

$$R_t=1 \quad \cdots\cdots(2)$$

$$K_t=\frac{(1+r)^m-1}{r} \quad \cdots\cdots(3)$$

$$D_t=\frac{K_t}{m}=\frac{(1+r)^m-1}{rm} \quad \cdots\cdots(4)$$

$$\frac{D_t}{G_t}=\frac{1+\dfrac{1}{(1+r)^m}}{rm} \quad \cdots\cdots(5)$$

$$\frac{R_t}{G_t}=\frac{1}{(1+r)^m} \quad \cdots\cdots(6)$$

$$\frac{R_t}{D_t}=\frac{rm}{(1+r)^m-1} \quad \cdots\cdots(7)$$

Now, we have to turn our attention to the fact that, from the point of

view that " dealing with a economy rather than with a firm, we can dispense here with the initial m years when no replacement is required "[18], the analysis has been developed, in the foregoing analytical procedure, as to those years after the expiration of the mth year (in Table V, those years including and after the eleventh year) when depreciation and replacement are carried out at the same time, and that the m preceding years when depreciation is carried out but no replacement is required were left out of consideration. Of course, Domar did not neglect the initial m years completely, but expressed $\frac{D_t}{G_t}$ in any given year t preceding the mth year as follows, in order " to make our results applicable to a new firm as well "[19]

Table VI

rm	%		
	D/G	R/G	R/D
0.1	95	91	95
0.2	91	82	90
0.3	86	74	86
0.4	82	67	81
0.5	79	61	77
1.0	63	37	58
1.5	52	22	43
2.0	43	14	31
2.5	37	8	22
3.0	32	5	16
3.5	28	3	11

E.D. Domar, *Essays in the Theory of Economic Growth*, New York, 1957, p. 162.

When $t<m$,

$$\frac{D_t}{G_t}=\frac{1-\frac{1}{(1+r)^t}}{rm}$$

For all that, it is evident that emphasis is laid on the analysis of years following the mth year when depreciation and replacement are carried out in parallel. Because, as *Marx* stated, " every year registers the demise of some fixed capital which must be replaced in this or that individual business, or in this or that branch of industry. In the case of one and the same individual capital, this or that portion of its fixed capital must be replaced, since its different parts have different durabilities. On examining annual reproduction, even on a simple scale, that is to say, disregarding all accumulation, we do not begin at the very beginning of things. The year which we study is one in the flow of many, it is not the first year after the birth of capitalist production."[20] Probably it may be called a logical conclusion that in consideration of these points, " the American type theory of depreciation financing " that had been concerned with and had developed the analysis of " established firm or the economy as a whole "[21] could obtain the following results. R/D will equal 1 if the rate of growth is at

18) Domar, *ibid.*, p. 169.
19) Domar, *ibid.*, p. 156.
20) Marx, *a.a.O.*, S. 457.
21) Domar, *ibid.*, p. 156.

zero. It will grow smaller than 1 as the rate of positive growth becomes greater whereas it will grow larger than 1 as the rate of negative growth becomes greater. And in these cases, the longer the durability, the greater will become the deviation of R/D from 1. It may be easily understood that from these analytical results will be deduced the following propositions proper to "the American type theory of depreciation financing".

(i) The depreciation charges and the replacement costs are identical in a stationary economy or firm where the gross equipment investment has been maintained on the same scale (the case of simple reproduction).

(ii) The depreciation charges exceed the replacement costs in a growing economy or firm where the gross equipment has continued to expand from year to year (the case of reproduction on an extended scale). This excess which is to be employed for the expansion of equipment will be greater the larger the rate of growth of the gross equipment investment is and the longer the durability is.

(iii) The reverse of (ii) will be the case in a declining economy or firm where the gross equipment investment has continued to dwindle from year to year (the case of reproduction on a contracted scale). In this case, the depreciation charges will be less than the replacement costs, and this deficiency will be greater the greater the rate of decline (the rate of negative growth) of the gross equipment investment is and the longer the durability is.

Needless to say, the most important of these three propositions is the second one[22]. However, in the case of Marx, the first proposition for the case of simple reproduction is all he obtained. In Chapter 20 "Simple

22) Applying the second proposition to an actual growing economy, Domar computed the ratios D/G, R/G, and R/D of the United States and Soviet Russia. According to Domar's figures, "a reasonable approximation would place" the average United States m at 30 years or so, and the average real r over the last 80 years at, or slightly above, 3 per cent, with rm thus being in the vicinity of 1. The column rm of 1.0 in Table VI gives us the magnitudes of D/G, R/G, and R/D as 63%, 37%, and 58%, respectively. From this, we may reasonably assume that in the United States, 63% of G should be financed from D, and the remaining 37% from net saving, and 58% of D should be applied to R which corresponds to 37% of G, and remaining 42% to the expansion of equipment. On the other hand, the Soviet r averaged 12% over the period 1930–50. The mean value of m is estimated to be 30 years, hence we obtain an rm of 3.5. If we look into Table VI as we did, the column rm of 3.5 gives us the magnitudes of D/G, R/G, and R/D as 28%, 3% and 11%, respectively. From this we can assume that in Soviet, 28% of G is financed from D, and the remaining 72% from net saving, and 11% of D is applied to R which corresponds to 3% of G, and the remaining 89% to the expansion of equipment. With an r of 8% which seems quite conservative, and with rm thus being 2.4, the ratio D/G will be put below 40%, and both R/G and R/D would not go much higher than the 8% and the 22% levels, respectively.

Reproduction", Vol. II, "The Capital", he states as follows: "The condition precedent is here evidently that this fixed component part of constant capital II, which is reconverted into money to the full extent of its value and therefore must annually be renewed in its natural form (section I), should be equal to the annual depreciation of the other fixed component part of constant capital II (section II), which continues to function in its old natural form and whose wear and tear, depreciation in value, which it transfers to the commodities in whose production it is engaged, is first to be compensated in money. Such a balance would seem to be a law of reproduction on the same scale"[7]. This proposition of Marx applies to constant capital I as a matter of course, and therefore, "constant capital II" in the quotation may be replaced with "constant capital". Now, we shall see that the statement of Marx is the same in contents, though different in expression, with the first proposition of Domar, that is to say, "$R=G$ made m years earlier. Let the latter equal 1. Let the latter equal 1. If G has remained constant, the present stock of capital, being the accumulation of investment over the past m years, is simply m. Since by definition D is $1/m$ of the capital stock, $D=1$. Hence (after the expiration of the first m years) R and D are identical"[8]. Perhaps nobody can deny that the first proposition embraces a logical possibility of evolving the second and the third propositions from itself. Thus Marx did hit upon the clue as to the analysis of reproduction on an extended scale, too, but because he passed away before he traced up the clue, the task was left for "the American type theory of depreciation financing" to finish up.

Assisted with the achievements of "the American type theory of depreciation financing" which complemented the analysis Marx had left unfinished, the author will now try to construct a theory of national economic-enterprise depreciation financing to be based upon a constant flow of net equipment investment.

(5)

Fixed capital has a peculiar mode of turnover that while it yields up value to the product in proportion as it loses its own exchange-value together with its own use-value in constantly repeated labor-processes, one part of its value remains attached to its use-form or natural form belonging in the process of production. Now, fixed capital of firms constituting a national economy or of business departments constituting an existing firm is in the

7) Marx, *a.a.O.*, S. 469.
8) Domar, *ibid.*, p. 161.

Table VII

				Before the expiration of
Year	Gross investment	Book-value by indirect method, the use-form (Period production capacity)	Book-value by direct method, the value, the use-value (Total production capacity)	Renewal in natural form (Replacement)
t	G_t	$K_t=\sum G_t-\sum R_t$	$V_t=\sum G_t-\sum D_t-\sum R_t$	$R_t=G_{t-n}$
1	100	100	100	0
2	100	200	190	0
3	100	300	270	0
4	100	400	340	0
5	100	500	400	0
6	100	600	450	0
7	100	700	490	0
8	100	800	520	0
9	100	900	540	0
10	100	1,000	550	0
n				After the expiration of
11	100	1,000	550	100
12	100	1,000	550	100
13	100	1,000	550	100
14	100	1,000	550	100
15	100	1,000	550	100

Table VIII

				Before the expiration of
Year	Gross investment	Book-value by indirect method, the use-form (Period production capacity)	Book-value by direct method, the value, the use-value (Total prodution capacity)	Renewal in natual form (Replacement)
t	G_t	$K_t=\sum G_t-\sum R_t$	$V_t=\sum G_t-\sum D_t-\sum R_t$	$R_t=G_{t-n}$
1	100	100	100	0
2	110	210	200	0
3	120	330	299	0
4	130	460	396	0
5	140	600	490	0
6	150	750	580	0
7	160	910	665	0
8	170	1,080	744	0
9	180	1,260	816	0
10	190	1,450	880	0
n				After the expiration of
11	200	1,550	935	100
12	210	1,650	990	110
13	220	1,750	1,045	120
14	230	1,850	1,100	130
15	240	1,950	1,155	140

working period (durability)			
Replacement in money (Depreciation)	Net investment, and the increase of V_t and K_t thereby	The increase of K_t by reinvestment	Extended investment and the increase of K_t thereby
$D_t=\frac{K_t-1}{n}$	G_t-D_t	D_t-R_t	G_t-R_t
0	100	0	100
10	90	10	100
20	80	20	100
30	70	30	100
40	60	40	100
50	50	50	100
60	40	60	100
70	30	70	100
80	20	80	100
90	10	90	100
working period (durabiliey)			
100	0	0	0
100	0	0	0
100	0	0	0
100	0	0	0
100	0	0	0

working poriod (durability)			
Replacement in money (Depreciation)	Net investment, and the increase of V_t and K_t thereby	The increase of K_t by reinvestment	Extended investment and the increase of K_t thereby
$D_t=\frac{K_t}{n}$	G_t-D_t	D_t-R_t	G_t-R_t
0	100	0	100
10	100	10	110
21	99	21	120
33	97	33	130
46	94	46	140
60	90	60	150
75	85	75	160
91	79	91	170
108	72	108	180
126	64	126	190
working perid (durability)			
145	55	45	100
155	55	45	100
165	55	45	100
175	55	45	100
185	55	45	100

most diverse stages of its reproduction. In other words, in the case of some of them it has arrived at the stage where it must be entirely replaced in kind. In the case of the others it is more or less remote from that stage, and the wear and tear portion of the value is gradually being transformed into money. Therefore, on examining annual reproduction, we cannot begin *ab ovo*. We must begin at least from the year when fixed capital is replaced in money (depreciation) and in natunal form (renewal) at the same time.

(i) Simple reproduction (stationary economy)

Now, let us suppose that a sum of gross equipment investment amounting to $ 1 million is sunk annually (at the beginning of each year) on the same scale in fixed capital (equipment) whose constituent units have the same working period (durability) of 10 years, and further that new fixed capital worth $ 100,000 has 10 units of use-value (the total production capacity) and one unit of use-form (the period production capacity) and is fixed in its appropriate natural form (the number of sets). Then, in and after the eleventh year when the replacement of fixed capital in money and the renewal in natural form are carried out at the same time, the gross equipment investment, the replacement in money, and the renewal in natural form will be identical, each amounting to one million dollar, as is shown in the lower part of Table VII.

And in this case, since the additional net investment in fixed capital from a part of surplus value is at zero, no increase will be resulted in the value, use-value, use-form, and natural form of fixed capital. On the other hand, the reduced portions of the value and the use-value of fixed capital will be replaced simultaneously and continuously by means of re-investing in fixed capital so that the value and the use-value of fixed capital itself may be maintained, but at the same time the replacement in natural form is being carried out.

Hence, it may be said that the depreciation financing in the case of simple reproduction performs the function of replacing equipment as well as maintaining the value and the use-value of equipment.

(ii) Reproduction on an extended scale (growing economy)

Now, let us assume that the gross investment in fixed capital whose constituent units have the same working period of 10 years increases by $ 100,000 annually as $ 1,000,000 in the first year, $ 1,100,000 in the second year, $ 1,200,000 in the third year and so forth, and further that new fixed capital worth $ 100,000 has 10 units of use-value and one unit of use-form and is fixed in its appropriate natural form, as was the case with (i). Then, in and after the eleventh year the gross investment in fixed capital will exceed the replacement in money by $ 550,000 each year, and the replacement

in money will exceed the renewal in natual form $ 450,000 each year.

And in this case, since an additional net investment in fixed capital amounting to $ 550,000 is carried out every year, the value, the use-value, and the use-form of fixed capital will be increased by $ 550,000, 55 units, and 5.5 units respectively, and its natural form will also undergo a corresponding change. On the other hand, the reduced value and use-value of fixed capital will be replaced simultaneously and continuously by means of reinvesting in fixed capital so that the value and the use-value of fixed capital itself may be maintained, but at the same time, not only is the renewal in natural form carried out but also the use-form as well as the natural form are increased. In other words, the book value by the direct method representing the value and the use-value of equipment will be restored to the original level through the reinvestment of depreciation fund in equipment, but the use-form of equipment will be enlarged by 4.5 units annually in proportion to the annual increase of $ 450,000 in the book value by the indirect method, and its natural form will also be expanded correspondingly.

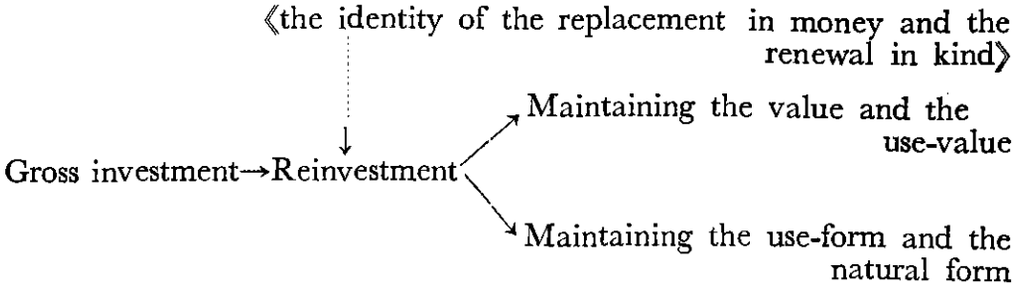
Hence, it may be said that the depreciation financing in the case of reproduction on an extended scale performs the function of replacing and enlarging equipment as well as maintaining the value and the use-value of equipment.

What have been said above may be arranged in the following diagrammatical expression.

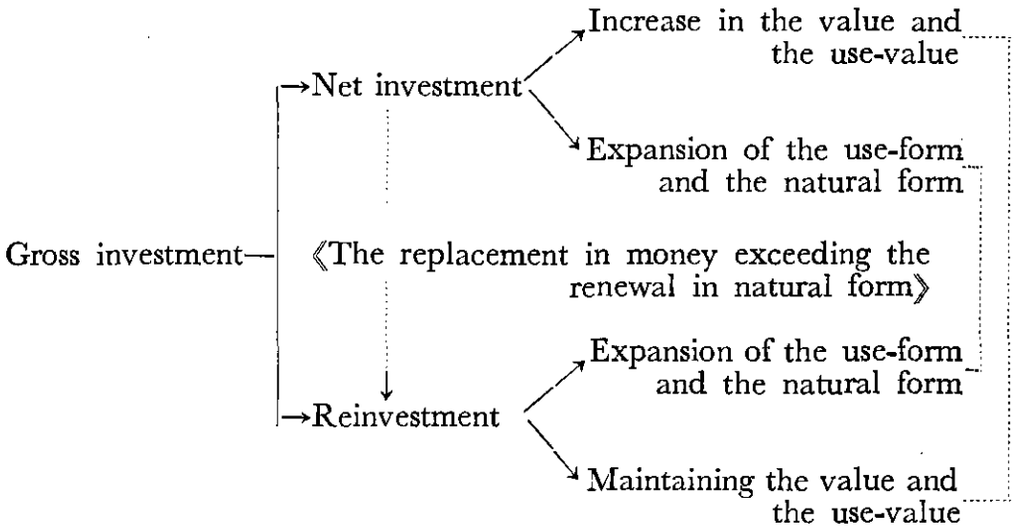
Then, where is the secret of increase in the use-form and the natural form of fixed capital through reinvestment of depreciation fund in equipment? In the case of simple reproduction where the net equipment investment is at zero, the replacement in money and the renewal in kind are identical, and no increase will be resulted in the use-form and the natural form. In view of this fact, it may be easily understood that the real cause that makes the replacement in monoy larger than the renewal in kind, and with this as a motive power, acts to increase the use-form and the natural form through reinvestment in equipment, is nothing but the net equipment investment which is a prerequisite for reproduction on an extended scale. Therefore, in the case of reproduction in an extended scale, the process evolving from net equipment investment and the process developing from reinvestment in equipment that involves the expansion of the use-form and the natural form are inseparable from each other, and neither of them can exist independently.

Thus, once we understand that net equipment investment is the real cause of the expansion of the use-form and the natural form through reinvestment in equiment, we can easily draw out the following propositions

(i) Simple Reproduction



(ii) Reproduction on an Extended Scale



without troubling ourselves with the mathematical demonstratration.

(i) The greater is the sum of additional net investment out of a portion of surplus-value in fixed capital in a national economy, the greater will be the excess of the replacement in money over the renewal in natural form and the larger will be in scale the expansion of the use-form and the natural form of fixed capital due to the reinvestment in fixed capital of that part of fixed capital that has been set free. Hence, in a national economy where the growth rate of net equipment investment is higher, the expansion effect due to reinvestment in equipment will be of a larger scale than in an economy where it is low.

(ii) In those enterprises where a greater sum of net equipment investment is effected through capital formation from inside (self-financing) or that from outside (capital stock financing or borrowing), the expansion effect due to reinvestment in equipment will be larger as was the case with (i). As a matter of course, in the case of newly established enterprises, the expansion

effect will be of a smaller scale than in existing enterprises at the initial stages after their establishment as is shown in the upper parts of Tables VII and VIII because it is conditioned by the characteristics proper to young enterprises which do not need the renewal in natural form before the expiration of the working period of fixed capital invested at the time of their establishment. However, if we take the average at the initial stages, the expansion effect arising from the same amount of net equipment investment does not differ between existing enterprises and those newly established as we can see clearly from the comparison between the upper part of Table VII and the lower part of Table VIII. That is, there will be brought about an average increase of 4.5 units of the use-form due to the reinvestment in equipment from the net equipment investment averaging $ 550,000 for the first ten years in a newly established enterprise, and in like manner an expansion of 4.5 units of the use-form is expected from the net equipment investment of $ 550,000 for one year in an existing enterprise[23].

Therefore, in the case of monopolistic enterprises, particularly, a 'Konzern' or a combination of such enterprises, where the growth of net equipment investment is rapid, it is obvious that the expansion effect due to reinvestment in equipment will be of a larger scale than in small or middle-sized enterprises that grow slowly.

23) The expansion effect will take place where reinvestment in equipment is effected. For instance, when net equipment investment is effected in a firm through borrowing, no expansion effect will arise in this firm at least, provided that the depreciation fund is applied to the repayment of borrowing and no reinvestment in equipment is made. In this case, if the depreciation fund applied to the repayment of borrowing to banking facilities or others should be reinvested in equipment of another firm, the expansion effect will move there. Of course, it goes without saying that the expansion effect will take place in the said firm should reinvestment in equipment be carried out in effect through the conversion of the old loan or the arrangement of a new loan. The same thing will happen when the depreciation fund from net equipment investment effected by means of capital stock financing or self-financing be loaned to another firm and be applied to the reinvestment in equipment of that firm.