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PROFESSOR KNIGHT AND THE "PERIOD OF PRODUCTION"

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THE past few years have been prolific of contributions about "capital and the period of production."[1] Any increase in the output of such contributions certainly takes place under increasing cost (because it is necessary for the writer to study all his predecessors' products), and, probably, under decreasing return. Nevertheless, there seems to be good reason for submit-

[1] Frank H. Knight, "Capitalistic Production, Time, and the Rate of Return," *Economic Essays in Honour of Gustav Cassel* (London, 1933); "Capital, Time, and the Interest Rate," *Economica*, August, 1934; "Professor Hayek and the Theory of Investment," *Economic Journal*, March, 1935; F. A. von Hayek, "Capital and Industrial Fluctuations," *Econometrica*, April, 1934; "On the Relationship between Investment and Output," *Economic Journal*, June, 1934; Martin Hill, "The Period of Production and Industrial Fluctuations," *ibid.*, December, 1933; C. H. P. Gifford, "The Concept of the Length of the Period of Production," *ibid.;* "The Period of Production under Continuous Input and Point Output in an Unprogressive Community," *Econometrica*, April, 1935; J. Marschak, "A Note on the Period of Production," *Economic Journal*, March, 1934; K. E. Boulding, "The Application of the Pure Theory of Population Change to the Theory of Capital," *Quarterly Journal of Economics*, August, 1934; Wassily Leontief, "Interest on Capital and Distribution: A Problem in the Theory of Marginal Productivity," *Quarterly Journal of Economics*, November, 1934; R. F. Fowler, *The Depreciation of Capital, Analytically Considered* (London, 1934); Erich Schiff, *Kapitalbildung und Kapitalaufzehrung im Konjunkturverlauf* (Vienna, 1933); Richard von Strigl, "Lohnfonds und Geldkapital," *Zeitschrift für Nationalökonomie*, January, 1934; *Kapital und Produktion* (Vienna, 1934); Walter Eucken, *Kapitaltheoretische Untersuchungen* (Jena, 1934); Karl H. Stephans,

ting another unit of product. In a series of ingenious articles[2] Professor Knight has proposed to discard as worthless some tools of economic analysis which I consider indispensable for successful handling of certain problems. The tools he wants to scrap are those concepts which have been used in capital theory under different names, such as "length of the production process," "roundaboutness of production," "period of waiting," "period of production," "period of investment," "time structure of production," "period of maturing," and similar terms. Professor Knight's opinion has great weight with every serious student of economics; if the disputed concepts are to be rehabilitated, Professor Knight's criticism must be answered. This will be attempted here, partly with explicit reference to the contentions of Professor Knight, partly by way of general discussion of the concepts and the problems involved. An effort will be made, upon this occasion, to clear up a number of obscurities and ambiguities connected with the theory of capital "promulgated by Böhm-Bawerk and his followers and generally accepted and taught in the past generation."[3]

I. IS CAPITAL PERPETUAL?

1. *Stationary, growing, or retrograde economy.*—The usefulness, or even necessity, for economic theory of the conception of a "stationary economy" cannot be seriously questioned. This concep-

"Zur neueren Kapitaltheorie," *Weltwirtschaftliches Archiv*, January, 1935. The following articles come to my attention too late to be taken account of in the present analysis: Howard S. Ellis, "Die Bedeutung der Produktionsperiode für die Krisentheorie," *Zeitschrift für Nationalökonomie*, June, 1935; M. Joseph and K. Bode, "Bemerkungen zur Kapital- und Zinstheorie," *Zeitschrift für Nationalökonomie*, June, 1935; Oskar Morgenstern, "Zur Theorie der Produktionsperiode," *Zeitschrift für Nationalökonomie*, June, 1935; Richard von Strigl, "Zeit und Produktion," *Zeitschrift für Nationalökonomie*, June, 1935; Ragnar Nurkse, "The Schematic Representation of the Structure of Production," *Review of Economic Studies*, June, 1935. Besides the published material, manuscripts by F. A. von Hayek and an unpublished discussion in correspondence between G. von Haberler, F. A. von Hayek, J. Marschak, L. von Mises, and myself were drawn upon in writing this article.

[2] Besides the three articles by Professor Knight listed in the last footnote, see also his paper, "The Ricardian Theory of Production and Distribution," in the *Canadian Journal of Economics and Political Science*, February, 1935.

[3] Knight, *Economic Journal*, XLV (March, 1935), 79.

tion is inseparably bound up with the application of the method of variation in economics. One cannot arrive at any conclusion about the effects of any change if the "other" (independent) things (or conditions) are not set "invariant" or assumed to be unchanged. Thus, in a discussion of the effects of a certain "shift in demand," or of a changed supply of money, or of better crops, or of any other "substantive" change, one conveniently starts out with the assumption that the supply of "capital" does not change independently at the same time. One of the greatest difficulties in our theory, the problem of "maintaining capital intact," is, of course, evaded by assuming a stationary economy, but this can be considered permissible for certain problems. There is, however, one problem in the discussion of which the simple assumption of the stationary state is not permissible, namely, the problem of the capital stock or capital structure itself. To assume perfect maintenance of capital where one should discuss the conditions of such maintenance is a case of begging the question, or, at least, of avoiding the problem which is to be solved.

A statement such as "all capital is inherently perpetual"[4] is of doubtful value. If it is limited to the case of an economy which is assumed to maintain, or to add to, its capital, it is but a repetition of the assumption. If it is stated as a fact, it is wrong. If we define a stationary economy as one which (perhaps among other things) maintains its capital, and if we call capital "perpetual" when it is (at least) maintained, then the assertion that for a stationary economy all capital is inherently perpetual obviously means no more than that an economy which maintains its capital maintains its capital. Much more important is the question whether economies always maintain their capital, and under what conditions they do so.

Professor Knight thinks he is warranted in asserting "the *fact* of perpetuity."[5] He adds, however: "Unless society as a whole becomes decadent with respect to its stock of capital, no increment of capital viewed as a quantity ever is disinvested."[6] This "un-

[4] Knight, *Economica*, August, 1934, p. 264.

[5] *Canadian Journal*, February, 1935, p. 15 (italics are his).

[6] *Ibid.*, p. 15.

less" qualification reduces the "fact" again to tautology. (Unless society acts differently it acts in the asserted way.) In other places the "fact of perpetuity" is stated in a less safe—because less tautological—formulation.[7] There was and is always the choice between maintaining, increasing, or consuming capital. And past and "present" experience tells us that the decision in favor of consumption of capital is far from being impossible or improbable.[8] Capital is not necessarily perpetual.

2. *Individual disinvestment, social disinvestment.*—In a "capitalistic society," in which property is owned privately, the process of capital disinvestment is the result of action or inaction of individuals, under the influence of their personal preferences or of certain institutional forces or of state interference.[9] It must be clear that at any moment of time the alternatives are open to change in either direction, or to leave unchanged the relation between the current stream of consumption income and the future stream of consumption income, the latter partly being represented in the existing capital (which is the "capitalized" value of future income). The conditions under which such alternatives can be realized are dependent on the given production structure of the whole community and on the simultaneous choices on the part of the other individuals within the community. Dissaving and disinvesting by one individual can be offset by saving and investing by another individual, in which case the individual disinvestment does not become social disinvestment. That "in a stationary or growing society disinvestment by an individual owner in no wise involves actual reconversion of 'capital' into income"[10] is again nothing but a tautology. It is just the relation of the total amounts of capital individually disinvested to the total amounts

[7] "Capital is perpetual in so far as economic principles obtain and economic reasoning is applicable" (*Economica*, August, 1934, p. 277); or, "in a society which is not planning for the end of all things, all property income is perpetual" (*ibid.*, p. 268). Neither of the two contentions seems to be correct. Economic reasoning can be perfectly well applied to an economy which consumes parts of its capital. Nor is it necessary that such a society plan for "the end of the world."

[8] For an illustration of a case of capital consumption see my article, "The Consumption of Capital in Austria," *Review of Economic Statistics*, January, 1935.

[9] *Ibid.* [10] Knight, *Economica*, August, 1934, p. 273.

of capital individually invested at any moment of time which makes society stationary, growing, or retrograde.

The problem of social "net" investment or "net" disinvestment is important, and its discussion calls for consideration of certain "time relations." Since investment is a conversion of present income into future income (i.e., capital) by abstaining "for a certain interval" from a "strip" of the present consumption stream; and since disinvestment is a "reconversion of 'capital,' i.e., of [future] income, into income for a short period at a correspondingly higher time rate,"[11] it is an economic problem of major importance to find out about the time distance between those present and future incomes, about the mentioned "interval," and about the mentioned "period." These "periods" are important for the main problems of capital theory which is the theory of actual or potential changes in the quantity relationship between present and future services—or, in other words, the theory of distribution of services over time.

3. *Are production and consumption simultaneous?*—The assertion that all capital (in terms of value of anticipated future income) is always maintained and, therefore, "perpetual" was made to support the view that the notion of a period between production and consumption is meaningless. The assertion to the contrary that capital need not, and, in fact, is not, always maintained ought to support the view that the notion of the mentioned period has meaning and significance. Professor Knight is prepared to admit that "the notion of a lapse of time between production and consumption has practical meaning where society has to meet *unanticipated* changes in conditions."[12] Apart from the theoretical and practical importance of unanticipated changes in conditions —it is not far from correct to call reality a continuous series of unanticipated changes—it is clear to me and many others that the "potentiality" of change is always present and that the choice between alternatives (only one of which is to abstain from changing, and hence to repeat, former choices) is a category in economics.

For the picture of a stationary state, from which change is ab-

[11] *Ibid.* In the original, "perpetual" income stands for "future" income.

[12] *Ibid.*, p. 276.

sent, simultaneity of production and consumption can be a useful fiction. With the aid of a "cross-section" view of production and with the element of time abstracted, certain relations in the economic system become more readily perceptible. Hence, propositions such as "production and consumption are simultaneous,"[13] or "the production period for consumed services . . . . is zero,"[14] are useful and admissible (fictitious) assumptions for the discussion of certain problems of the stationary economy. But the "as if" character of such heuristic suppositions must never be forgotten. And for discussion of problems other than those of an absolutely stationary state, especially of problems of capital, of investment,[15] of changes in demand, and similar ones, the assumption of "simultaneity of production and consumption" is misleading and inadmissible and has to be dropped. Only for problems of the first type may maintenance of capital, including replacement of particular items of "plant," be conceived as a part of the production of the output consumed at the same time.[16] But any theory of economic change and any theory of capital has to regard the time element as its integrant part. The production of a definite quantity of output can be done with or without full maintenance of the instruments necessary for its production. Therefore, the output of consumable services is not dependent upon the simultaneous input of productive services used for maintenance or replacement of plant; the productive services used for maintenance or replacement of plant are not a part of the production of services consumable at the same time, but at later moments of time; there is a time interval between the input of services and the "dependent" output of services,[17] and this

[13] *Ibid.*, p. 275.

[14] Knight, *Economic Journal*, March, 1935, p. 88.

[15] Note the following concession of Professor Knight's: "In the act of growth, 'waiting' can be said to be involved, both during the interval of construction itself and at least for such time thereafter as is required for the new capital to yield a total of consumption equal to that which was sacrificed in creating it" (*Economic Essays in Honour of Gustav Cassel*, p. 339).

[16] Knight, *Economic Journal*, March, 1935, pp. 84–85.

[17] It is absolutely incomprehensible to me that Professor Knight, as one of the rare economists who understands, holds, and teaches "the only theory which makes

interval may conveniently be called "period of production" or "period of investment."

4. *Capitalization of perpetual or of time-limited income.*—That the cost of production of any "capital good" is equal to its capitalized future return is a well-established condition of equilibrium. How the rate of interest enters into both sides of the equation was shown by Professor Knight with utmost clarity.[18] On the cost-of-production side of the equation interest is calculated (as "carrying charges") on the services successively invested during the "period of construction." On the capitalized-income side of the equation interest is calculated on the series of future yields to reduce it to the "present value." There are two methods of capitalization. The one simply capitalizes the series of gross returns expected during the service life of the capital good; the other method reduces first the time-limited series of gross returns by way of deducting all maintenance and replacement costs to a perpetual series of net returns and then capitalizes this perpetual series. However, "it happens to be somewhat simpler algebraically not to make this conversion formally, but to express the present worth of the time-limited income stream directly."[19]

In practical life capitalization of a limited series of returns is more usual than that of an infinite series, not only on account of mathematical simplicity but on account of the character of the capital items. Cases of perpetual annuities are rare. The valuation of plants, buildings, machines, etc., fixes attention upon a limited service life of the particular object valued. The valuation of bonds takes into account the maturity of all payments for interest as well as for the "principal." How complicated capitalization would be if the "perpetual income method" were to be used

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sense at all" (*ibid.*, p. 82), namely, the theory which explains "cost" as "displaced alternative," should not see this point. Consumable services available at different, more or less distant, future points of time are the "alternative" uses of the productive services available at any one moment of time. The simultaneous output is not—or only for an infinitesimally small part—among the alternatives.

[18] *Economica*, August, 1934, pp. 265–66; *Canadian Journal*, February, 1935, pp. 14–15.

[19] *Canadian Journal*, February, 1935, p. 14.

is easily seen when one again faces the fact that we live in a changing world. With "bygones forever bygones," the cost of production of existing items does not count for their valuation. There is now no "actual" capital value to start with, and replacement quotas could be known only with respect to the "historical value" but not to the "present value." With replacement quotas unknown there is no way of knowing the net yield. There is, then, nothing but a limited series of gross returns, and this is what is capitalized. Only afterward, when the calculation of the present value has been finished, could a "perpetual-income series" be constructed. Take the case of finding the capital value of a plant in an industry which is experiencing bad times. Maintenance of the plant[20] would mean negative net returns. But this does not at all mean that the value of the plant is negative. If there are positive gross returns, for a limited period of time, of course, there will be a positive capital value.

These few illustrations, I hope, make it sufficiently clear that practice does not make things obscure by supposing "perpetuity" of income or of capital. Theory should not do so either.

II. THE LENGTH OF THE PRODUCTION PERIOD

5. *The concept and its name.*—It has been stated, in the preceding discussion, that the time interval between the input of (productive) services and the "dependent" output of (consumable) services is significant for a number of economic problems. This time interval was called, by Böhm-Bawerk, the "degree of roundaboutness of production," or the "length of the production process," or the "period of production." The last two names, which Böhm and most of his followers continued to use in spite of the protests of Wicksell and others, contributed much to the confusion about the concept. The words convey a meaning which is not that of the concept: one thinks of the duration of the process of production proper, which is by some writers called "*direct* production period" (as distinguished from the duration of *indirect*

[20] It is fair to note that Professor Knight does not assume maintenance of particular capital items, but only of their actual value.

production) and by others "duration of the technical process" (as distinguished from direct and indirect *durability*).

A number of different sorts of durations or periods are embraced by Böhm's concept. If one had to find out what time would elapse from the moments at which certain services, say a number of labor hours employed in a machine shop, are being "put in" (invested) until the moments at which the dependent consumable services mature, the following durations would have to be considered: (*a*) the duration of producing the machine; (*b*) the duration of the production of the goods made with the help of the machine, and the duration of the production of the succeeding products made with the help of the mentioned goods, etc., all the way up to the final stage; (*c*) the durability of the machine, (*d*) the durability of the goods made with the help of the machine, and the durability of the products made with the help of the mentioned goods, etc., all the way up to the final services which are to be had. All these four sorts of durations have to be considered, but this does not at all mean that they have to be added. We shall speak about this presently. First it should frankly be stated that all objections to "period of production" as a name for that composite period meant by Böhm's concept are fully justified. Terminological magnanimity may tolerantly pass over the misnomer and continue to use it. But it certainly would be better to return, according to Professor Hayek's recent suggestion, to Jevons' and Wicksell's practice and speak of the "period of investment."[21]

6. *Absolute versus average length of the period.*—We warned against the fallacy of adding up all the "durations" of direct and indirect production and direct and indirect service life. It is easily understood that, under the technique of our times, such adding-up would arrive at an infinite period. Production is continuous—not only in the sense that at any moment of time "past services" are consumed and "future services" provided, but also in the

[21] Professor Eucken, in his *Kapitaltheoretische Untersuchungen*, coined the word *Ausreifungszeit*, i.e., "period of maturing." The choice of the name is, however, a matter of indifference compared with the importance of using the concept in an appropriate way. In the rest of the discussion the terms period of production and period of investment will be used interchangeably.

sense that durable instruments constructed in the past are used in the construction of durable instruments for future use. In this sense "the production period has no beginning and no end unless . . . . the date of the end of the world is known from the beginning."[22] Or, more correctly, only "the beginning and end of social economic life"[23] would mark the boundaries of that "period of production." And "it would never be possible to give any sensible answer to the question" when (to repeat Professor Knight's examples) the production of a certain glass of milk "began," or when the process of consuming the result of productive activity such as feeding a cow would "end."[24]

Has the *naïveté* or absurdity of the whole conception employed by Böhm-Bawerk now been revealed and sufficiently ridiculed? Let Böhm himself give the answer:

> Where I have spoken [above] of extension or prolongation of the roundabout process of production . . . . I must be understood in the sense [just] explained. The length or the shortness of the process, its extension or its curtailment, is not measured by the absolute duration of the period that lies between the expenditure of the first atom of labor and the last—otherwise the cracking of nuts with a hammer which might chance to be made of iron brought from a mine opened by the Romans would perhaps be the most "capitalistic" kind of production.[25]

Can one warn more expressly against the pitfall of taking the absolute period of production for the significant time interval? Böhm's concept was "the *average* period which lies between the successive expenditure in labor and uses of land and the obtaining of the final good."[26] The fact that some of the services reach into the indefinite future represents no difficulty for averaging the time dimensions. The bulk of the services mature in the near future and fewer in the more distant future, while the number of services maturing after infinite intervals is infinitesimally small.

In the well-known diagrams used by Jevons, Böhm, Hayek, and others—be it the ring diagram or the triangle diagram—the ab-

[22] Knight, *Economic Essays in Honour of Gustav Cassel*, p. 338.

[23] Knight, *Economica*, August, 1934, p. 275.

[24] *Ibid.*

[25] *The Positive Theory of Capital* (London, 1891), p. 90.

[26] *Ibid.* On the limitation to "labor" and "land," see below (sec. 14).

solute period of investment is assumed to be finite. This assumption would imply that there is one stage of production at which no tools and no instruments, but only the "original" services of land and labor, are employed. If to this entirely unrealistic assumption another one is added, namely, that the further input of "original" services takes place continuously at a uniform rate during the whole absolute period, then the average period of investment is half of the absolute.[27] The fiction of a finite absolute production period facilitates the exposition of certain relations but has to be dropped in the course of any further analysis. It is to be regretted that it has contributed to so many serious misunderstandings.

7. *Average period versus shape of the investment function.*—It might be well to familiarize ourselves somewhat further with the meaning of the average investment period, before we deal with a more complicated concept. Imagine for a moment that labor is the only kind of productive service and is homogeneous in quality. At any point of time all labor being invested at that instant is planned and expected to yield (to contribute to) consumable services at some future time. (Most of the input of labor of that instant is planned to be combined with additional labor which is to be invested at successive moments of time, and the final product will be, of course, a joint product of services invested at different points of time.) The labor invested today includes a certain amount which is to yield services consumable today, another amount which is to yield services consumable tomorrow, another the day after tomorrow, etc. Smaller amounts of labor invested today in some durable instrument of production will get very high "futurity indices" and an infinitesimal amount will get the futurity-index (or time-dimension) infinity. The average of all these indices, weighted according to the respective number of labor units, is the average period of investment.

[27] There is another concept which is sometimes confused with the average period of production, namely, the "average period of waiting," which is dependent, apart from the other time dimensions, upon whether production is arranged in simultaneously operating stages, i.e., upon whether output becomes available continuously or with intervals (e.g., crop output). See Böhm-Bawerk, *op. cit.*, pp. 327–28. The subsistence-fund theory refers directly to the "waiting period" and through it to the production period.

The "average period" as an expression for the distribution of services over time is serviceable only for certain purposes and only if this distribution scheme is rather simple. Imagine changing our plans, one day, simply by switching some units of labor to activities of later maturing yield. This switching may be expressed by saying that the average period of investment has been lengthened. But take another type of rearrangement, where some productive services are transferred from uses with quick maturity to uses with later maturity, but also some other productive services are transferred from uses with very late maturity to uses with medium-high futurity indices.[28] Such a change in the distribution of services over time would be possible without any change in the "average." This shows that not only the average of all time dimensions but also their dispersion may be significant. The "shape of the investment function" would tell what the simple "average investment period" conceals.

There are other reasons for not accepting the "average period of investment" as an adequate expression for, or measure of, the time structure of investment. Professor Hayek reminds us that the time intervals of waiting are, as to their economic significance, not homogeneous magnitudes which can be averaged.[29] Another argument advanced by Professor Hayek is concerned with the relationship between the interest rate and the investment function. The investment function, he explains, is rather complicated because of the "investment in compound interest"; this makes it not only impracticable to represent it in terms of averages but also to represent it in one-dimensional diagrams.[30] But this need not

[28] Changes of this type play a rôle in the business-cycle analysis of Professor Strigl (see *Kapital und Produktion* [Vienna, 1934], pp. 192–95).

[29] Hayek, unpublished manuscript.

[30] Hayek, "On the Relationship between Investment and Output," *Economic Journal*, June, 1934, p. 217. Three principal kinds of investment functions should be distinguished. The most usual may be called the "cumulative investment function." It represents either the cumulative amount of services applied at any successive moment of time in the course of the process of producing the output finished at one moment of time or the cumulative amount of services (simultaneously) applied at successive stages (i.e., consumption distances) of production up to the final output. A second kind may be called the "service-application function," since it shows the application of services in the process of production at successive moments of

frighten us too much. For most analytical purposes it will be quite sufficient to bear in mind that one cannot do everything with the average period without reference to the "shape of the investment function." But one can use it for first approximations to the solution of a number of important problems in the theory of capital and, I believe, in the theory of fluctuations.

8. *"Time" per unit of output versus "time" per unit of input.*— Two more sources of confusion must be disclosed and blocked. The one originated from a careless use of the word "time" to measure both the input of productive services (labor hours, service hours, land-use years) and the interval elapsing between input and the dependent final output. The second confusion came from erroneous averaging of those intervals per unit of output rather than per unit of input.

A simple numerical example (Table I) will illustrate clearly this type of error. Under unchanged technical knowledge, unchanged length of the working day, homogeneous labor, and homogeneous product, three cases will be considered in one of which the average period of investment will be lengthened (Case II), and in another the number of workers will be increased (Case III). Both variations (support of workers through longer period, and support of more workers through unchanged period, respectively) are assumed to be rendered possible through the provisions of more "subsistence fund."

Comparing Case I with Case II we see that the increase in

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time or successive stages of production. It is simply the slope (first derivative) of the cumulative investment function. The third kind, investment function proper, represents the distribution of all productive services rendered at a moment (small interval) of time among the uses of different consumption distances. It is but the inverted service-application function. Services applied to the earliest stage of production are, for the inverted figure, services applied for uses of greatest consumption distance. Services applied to latest stages of production are, for the inverted figure, services applied for uses of smallest consumption distances.

Professor Hayek drew a figure of the cumulative investment function and inverted it instead of its first derivative (*ibid.*, p. 210). Unfortunately, he interpreted the inverted figure as though it were the inverted service-application function. I am afraid that this error may have confused some readers. It should be noted that for changing conditions only the third sort of investment function is significant, though it is for certain purposes too sensitive with regard to discontinuous outputs.

length of the investment period leads to a less than proportional increase in output per labor hour. Now "critics" would say: "The production of one unit of output needs in Case II not more but less time than in Case I; namely, one-eleventh rather than one-tenth hour." The "time" of which they speak obviously means "labor," which is, of course, measured by time. The saving of "time" in this sense, i.e., the saving of labor services per unit of

TABLE I

	Case I	Case II (Labor Constant; Subsistence Fund Increased)	Case III (Labor Increased; Subsistence Fund Increased Proportionately)
Number of workers	100 men	100 men	120 men
Length of working day	10 hours	10 hours	10 hours
Average period of investment*	100 days	120 days	100 days
Labor input during this period	100,000 hours	120,000 hours	120,000 hours
Output during this period	1,000,000 units	1,320,000 units†	1,200,000 units
Labor input per day	1,000 hours	1,000 hours	1,200 hours
Output per day	10,000 units	11,000 units	12,000 units
Output per hour	1,000 units	1,100 units	1,200 units
Output per man hour (i.e., per unit of labor input)	10 units	11 units	10 units
Labor input per unit of output	$\frac{1}{10}$ hour	$\frac{1}{11}$ hour	$\frac{1}{10}$ hour

* The length of the investment period is assumed (not calculated from the other data). In Case II production is assumed to be more roundabout through the use of an intermediate tool which is entirely used up at the end of the 120 days. In Case III the same production method as in Case I is applied.

† This figure does not show increasing returns. It has to be more than in proportion to the increase of the average period of investment, i.e., 100:120, even to show decreasing returns. A figure of less than 1,200,000 units of output over the longer period would imply negative return to the added 20 days of investment. The total "waiting" is increased not simply by the lapse of time, but by time multiplied by the amount invested at any moment.

output, is the very objective of the lengthening of the investment period. The increment in product per labor hour constitutes the "productivity" of the extension of the investment period. The measurement of the amount of services invested in terms of time units must not be confused with the "time dimension" of the investment in the sense of its "time distance" from consumption.

But other "critics" would say: "Not only 'labor time' but also 'waiting time' per unit of output is less in Case II. In Case I we had to wait 100 days for 1,000,000 units of output; in Case II we have to wait 120 days for 1,320,000 units of output. Therefore,

average unit waiting time in Case I was one-ten-thousandth of a day; in Case II only one-eleven-thousandth of a day." This "waiting time per unit of output" is an embarrassing confusion. The 100 and 120 days, respectively, were already averages per unit of labor input, and there is absolutely no sense in dividing these figures by the amount of output. That it does not make sense is shown by a comparison between Cases I and III, both of which include an equal and unchanged production period. In Case III, 1,200,000 units are produced in 100 days. The absolute increase in output, due to the increase in men and the proportional increase in "subsistence fund," with the unchanged period of production would give a shorter "period of production per unit of output"[31] if this had any meaning. The production period is the average number of waiting hours applied to the labor hour; it is an average period only in terms of input (of services other than waiting). If the average investment period is to be set in relation to output, not the absolute amount of output but average output per unit of labor input is the adequate magnitude for comparison. An "average period in terms of total output" is meaningless.

9. *Construction period and utilization period.*—The misconceptions dealt with in the last sections are of very old acquaintance—Böhm-Bawerk himself was concerned with them in his "excursus."[32] A novel method of arriving at erroneous averages is applied by Professor Knight. He divides the sum of the periods of construction and utilization of different plants by the number or value of plants, and states then, correctly of course, that an addition to the existing equipment may well "involve an increase in

[31] The erroneous reasoning would be: "We have to wait 100 days for 1,200,000 units; average waiting time per unit of output is therefore one-twelve-thousandth of a day; this is less than the one-ten-thousandth in Case 1." It should be noted that in Case III more workers are employed in an unchanged production period, hence with a constant amount of "capital per head." This will be discussed later. It was on purpose that I assumed here the subsistence fund to be increased proportionately with the number of men at work, in order to avoid the complications of shortening the investment period necessary when less "capital per head" is available. This is also reserved for later discussion.

[32] See the third or fourth German edition of his *Positive Theorie des Kapitales.*

the capital, while *shortening* the average cycle."[33] He thinks of the replacement cycle of durable capital goods. This cycle consists of the period of construction of the equipment plus its durability. Imagine that there are three plants, one with a period of construction plus utilization of 5 years, another with such a period of 10 years, and a third with one of 15 years. Now, additional investment is made by creating a fourth plant with a 6-year period. (The productive services engaged in constructing and maintaining the fourth plant must have been employed formerly in other lines, say, in farming.) In the case of three plants Professor Knight's "average period" was 10 years (5+10+15 divided by 3), while in the case of four plants (more capital!) the "average period" is only 9 years (5+6+10+15 divided by 4). This "average per unit of plant," or, weighted with the value of plant, the "average per capital invested," he erroneously took as the average investment period and, of course, found that it did not bear the well-known relation to the quantity of capital, viz., that it failed to increase with the increase in investment. The "average period of construction" plus the "average period of utilization" (both averages per unit of plant value) is by no means equal to the average period of investment (which is an average per unit of productive service inclusive of those not engaged in the construction and replacement of durable goods).

Making goods which need a longer time of construction and making goods which last longer are perhaps only "two details which are of the same significance as any of an infinity of other details," and are certainly only two "among an infinite number"[34] of ways of investing more capital. But "the two together" do certainly not constitute, as Professor Knight so strongly believes,[35] Böhm-Bawerk's period of production. It is inexplicable how Professor Knight could arrive at such an extremely narrow definition of the production period. Böhm-Bawerk, who is now accused of "simply selecting these two details" and giving them "the false

[33] *Economic Journal*, March, 1935, p. 81 (italics are his).

[34] Knight, *Economica*, August, 1934, p. 268.

[35] *Ibid.*, pp. 268–70; *Economic Journal*, March, 1935, pp. 78, 81, 88, etc.

designation of length of the production process,"[36] wrote the following sentence about investment in increased durability:

> It represents but one of the many special forms of using labor for obtaining consumption goods by those roundabout processes which make it possible to get out more goods per unit of original factors of production but at points of time which on the average are more remote from the time of input of those factors.[37]

Hence there is no conflict of opinion between the critic and the criticized that "average durability of the goods" and, similarly, the "average construction period for such goods"[38] need not be increased if total investment increases.

10. *Average durability.*—In spite of the fact that it was quite foreign to the theorists who reason in terms of investment periods to identify this concept with average construction periods plus average durability of goods, it should be noted that the relationship between "average durability" and "capital supply" is much closer than Professor Knight seems to allow for. An increase in "capital supply," in a money-enterprise economy, leads to increased investment through a lower rate of interest. (The supply of other services is assumed to be unchanged.) A reduction of the interest rate decreases construction cost as far as "carrying charges" are concerned and increases the present value of durable goods because of the lower discount of future returns. The latter phenomenon is of major significance. The increase in present value is the stronger the more durable the instruments are.

Let us compare this effect on the value of instruments of different durability. An instrument with a service life of one year and a gross return of $1,000 would have a present value of $940, if the interest rate is 6 per cent, and a present value of $970 if the interest rate is only 3 per cent. An instrument with a service life of two years and a gross return of $1,000 in each year would have under simple interest of 6 per cent a present value of (940+880=) $1,820, and under simple interest[39] of 3 per cent a present value of

[36] Knight, *Economica*, August, 1934, p. 268.

[37] *Op. cit.* (3d ed., 1909), p. 170; *ibid.* (4th ed., 1921), p. 127.

[38] Knight, *Economic Journal*, p. 78.

[39] A simple example was preferred here. Compound interest should be calculated for almost all practical (and theoretically important) cases.

(970+940=) $1,910. A fall of the interest rate from 6 to 3 per cent raises the value of the short-lived instrument from $940 to $970, i.e., by 3.2 per cent, while it raises the value of the long-lived instrument from $1,820 to $1,910, i.e., by 4.9 per cent. Cost of construction (aside from interest) being unchanged—the case is still stronger if the more durable instrument requires a longer time for construction and, hence, becomes now relatively cheaper in construction—it will be much more profitable to construct the more durable instrument.

The differences in the price increases of goods of different durability become the sharper the greater the expected service life is. Let the rate of interest drop only from 5 to 4 per cent and there results an increase in present value of a good with ten years' service life by about 5 per cent whereas the increase is more than 9 per cent for a good with twenty years' service life. (Compound interest was calculated here.)

There is, hence, a very strong presumption for the belief that increased supply of liquid capital leads to increased investment in durability, even in the sense of "average durability of goods," the concept emphasized by Professor Knight.

11. *"More durable" goods versus more "durable goods."*—In his criticism of the production period Professor Knight concentrates his forces against the alleged increase in the durability of goods. Again and again he asserts that increased investment need not involve increased durability and "therefore" need not involve increased "time between production and consumption,"[40] i.e., a longer investment period. The crux of the whole argument is the idea that making goods "more durable" is, but making more "durable goods" need not be, a lengthening of the investment period, according to Professor Knight's interpretation of the "Austrian" theory of capital.

Investment means, for the "Austrians" at least, using productive services for future consumable services. Increased investment means using the productive services on the average for consumable outputs in a more remote future. This lengthening of the period of maturing can be done in many ways, one of which is

[40] *Economica*, August, 1934, p. 269.

the making of goods and instruments of higher durability, another is the making of a greater amount of durable goods and instruments. If the primitive inhabitants of the famous isolated island, where fishing is the only line of production, and nets are the only type of durable instruments, abstain temporarily from some portions of consumption and add one more net to their stock, they certainly lengthen their investment period. (Labor is withdrawn from fishing and employed for making the net. Total labor supply remains constant, of course.) "Average durability" per unit of stock, per net, would remain equal. But even if they make the new net of lower durability, and decrease thereby the "average durability" of nets, the investment period would still be lengthened. Or if our good old Robinson Crusoe adds to his stock of tools, which last "on the average" one year, a new knife which lasts only two weeks, he still lengthens his production period. By refraining from direct consumptive use of some labor hours and using them for making the knife (and, later on, for maintaining or replacing the knife), he changes the average time distance between input and dependent output.

That, with a given amount of productive services employed, the making of a greater amount of durable goods per se would not involve any greater length of the investment period is a unique interpretation of the concept. The emphasis placed on this point by Professor Knight is striking. "More goods of the same kind," he says, "would mean no permanent change in either investment function or output function, as defined by Professor Hayek."[41] This should be contrasted with Professor Hayek's statement about the possibility of "changing the investment function for industry in general without changing it for any one industry."[42] The proportions *within* any one industry may be rigid and remain unchanged (the durability of their equipment, of course, too), but the proportions *between* industries may change. The investment function of society as a whole changes not only if goods are made "more or less durable" but also if more or less "durable goods" are made.

[41] *Economic Journal*, March, 1935, p. 78.

[42] "The Relationship between Investment and Output," *ibid.*, June, 1934, p. 224.

III. DIFFICULTIES AND COMPLICATIONS

12. *The view backward and the view forward.*—In the few places where we, thus far, had to define the production period we tried to avoid one dilemma which probably has not been seen clearly by Böhm and some of his immediate followers. The question how far into the future the output that depends on present activities is expected to reach, on the average, is different from the question how far back into the past reach, on the average, the activities on which the present output depends.[43] Under the assumption of a stationary economy in an unchanging world, the "historical" production period and the "anticipated" production period may be equal. But how are the two "production periods" related to each other in a changing world with changing men of changing mood? If people decide to change the time distribution of their current service input, how does this affect the "age distribution" of the output of today, tomorrow, and the immediate future? Is there not a considerable lag of the "real" time structure of production behind the "anticipated" one? And if the "anticipated" period undergoes heavy fluctuations, is it likely or possible that the "real" production structure varies concomitantly? And if this is found to be impossible, is it then not illicit to theorize about fluctuations in the production structure in the short run?

When Mr. Hill raised all these doubts he did not suggest the scrapping of the concepts altogether but a reconsideration, or the discontinuance, of their use in business cycle theory. The reconsideration may lead to a number of distinctions, refinements, qualifications of the concept, and what has been stated about it. So much seems to be clear: (1) that the significant hypotheses about the investment period and its changes refer exclusively to the so-called anticipated period, i.e., to the time distribution of the current input of services; (2) that the "historical"[44] produc-

[43] Hill, "The Period of Production and Industrial Fluctuations," *ibid.*, December, 1933, p. 601. In drawing the distinction Hill followed F. Burkhart, "Die Schemata des stationären Kreislaufs bei Böhm-Bawerk und Marx," *Weltwirtschaftliches Archiv*, Vol. XXXIV (1931).

[44] Mr. Hill speaks (*op. cit.*, p. 603) of the "completed" period rather than of a "historical." It is better to reserve the term "completed" for the discussion of other phenomena in the process of lengthening or shortening the period.

tion structure undoubtedly offers resistance to quick changes or even to fluctuations, a resistance which is the very substance of the explanation of cyclical and other disturbances; (3) that a production period between past input and present output[45] seems to be of no heuristic value for economic theory other than as a historical account of some "given data."

The "view forward" determines the employment of services available. That "it is by its nature hypothetical, representing an average of anticipations which may not be realized"[46] is not in contradiction with the fact that it is very real in its effects on what is being done at any one moment of time.

13. *Current investment versus total investment.*—The clean distinction between the "anticipated" investment period and the "historical" period is more or less the distinction between an economic problem and the data given for its solution. The economic problem is the problem of choice, in this case the problem of distributing the available productive services among purposes of different time index. The data include the total equipment available which is the result of history. The historical time distributions are materialized in the stock of "capital goods," the quantity, composition, and quality (including durability) of which are, of course, of influence upon the present choices as to the distribution of services over time. In other words, "past" investment, through the man-made equipment available "at present," influences (together with other factors) the "present" or current investment for "future" output. The investment function (the only significant one as an economic problem) refers wholly to the current investment. Hence it does not contain what one could call "total investment," i.e., the current investment plus the existing capital

[45] Mr. Hill writes (*op. cit.*, p. 605): "Owing to the existence of fixed capital the structure of production will not contract as rapidly as the anticipated production period. The average time in which existing specific capital-goods . . . . pass into consumers' goods is not likely to change appreciably over a short period." One should not forget that the fact that less or no services are currently employed to construct or reconstruct such fixed capital is quite an "appreciable change," even in the shortest run. Moreover, the "contraction" of the structure of production may be very rapid indeed, if value changes rather than physical changes are considered.

[46] *Ibid.*, p. 610.

goods (durable and non-durable), which are the result of past investments.[47] To mix existing capital goods with current investment and to make out of both one investment function is to mix historical data with economic problems. Past investments, so far as they are materialized in existing equipment (capital goods), certainly influence the shape of the current investment function (the investment period), but they are not contained in it with respect to the productive services which they will yield in the future. Only the productive services rendered at the moment of investment[48] constitute (with their consumption distances) the investment function.

14. *Investment of services of "original" factors versus services in general.*—At this point in the present discussion it is high time to dispense with the idea that only "original" factors of production should be considered. It was undoubtedly a mistake to look only at the services of "labor" and "land," as Böhm-Bawerk did throughout his discussion. Whether it was an inappropriate use of the stationary-state fiction, or whether it was the fear of reasoning in a circle, which led to the exclusion of the services of existing equipment from the investment account, it was a mistake to assume that the services which can be had from capital goods are, apart from their history, different in principle from the services of land and labor. (That there is no homogeneity within these categories should be clear.)[49] At any moment of time the services available from any sources of any kind—"free gifts" of nature as well as human labor-capacity as well as the results of past investment—are "given" for the economic choice. Labor services, land services, machine services, are institutionally, biologically, and

[47] It should be noted that this does not fit into Jevons' terminology. Our "total investment" would correspond to his "amount of capital invested" but not to his "amount of investment of capital." See his *Theory of Political Economy*, chap. vii (esp. p. 229 in the 4th ed.).

[48] To make it indubitably clear: The durability of existing equipment influences the current decisions about current investment and through it the investment period, but it does not enter as an item into the investment function.

[49] See Knight, *Economica*, August, 1934, p. 279. Professor Knight forcefully criticizes the fallacy of distinguishing "primary" from "produced" factors. I also owe much to an unpublished manuscript by Professor Hayek.

historically different, but there is no difference with regard to their economic position in the time structure of investment.

The resources that yield the productive services may be permanent or durable or perishable. The services are perishable altogether because they are related to the single moment of time. The labor hours, land-use hours, machine hours, become, in being employed, the items which constitute the current investment.

15. *The "unit" of investment.*—Labor is not homogeneous in kind, in quality, in efficiency; nor is land or capital goods. There is not much more sense in trying to compare in "physical units" the floor-space hour in a factory with the water-power hour from a river (both in some way related to "nature" or "land") than in comparing them with the labor hour of a bricklayer, or with that of a stockbroker, or with the hourly service from a steel hammer or that from a paper machine. And yet, should all of those services and their time dimensions be "averaged" in an investment period or, at least, brought into one investment function? (An additional complication consists in the circumstance that the special form of employment of transferable and versatile factors sometimes depends on the length of the investment period.)[50]

Is there a way out of the dilemma? Is it fair to "assume" homogeneity of services, to theorize on that basis, and be satisfied with conclusions *per analogiam?* Or is it better to take "value" as the only possible *tertium comparationis?* There may be an impenetrable series of implications in adopting value as the "unit" of input. If it is done, the time dimensions of the productive services being invested at a moment of time would have to be weighted with the values of these services.[51]

16. *Investment period and the amount of capital goods.*—The correlation between the investment period and the amount of capital

[50] Much emphasis was placed on this point by Franz X. Weiss, "Produktionsumwege und Kapitalzins," *Zeitschrift für Volkswirtschaft und Sozialpolitik*, N.F., I (1921), 568–72.

[51] This raises a number of the most serious theoretical problems. The value of productive services is dependent on the value of their future consumable services. Both are dependent on the length of the investment period, since an increase in that period yields an increase in future output. It is not only a matter of space when I abstain from entering into so trying a discussion. I may recall to the reader that

goods has sometimes been held to be true "by definition," sometimes rejected as meaningless or wrong. The customary proofs for the existence of the correlation run again in terms of a stationary state. The assumption of the stationary state implies that the investment function does not change but remains the same through time. The investment function of "today" would look exactly like that of any time in the past, and exactly like that of any time in the future. In this case the amount of capital goods in existence at any moment of time would be a certain function[52] of the investment function. It goes without saying, then, that the investment function and the amount of capital goods in existence are correlative.

Imagine now a change in the system; people start saving and investing; this involves a change in the investment function through a switch of services from lower to higher consumption distances. Assume, furthermore, that the new investment function is being maintained from then on and that the mobility and transformability of capital goods was sufficient to make the change take place without any losses. The changed investment function would tell that the physical quantity of capital goods of any type

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Pigou withdrew the "Pound Sterling worth of resources" from his last editions of the *Economics of Welfare* and substituted physical units for it. The issue was a different one but similar considerations are likely to be relevant in our problem. (Cf. the recent remarks by Howard S. Ellis, *Zeitschrift für Nationalökonomie*, June, 1935, pp. 158–59.)

[52] The investment function, as we defined it, represents the distribution of all services invested at a moment (small interval) of time among uses of different consumption distance. If such an investment function is (for a stationary state) drawn only for the services of original factors, then inverted and transformed to a cumulative function (now looking like Hayek's Fig. 1*b*, in his article in *Economic Journal*, June, 1934, p. 210), then the area under the cumulative investment function represents the stock of produced production goods. (About the simple and the cumulative investment function see also *supra*, p. 588, n. 30.) The statement in the text about the constancy through time of the investment function must be qualified by the further assumption that output is continuous. While cumulative investment functions are insensitive to discontinuities of output, and are therefore constant for a stationary state, the investment function as we defined it would vary according to the crop-distance. This is a technical defect. Better technicians may find an improved mode of expressing the investment function.

will be greater in the future than it is at the moment of change.[53] One could hold, however, that, although the physical quantity of capital goods is still unchanged at the very moment of the change of the investment function, there may be an immediate increase in stock value because of the lower capitalization rate of future income. In other words, the same "causes" which change the investment function change at once the rate of capitalization and, therefore, the value of existing equipment.

Another approach seems to be better adapted to the concepts as we have used them in this discussion. The relationship between the amount of capital goods and the investment period shows itself in both directions. First, the greater the amount of serviceable capital goods in existence, the greater is the part of the current productive services from resources of any kind which can be invested for a more distant future. Thus, the amount of capital goods in existence represents, so to speak, a potentiality of investing more for longer periods. It is a potentiality which has not necessarily to be made use of. (And, indeed, capital goods may lose in value if and when, through a change in time preferences, given "specific" equipment cannot be utilized fully.) But, generally speaking, the investment period tends to be longer the greater the amount of capital goods in existence. Second, if we use an increased part of the given productive services for things of greater time distance, the amount of capital goods in existence will increase. This means that, other things remaining equal, a lengthening of the investment period gradually increases the amount of capital goods in existence.

17. *Investment period and the supply of free capital disposal.*— In a single-plan economy, from the simple economy of the Crusoe type up to a communistic economy, the change in time preference

[53] If all productive services are consumed simultaneously, no "intermediate good" can exist. If production takes time, goods in process, and perhaps tools, are likely to be on the "inventory" at any moment of time. If production is arranged in stages which work continuously, the more goods must be on the inventory the longer the production period which is chosen. With a given input (per time) of productive services the inventory, at any moment of time, must be greater the greater the average time interval is until output is consumed.

(in the plan-makers' taste) and the change in the investment function are analytically the same. The time preference expresses itself in the distribution over time of the use which is made of the productive services currently available.

In an exchange-enterprise economy the time distribution of productive services is not *uno actu* changed with the time preferences on the part of certain individuals. Individuals who save transfer their disposal over services to other individuals who invest. Increased supply of "free capital disposal"[54] tends to reduce the exchange ratio of present to future income, which in turn leads to increased investment of productive services for longer periods. Individuals who disinvest, so far as they cannot draw upon the disposal over services released from individuals who save, withdraw the disposal over services from entrepreneurs. Decreased supply of "free capital disposal" tends to increase the exchange ratio of present to future income, which in turn leads to decreased investment of productive services for longer periods.

In a money-enterprise economy "free capital disposal" is supplied and demanded in the form of "money capital." Insight into the functioning of this system is much impeded by the fact that goods in process are passed over from firm to firm by way of exchange against money, whereby money appears to be free capital disposal for the individual without being so for the community as a whole. This is why the unreal assumption of production vertically integrated in a single firm is so convenient; and why under more realistic assumptions problems of great complexity emerge from monetary changes. So much seems to be clear that an increase in the supply of money capital tends (other things, including the amount of services, being equal) to lengthen the investment period; and, vice versa, a decrease in the supply of money capital tends to shorten the investment period. And this is so, whether disposal over services really is released by savers or withdrawn by dissavers, respectively, or whether only the "elasticity"

[54] I follow Cassel in using the term "capital disposal." It is better to avoid the term "capital" *simpliciter*. The terms "capital goods," "capital disposal," "capital value," "money capital," convey more definite meaning than the ambiguous word "capital."

of the money system does the trick. Thus changes in the investment structure are inseparably linked with the credit cycle.

18. *"At" a point of time versus "within" a period of time versus "for" a period of time.*—Discussions of "capital" and "investment" suffer not only from ambiguous meanings of these terms but also from confusion with respect to their time quality. The terms suggested by Jevons were not striking enough to be accepted by later writers. The "amount of investment of capital" was to mean something different from the "amount of capital invested,"[55] but neither of them was the "amount of capital being invested." The first was to be a product of a multiplication (more correctly, integration) of the amount that has been invested by the time for which it has been invested. The second, the "capital invested," was the amount that has been (and continues to be) invested up to a certain point of time, but without consideration of "the length of time during which it remains invested."[56] In other words, it was the inventory at a point of time. The third is the amount that is being invested within a (very small) interval of time.

"Capital invested" in the sense of capital that has been invested can, in a changing world, apart from setting up a profit-and-loss account, be significantly expressed, not in terms of its (historical) cost—i.e., in terms of the value it had at the time when the investments were made—but only in terms of the present value of the goods or resources which exist as result of those past investments. The present value is, of course, the capitalized income which is expected to accrue from the services from these goods or resources. Since the present value of these goods or resources has not much to do with the historical amounts invested, the term "capital invested" had better not be used for them. "Capital equipment" or "capital goods" are adequate terms.

"Capital invested" in the sense of capital that is being invested within a small interval of time can be expressed in terms of cost or value, both being the same under the assumptions of equilibrium theory. Can this "capital being currently invested" be expressed without time dimension? It certainly needs a reference to

[55] Jevons, *op. cit.* (4th ed.), p. 229. [56] *Ibid.*

the unit of time chosen, since it is a time rate (such as per hour, per day, per week). Is it necessary to add to the time within which it is being invested, also the time for which the investment is to be? The answer to this becomes clear if we recall what is being invested. If we think of capital disposal or of money capital, it can be expressed as a mere quantity without reference to the duration of investment. But if we think of the "real" investment, of productive services, we immediately see that the time dimensions become necessary because almost all productive services employed —except the personal services of servants, actors, etc.—are "invested" and the question is only one of their distribution over time. Under full employment no increase in investment would be conceivable if it were not for the investment of services for periods longer than those for which they were hitherto invested.

This circumstance is, I think, rather significant. The money capital which is being invested need not, and cannot, be assigned to any certain period of investment. Even if the individuals who supply it were quite determined as to the length of time for which they would like to tie it up, or even if the individuals were determined to invest it for eternity, the services which are invested by means of the money capital are invested for a period which is independent of the will of the particular saver. And the single new investment makes, *ceteris paribus* (hence, with the amount of services unchanged), the average period of investment just a little longer than it was before. If there is full employment, the increase in the amount of money capital being invested per unit of time increases the period for which the services are being invested on the average.

19. *Capital per capita.*—Productive services are distributed among uses of different consumption distance. To distribute a given amount of services is one problem. To distribute the services from a given amount of resources and men is another problem, because the capacity of resources and men may not be utilized fully. To distribute the services from a changing amount of resources and men is a third problem. It goes without saying that these distinctions are highly relevant for the problem of the average period of investment or, more correctly, for the problem of comparing investment structures.

A greater amount of services distributed over time (over consumption distances) in the same proportions as a smaller amount of services means, of course, an unchanged average period. Should there be an increase in the number of men employed, the amount of other resources would have to increase too, if a change in time distribution is to be avoided. This is often expressed by saying that changes in the average period of investment can be seen by changes in the amount of "capital per head." If population grows more quickly than capital equipment, with the result that less "capital per head" is available, shorter periods of investment become necessary. On the other hand, increased investment permits lengthened investment periods only so far as it is not accompanied by a proportional increase in men.

This interrelation (which I chose to formulate as a statement of tendencies) is sometimes suggested in the form of an analytical statement. If a cumulative investment function is drawn in the customary way (representing cumulatively the amounts of services applied at successive moments of time in the course of one process of producing the output finished at one moment of time),[57] the area under this investment curve is defined as capital (more correctly, capital goods in terms of incorporated services). The average period of investment is measured by dividing the area under the curve by the final output (i.e., by the income measured in terms of input or incorporated services.) This division represents, by definition, the ratio between capital and income.[58] If only labor income, rather than total income, is considered, and if it is (according to the ordinates of these diagrams) expressed in terms of service input, the analogous division gives the ratio between capital and labor services, or, if labor hours per laborer are fixed, capital per head.[59]

[57] See, among recent publications, the diagram in Marschak's article, *Economic Journal*, March, 1934, p. 147, or Fig. 1*a* in Hayek's article, *ibid.*, June, 1934, p. 210. For a short explanation see above, p. 588, n. 30.

[58] Professor Knight (*Economic Journal*, p. 88) considers this ratio "one of the least meaningful."

[59] Which of the two ratios is more significant for capital theory is still an open question. The discussion in the following paragraph places more emphasis on the second ratio. I owe much to Dr. Marschak's previously cited article and to his unpublished contribution to our private "round-letter" discussion.

An increased supply of money capital with unemployed labor services available would lead to an absorption into the production process of more labor services rather than—or in addition to—a redistribution over longer investment periods of the hitherto employed services. (Without increase in the supply of money capital, such absorption would be practicable only by a shortening of the investment period with lower returns to labor services). There would, however, be a different sequence of events if the additional money capital is supplied by an expansion of bank credit from what it would be if it were supplied by voluntary saving, i.e., under voluntary abstinence from consumption.

20. *The proportion between the factors employed.*—The reflections upon "capital per head" above suggest the coherence between the concepts of the "investment period" and the "proportion between the factors employed." So far as changes in the investment period are connected with changes in methods of production within single industries or even single firms, reasoning in terms of proportion between factors becomes necessary. A single firm which, under the influence of lower interest rates, buys new machines to substitute them for less efficient ones or for labor services, certainly does not calculate investment periods. The firm makes cost comparisons, and the elasticity of substitution[60] will, among other conditions, be decisive for the firm's choice. The result is, for the particular section of the economic system, to be stated only in terms of the proportions in which the factors are employed by the single firm or industry.

An average investment period or a certain investment function becomes significant only for the community as a whole. In a total system analysis it will sometimes be more convenient to theorize in terms of the proportion between the factors employed, sometimes in terms of the investment period. The use of the latter conception recommends itself in all problems where explanations of changes through time are essential. The "analytical correlation,"

[60] See J. R. Hicks, *The Theory of Wages* (London, 1932), p. 117; Joan Robinson, *The Economics of Imperfect Competition* (London, 1933), pp. 256–60; C. H. P. Gifford, *Econometrica*, April, 1935, pp. 208–10; Fritz Machlup, "The Commonsense of the Elasticity of Substitution," *Review of Economic Studies*, Vol. II (June, 1935).

mentioned in the preceding paragraph, is, of course, without significance for causal relations. What are really significant are questions as to the probable effect upon the investment period of an increased supply of money capital, and as to the effect upon the quantity of capital goods (producers' goods) of a lengthening of the investment period. Lags and friction in the realization of such sequences are not unimportant; the appreciation (increase in present value) of the bulk of existing capital goods in the case of a lengthening is not less relevant than the differentials for longer-lived and shorter-lived goods and (in the case of a sudden increase in voluntary saving) the depreciation of some specific instruments adapted for the production of consumers' goods.

The chances for a statistical measurement of the investment period are not too good,[61] for reasons which have been sufficiently indicated in the discussion of the difficulties and complications. Of these difficulties the greatest is the problem of comparability—which is present throughout the field of economic statistics and is comprehensible to anybody who has a clear understanding of subjective value theory. The chief working hypothesis of every statistical attempt at measuring the investment period seems to be its approximate correlation with the proportions in which the factors are employed.[62]

IV. SPECIAL PROBLEMS

21. *Width of income stream versus length of investment period.*—A great many economists substitute for the concept of the "length of the investment period" the concept of the "width of the income stream." The latter concept does not encounter so many complications as the former and has the advantage of not only suggesting a picture readily grasped but also of easily fitting into any analysis of economic dynamics, i.e., of fluctuating, progressive, or declining

[61] See Marschak, "Economic Parameters in a Stationary Society with Monetary Circulation," *Econometrica*, January, 1934; and Gifford, *Econometrica*, April, 1935.

[62] Lack of statistical "verification," or even theoretical impossibility of measurement, is no evidence whatsoever against the usefulness of a concept. As Professor Knight has said, absolutely to the point, clear and indispensable notions often "cannot be given exact definition; but this limitation applies to all quantitative analysis in economics" (*Economic Journal*, March, 1935, p. 90 n.).

economies. Saving is pictured as a narrowing of the income stream, which later becomes wider again, wider than it was before the narrowing; dissaving is pictured as a widening of the stream, which later becomes narrower again, narrower that it was before the widening. There are possibilities of continuous and of discontinuous changes in the width—in short, the concept is useful and adaptable.

Yet, it is a mistake to believe that one could dispose of the investment-period concept without disposing of one of its most significant purposes: to solve the time problem. Of course the "income stream" is a function of time, but one which remains unknown as long as the "investment period" is not introduced. It is certainly true that the income stream becomes wider again after having been narrowed by voluntary saving—but only after a while. After how long a while? How long a time does it take before the widening of the income stream occurs, and how long before the "abstinence" is fully offset? The answer may be sought by using a concept like the "investment period," or it may not be sought at all. What relates the changes in width of the income stream with one another is the investment period which has been thought to have been thrown overboard. That these intervals have meaning and significance is admitted by almost every economist—even by Professor Knight.[63]

22. *Investment period and the "stages of production."*—In discussions of the length of the investment period one ordinarily meets also propositions about the "stages of production." It would, however, be too optimistic to believe that these terms have a clear and unambiguous meaning. Although there is much over-

[63] See *Economica*, August, 1934, p. 273: "In reality most investments not only begin *at a fairly early date* to yield their income in consumable services . . . . but in addition they begin *fairly soon* to yield more than interest on cost in this form, and entirely liquidate themselves *in a moderate period of time*" (italics are mine). Or, on p. 278: "Any net saving and investment naturally means reduction in consumption somewhere and subsequent increase somewhere, raising the total rate of consumption in the system above that obtaining before saving started, the increase measuring the rate of return. In terms of *income* sacrificed for an interval and ultimately more than made up, the notions of roundaboutness and waiting have some meaning . . . ." (italics are Professor Knight's). Any investment is displaced earlier consumption income; this is the very point of the theory of the investment period.

lapping, one can distinguish "stages" of production in terms of (*a*) units of technical acts or divisions of the process (different acts), (*b*) locational units (different plants, buildings), (*c*) vocational units (different crafts, professions), (*d*) financial units (different firms), (*e*) time units (different consumption distances). Only the last of these concepts is inherently connected with the concept of the investment period, while the others are sometimes merely phases of the underlying technical conditions, sometimes among the more or less probable accompanying phenomena, but sometimes entirely unconnected.

In the attempt at illustrating an abstract exposition by concrete examples many authors pictured the lengthening of the investment period by pointing to the introduction of certain technical or financial stages of production. Readers—indeed, sometimes the authors themselves—then took the technical or financial properties of the process for the essential factors. In the discussion of production processes without durable instruments, the divergence of the technical stages from those in terms of "time distance from consumption" is not too disturbing; but when durable instruments are introduced into the scheme, the divergence between the two concepts becomes considerable. The steel plant and the machine shop, two definitive stages, of course, in the technical process, represent by no means two stages in the sense of consumption distance but an infinite number of such stages. One has to keep in mind that services employed for the making of a machine are, as to their consumption distances, distributed over a great range of time. Unless one goes through the procedure of averaging these time distributions for any single unit of equipment, or unit of plant—which is neither necessary nor possible—one must not consider a certain technical stage of production as a certain time stage of production.

The divergence between financial stages and time stages is not much less remarkable. This was not made clear enough by Professor Hayek in his *Prices and Production*, and led to much confusion. His diagrams are devised to show the money stream between the financial units engaged in the production process. That the lengthening of the investment period (i.e., the increase in the

time stages of production) would involve an increase in money transactions to be performed because of an increase in the number of financial stages of production was an assumption of Professor Hayek's which he certainly did not state clearly enough and which was justly criticized by Professor Ellis.[64] In anticipation of the confusion, Böhm-Bawerk had expressly given warning that the length "of the process, its extension or its curtailment . . . . is not measured by the number of independent intermediate members which the production process embraces."[65]

23. *The investment period during new capital construction.*—"In a sense, *all* work done in a stationary society is replacement work."[66] This mode of approach has perhaps much more justification than the crude division of the production system into producers' goods and consumers' goods production, whereby the "early stages" of production are assumed to be engaged in the one, the "later stages" in the other part of that process. According to this last view, the number or the work of the earlier stages is imagined to be increased if society becomes progressive. The question then arises whether lengthening of the investment period is not confined to the period of capital accumulation, while shortening occurs when the process of accumulation comes to an end and a stationary state sets in.

This is Professor Knight's view. If more capital goods are constructed, he says, "there will be, *temporarily* (while the expansion is taking place, but not after it is completed), a slight increase in the proportion of goods in the earlier stages of processing operations, in comparison with later stages."[67] It will be shown, nevertheless, that a society which stops constructing new capital and confines itself to maintaining capital does stop lengthening its investment period; it need not shorten it if the transition is not too sudden.

[64] Howard S. Ellis, *German Monetary Theory, 1905–1933*, ("Harvard Economic Studies," Vol. XLIV), p. 354. "A given increment of capital has nothing to do with the number of independent productive stages through which the intermediate products pass."

[65] *Positive Theory*, p. 91.

[66] Marschak, *Economic Journal*, March, 1934, p. 151.

[67] Knight, *Economic Journal*, March, 1935, p. 78 (italics are his).

The essential point in the argument is the gradual transition from a state of new capital formation to a state of pure capital maintenance. It is easy to see that there is a rate at which new saving and investing may slow down, and finally dwindle, without necessitating a shortening of the investment period (and difficulties in the construction-goods industry). Any increment of capital involves an increment in replacement funds necessary for full maintenance. If society is "progressive" but at a decreasing rate, the funds supplied for maintenance still continue to increase. The decrease in the supply of new savings may, therefore, be compensated by the increase in the supply of replacement fund, so that the total supply of free capital disposal remains equal.[68] In other words, the increase in construction of equipment for replacement purposes may offset the decrease in construction of new capital equipment. If the rate at which saving and investing falls off does not surpass these limits,[69] no shortening of the investment period need ensue.

On the other hand, it should be noted that if the increase in capital takes place within too short an interval, it will not be sufficient to maintain the lengthened investment period. If in an economy which has been stationary hitherto one single investment is made and not followed by any further complementary investments, the single investment is, generally, bound to be wasted.[70] The lengthening of the production process is itself a process which needs time to be completed and, hence, to become definitive. But if after a sufficiently long phase of capital formation the transition from this phase to a phase of pure maintenance of capital is gradual enough to "permit the processes which have already been

[68] Suppose a current replacement fund of 300 units and new capital formation of 40. In the next interval the replacement fund will have to be (if the replacement quota is 10 per cent) 304 so that new capital formation can fall to 36 without causing a reduction in the supply of capital disposal (see Fritz Machlup, *Börsenkredit, Industriekredit und Kapitalbildung* [Vienna, 1931], p. 106).

[69] These limits are determined, as shown by Fowler (*The Depreciation of Capital* [London, 1934], pp. 36–54), by the average durability and its relation to the average construction period of capital goods. Here is the place where these concepts used by Professor Knight (see above, sec. 9) adequately come in.

[70] For detailed explanations, see my book, *op. cit.*, pp. 103–11; and Hayek, *Econometrica*, April, 1934, pp. 153–58.

started to be completed,"[71] the lengthening of the investment period will have been not temporary but definitive.

24. *Changes in demand.*—Changes in the investment period are not always caused by changes in time preferences. Purely qualitative changes in demand of intentionally equal time index may cause changes in the investment function. For a single-plan economy, however, this is not true, since the omniscient plan-makers will see whether or not the changed tastes can be satisfied without any different, or more or less, equipment and, hence, without any changes in the time distribution of services. If changed tastes could be satisfied only by a changed time structure of production, the plan-makers would immediately have to balance the displaced alternatives, which in this case would be alternatives of different time index. In a money-enterprise economy the situation is different, because of the lag of cost reactions behind consumers' choices. The prices of consumers' goods between which the individuals choose may be, at the time of the choice, different from what they would be after all rearrangements of productive services necessary for the provision of the goods demanded had been performed or calculated. The change in investment periods comes about by way of interactions of entrepreneurs, and it is only through consecutive changes in prices that consumers find their changed tastes to be incompatible with unchanged time preferences.

Using less abstract language, we may say that the consumers' choices between goods made from different materials or made in different types might cause major adaptations in the productive equipment. If the specificity of equipment does not permit technical adaptation, the change can be made only out of replacement funds. The quasi-rent in the still underequipped line of production becomes apparent in higher rates of interest offered for free capital disposal. In this way replacement funds not only from the overequipped line of production (overequipped relative to the changed demand) but also from quite different industries are attracted by the more profitable production. Resulting price increases in other products force the consumer to reconsider the

[71] Hayek, *ibid.*, p. 157.

distribution of his budget. (This redistribution may include the item "saving" because it is not only prices of commodities but also the rate of interest which undergo change.)

The adaptation in the productive apparatus to a change in demand may lead either to merely temporary or to definitive changes in the investment structure. This depends on two circumstances: first, a change in demand so sudden and sharp that the producers of the product that fell into disfavor cannot earn any replacement quotas (definitive loss of the sunk investment) will tend to definitive shortening of the investment period; second, the quasi-rents of the producers of the favored product, if saved and invested, might counteract the first tendency.

There is another point calling for attention. Apart from the losses and gains of transition, differences in the "capital intensity" of the goods between which the demand has shifted may be important. The favored product may not only need different equipment but more or less equipment than the product in disfavor has needed for its production. The shift in demand may, for instance, finally be "capital saving." (Crude examples: Tents preferred to houses; services of stage actors preferred to services of automobiles.) Whether or not such changes lead to shorter investment periods depends on many questions, e.g., whether consumers use all the money diverted from capital-intensive products for purchases of less capital-needing products (or what else they use it for); whether the sunk capital can be extracted from the industries in disfavor; whether the capital extracted from these industries is used for reinvestment elsewhere (probably under reduced interest rates), etc.

In an economy in which new savings are continually forthcoming, a part of the new savings will be used for financing the adaptations of equipment to changed demand. Since the presumption that net losses of capital are connected with these adaptations is very great, it is fair to assume that an economy can be stationary in respect to its capital base only if it provides new savings to rebuild its equipment needed for changed tastes. An economy which is stationary in terms of new savings (i.e., savings are zero) is declining in respect to its capital base, if changes in demand oc-

cur. Or, to put it in another way, "quick change in the objects of consumption without the emergence of new savings is itself a form of consuming capital."[72] Changes in demand represent, therefore, one of the qualifications of the proposition that any increase in the supply of capital disposal leads to a lengthening of the investment period. Changes in demand represent, furthermore, one of the important, but neglected, points in the theory of the natural rate of interest. Changes in demand tend to raise the equilibrium rate of interest[73] and may involve a sufficient impulse for an (inflationary) expansion of bank credit.

25. *Changes in technical knowledge (inventions).*—The invention case was the basis of the very first critical discussions following publication of Böhm-Bawerk's *Positive Theory*. The greatest part of these discussions was occupied by repetitions of simple misunderstandings. The misnomer "period of production" led critics to look at the duration of the direct technical production process proper, and then to believe that almost all inventions shorten this period. Sewing by hand is a much slower method of making dresses than sewing by machine. Hence, thought the critics, the production period was shortened by the invention of the sewing machine. Böhm-Bawerk had a hard time to explain that sewing of the dress was only the last part of the process, while in the process as a whole services were invested in iron production and machine shops and in the sewing machine and only finally in the dressmaking.[74]

In his ardor to refute the assertion that the production period is shortened by such inventions, Böhm went so far as to assure us

[72] Machlup, "The Consumption of Capital in Austria," *Review of Economic Statistics*, XVII (January, 1935), 14.

[73] The effect upon the equilibrium rate of interest of changes in demand can be the result of several opportunities of investment, e.g.: (*a*) financing technical adaptations; (*b*) financing quick construction of the *different* equipment needed for the newly favored product; (*c*) financing construction of the *increased* equipment if the newly favored product is capital-intensive; (*d*) financing construction of different and increased equipment which was, due to lumpiness, hitherto not to be used profitably but becomes so if the demand for the newly favored product reaches a certain minimum.

[74] See especially Böhm-Bawerk's "Exkurse," e.g., "Exkurs II," in *Positive Theorie des Kapitales*, II (4th ed.), 44.

of the contrary, which is not true either. The invention neither shortens nor lengthens the investment period. All it does is to make investment opportunities more or less profitable. If and when new capital disposal is supplied (e.g., by new savings), then the investment period can be lengthened. But if these new savings would have come forth in any case, then the investment period would have been lengthened in any case. The new invention, if it was of the mentioned type, merely made the interest rate higher than it would have been otherwise.

If there is no increase in the supply of money capital above the current supply of replacement funds, then there is generally no possibility of a lengthening of the investment period. But if the new invention is connected with some especially durable instruments, will not substitution of new instruments of itself involve a lengthening of the investment period? If exploitation of the invention appears to be profitable in spite of its taking so much capital away from other industries (under a sharp rise of the interest rate), so many other investments which would otherwise have been made are omitted that the investment period is left unchanged. The high rate of interest might, of course, induce people to save or to dissave, and in this way lead to a change in the investment period.

New inventions may suggest new sorts of equipment which compete with, and render obsolete, existing equipment. This may cause major losses of sunk investment; the investment period may be shortened (in case replacement funds have to be attracted from other industries) or may be left unchanged (in case new savings are just sufficient to finance the new investment) or lengthened in a smaller degree than would otherwise have been possible. But it would be quite unwarranted to consider this a social loss. If an undiminished or even increased product can be provided with less capital or in a shorter investment period, there is no reason for resenting such a development. (Of course, if the inventions had been known many years earlier, many past investments would have been made differently and their obsolescence saved.) Obsolescence occurs if the new equipment is relatively more efficient or if it is cheaper. The latter is a case of a "capital-saving" inven-

tion. The old equipment is depreciated to the lower value of the new, because the price of the products of this equipment would no longer cover replacement of the former value. What the consumer had to contribute to this replacement now becomes his increased purchasing power, which may be spent for increased consumption or which may be saved. The capital loss through obsolescence is capital consumption in the sense that it is accompanied by increased consumption, but it is not capital consumption in the sense that it renders impossible permanent maintenance of consumption on the higher level.

In substance, the effect of inventions, capital-needing or capital-saving, upon the investment period is per se neither lengthening nor shortening; their indirect effects depend on the incidental losses of transition and on the incidental changes in saving and dissaving.

26. *Investment period and disinvestment period.*—Changes in technique, it has just been shown, need not involve changes in the investment period. But neither need changes in the investment period involve changes in the technical methods employed. In an economy where no durable goods exist and where no technical substitutability exists, so that the proportions between the factors in the production of any one product are fixed, shortening of the investment period would be possible through changes in the relative proportions of different industries. There are two ways of shortening the investment period without changing the technique of production in an economy which employs durable goods. One way is changing the proportions between industries; the other is neglecting temporarily the replacement of durable goods. To say this is not to assert that these are the only or the most likely procedures in disinvesting societies; but it is necessary to warn against the belief that an unchanged technique of production offers any evidence for an unchanged investment structure.

Consideration of the "disinvestment period" is necessary for the analysis of a number of problems connected with capital disinvestment either as a phase of the business cycle or as a general trend,[75] as well as of problems connected with the adaptation of

[75] See Machlup, "The Consumption of Capital in Austria," *Review of Economic Statistics*, XVII (January, 1935).

specific capital equipments to changing conditions. It is nevertheless not true that immobility or specificity of equipment are the only factors that matter. Even if every good were perfectly transformable into any other good, if we, therefore, could eat up machines and buildings directly rather than through a lengthy process of undermaintenance, even then the disinvestment period would remain significant for the questions how long "overconsumption" can be continued, and after what interval the consecutive shrinkage in width of the consumption stream will come about.

The statement that "in equilibrium the period of investment for the total volume of capital . . . . is equal to the period of disinvestment"[76] is liable to misinterpretation. Within what time the total capital of society can be disinvested is not the point in question. The notion of the investment period, being an "average" of an infinite number of time indices, would not help to answer such a question. To put the question for the length of the disinvestment period in terms of an individual investment would be still less sensible. The individual investor can exchange his property rights against present consumption income (of course not at a fixed ratio) at any time, whether they are taken over out of new savings or, in want of new savings, out of some replacement funds. And the marginal investment at one moment of time will hardly concern the same lines of production as the marginal disinvestment at another moment.

The use of replacement funds for "taking over" property rights of disinvesting individuals, hence the use of replacement funds for the disinvestors' consumption,[77] is the essential point. The speed or rate of supply of replacement funds, on the one hand, the consequences of withdrawing parts of them from reinvestment, on the other hand, are dependent on the time structure of investment. The average time interval from investment to consumption is also the average time interval from investment to the forthcoming of the capital disposal free for reinvestment, because it is the receipts

[76] Fowler, *The Depreciation of Capital*, p. 35.

[77] Not necessarily the disinvestors' personal consumption; if they disinvest, say, in order to pay taxes, state employees might be the persons who do the consuming. Disinvestment for the sake of financial liquidity is to be discussed later.

from the sales of the consumption goods which provide the replacement quotas for all the earlier stages of production.[78]

Imagine a barter-enterprise economy with vertically integrated production. The entrepreneur exchanges the final products of his production, or other consumption goods which he received in exchange for his, against productive services, if he wants to continue the enterprise, i.e., if he wants to reinvest. But he eats them himself if he does not want to reinvest. In a money-enterprise economy the money receipts for the final consumption goods are the funds available for reinvestment or disinvestment. The industry where a disinvestment takes place—i.e., where reinvestment is omitted—need by no means be the same as, or be closely connected with, the industry which received for its products the money that "financed" the disinvestment, first, because replacement, though continuous in the economy as a whole, is not continuous in single lines of production; second, because the money capital circulating in an economy with vertically differentiated production (i.e., not integrated in one firm) is a multiple of the "real" replacement funds. This monetary phenomenon is partly responsible for the difficulties, in practice as well as in theory, which result from the fact that the money capital *de facto* available for disinvestment exceeds in so large a degree the money capital "genuinely" released from production through the final sale of consumption goods. The meaning of these phrases is more readily apparent if one imagines the money funds which would be available for reinvestment or disinvestment in an economy with vertically integrated production.

V. THE CREDIT CYCLE

27. *Credit expansion and investment period.*—Analysis of the consequences of an increase in the amount of money capital given to entrepreneurs has to cover a number of possibilities. Apart from an increase in the holdings of cash reserves (hoarding), and from an increase in the money work to be done on account of a possible increase in "interfirm transactions," the incre-

[78] On this point see my *Börsenkredit, Industriekredit und Kapitalbildung*, pp. 15–16; and Strigl, *Kapital und Produktion*, pp. 30–37.

ment in money capital may be used (1) for employing a given amount of services for other work than that for which they were hitherto employed; (2) for paying higher rates per unit of service; (3) for employing a greater amount of services from the factors hitherto employed (longer labor week); (4) for employing a greater amount of services from factors hitherto unemployed.

An analysis that begins with full employment and given supply of services has to take into consideration only the possibilities (1) and (2). But these two will have to go together under almost all assumptions. If the increase in the amount of money capital given to producers is due to voluntary saving, hence to a decrease in the amount of money spent directly on consumers' goods, the tendency toward a rise in the prices of productive services will be smallest. But there will still be a tendency for such a rise, because marginal-value productivity of labor services should be assumed to rise in those employments which are made profitable by the interest-rate reduction that accompanies the increased supply of money capital. The rise in wage rates will, of course, be sharper if not voluntary saving (abstinence from consumption), but credit expansion is the source of the increased supply of money capital. But in both cases the first of the mentioned possibilities is rather certain to come true, and, according to what has been said above (see especially secs. 17 and 18), the work that will be favored at the expense of some other work will be of a type that yields consumable services at, on the average, more distant points of time.

The sequences of events characterized as lengthening of the investment period have mostly been described for the case of a fixed supply of productive services. Increased employment of services —i.e., the possibilities (3) and (4) above—have been ruled out. This was correct as a first approximation, but a further step is to analyze the sequences without the assumption of fixed supply of productive services.

The inclusion of the possibility (3)—i.e., of employing more services from an unchanged number of men—is theoretically fascinating (because of the interesting complications in assuming various shapes of labor supply curves), but it has less practical significance than the possibility (4)—i.e., employing formerly unem-

ployed factors of production. The absorption into the productive process of unemployed factors has been regarded by many writers as the realistic case where the irrelevance of an investment-period theory for the analysis of credit expansion would become apparent. And this for two reasons: first, it has been said that if sufficient productive capacity is available no services have to be withdrawn from consumption-goods industries as, owing to an expansion of credit, the production of investment-goods industries is extended; second, the amount of service input being increased, the increased investment need not involve any lengthening of the investment period. There is more investment, but there are also more productive services, hence no change in proportion and no "distortion of the investment structure" will ensue.

The correctness of this view and the applicability of an investment-cycle theory are not incompatible. One has to bear in mind that, according to the capital theory under consideration, an increased amount of services can be employed, without additional voluntary abstinence from consumption, only if the investment period is shortened[79] and the earnings per unit of service are reduced. By employing more services, through credit expansion, at unreduced rates of earnings without voluntary saving, the investment period, absolutely unchanged, becomes longer than it would be without credit expansion.

The case of credit expansion with full employment and that without full employment are, therefore, equivalent in respect to the fact that the investment period becomes longer than it would

[79] Less capital per head is available. See above, p. 590, and also p. 605. It need not be explained that the return to labor is smaller the shorter the period of investment. In terms of cost theory one would speak of decreasing returns of increased application of labor, or of increasing marginal cost of production. A qualification should be made with reference to the unused capacity argument. If unused capacity of equipment of all sorts is available in all stages of production, and if materials, goods in process, and finished goods of all kinds are on stock in sufficient quantities, synchronized production (and consumption) could set in at a stroke all at once. No additional waiting for intermediate or finished goods would be needed. (Why there should be unemployment, under such circumstances, is, however, hardly intelligible.)

be if the supply of money capital were confined to its "natural"[80] sources: namely, replacement funds and voluntary savings.

28. *Investment period and inevitableness of the breakdown.*—Absolute or relative overlengthening of the investment period is the probable result of expansion of producers' credit. The length is excessive in the sense that without any "outside" influences (without change in data) internal forces will lead to a reshortening of the investment period, sooner or later. The "internal forces" consist in a divergence between the individual time preferences (as expressed in the proportions in which the money incomes are saved and invested or spent for consumers' goods) and the time structure of production. The divergence is concealed so long as the credit system continues to subsidize successfully the employment of productive services for work of great consumption distance—work which would not be done if the voluntary distribution of the existing money funds alone were decisive for production.

A discussion of the details of business-cycle theory and monetary management cannot be embarked upon here. But all that is needed here is to point to the essential connection between investment period and credit cycle. While some writers find the causes of the breakdown of prosperity in the imperfections of monetary institutions or in lack of skill of monetary authorities, the investment-cycle theory suggests that there is no money system and no credit management conceivable which could permanently maintain a production structure (i.e., time distribution of productive services) which does not correspond to the structure of expenditures (i.e., time distribution of purchasing power). Though monetary forces help to bring about "prosperity," and lead to the excessive length of the investment period, monetary forces do not seem to be capable of maintaining it permanently.

Why the boom is doomed is explained by the investment-cycle

[80] No value judgment is implied in using the word "natural" as distinguished from "artificial." The "natural" sources refer to the concept of the "natural" rate of interest, which is simply that rate which equalizes the demand for money capital to the amount supplied out of replacement funds and voluntary savings.

theory. This theory does not make the pretense of being the only explanation of all cycles and crises that have ever occurred, nor does it pretend that it states unconditional necessities. The gist of the theory is that there is a high chance that increased bank credit,[81] unless offset by hoarding or similar phenomena, makes for investment periods different from what they would be otherwise; that there is, furthermore, almost no chance that the distribution of expenditures in consecutive phases will adapt itself to the investment structure;[82] and that, therefore, the investment structure will be forced to undergo a process of readjustment.

29. *Liquidation for consumption versus liquidation for liquidity.* —The "liquidation mania" commonly observed during crises and depression, the urgent attempts to exchange capital goods and property rights for liquid funds, are not motivated by the wish to use the liquid funds for buying consumption goods but by the wish to keep the liquid funds on reserve. These rather obvious facts are taken by some writers for the whole substance behind the notion of depression. The struggle for liquidity alone is held to account for the disinvestment after prosperity. Hence, the breakdown is considered either as the result of psychic (or psychopathic) phenomena or as the result of the failure of the credit system to supply the money necessary to satisfy this increased demand for liquidity.

Nobody can seriously question the fact or the significance of this "liquidation for liquidity." But this clearly visible fact should not lead us to forget that it is as a rule preceded and, in a sense, "caused" by "liquidation for consumption." This "liquidation for consumption" is the discontinuance of activities of great consumption distance forced upon, or suggested to, the entrepreneurs through lack of capital disposal or through cost increases which are but the expression of the comparatively more urgent demand

[81] Increased utilization of bank balances may take the place of increased amounts of bank balances. (Increase in V' rather than increase in M', i.e., "dishoarding.")

[82] The adaptation of the expenditure distribution to an excessive period of investment would consist in providing increased savings to take the place of infusions of new bank credit.

for consumption goods. That the use of productive services ceases to be profitable for a certain kind of work is the expression of the buyers' preference for other products, e.g., for "present" consumption goods. The first attempts at disinvesting—i.e., the failure to reinvest in work of great consumption distance—may easily, and actually did mostly, start a general flight from investment into greater holdings of cash. Although in reality the two types of liquidation are ordinarily combined, they should be distinguished in theoretical analysis. Complete absence of the liquidity rush would not imply elimination of the business cycle or of depression; only the depth of the trough, the amplitude of the cycle, would be much smaller.

30. *Deflation and shortening of the investment period.*—How much of the difficulties and frictions would be taken away from society if deflationary liquidation did not accompany and aggravate consumptive liquidation cannot be known. But that the shortening of the investment period is connected with difficulties and frictions of its own seems to be certain. They may result from several circumstances: (1) Many capital goods are specific, i.e., not capable of being used for other purposes than those they were originally planned for; major losses follow then from the change in production structure. (2) Capital values in general—i.e., anticipated values of future income—are reduced by higher rates of capitalization; the owners of capital goods and property rights experience, therefore, serious losses. (3) Specific capital goods serviceable as "complementary" equipment for those lines of production which would correspond to the consumers' demand are probably not ready; employment in these lines is, therefore, smaller than it could be otherwise. (4) Marginal-value productivity of labor in shorter investment periods is lower; wage rates are, therefore, depressed. (5) Under inflexible wage rates unemployment ensues from the decreased demand prices for labor.

That capital loss, wage cuts, and unemployment can be explained apart from any deflation does not mean that in reality they are not entangled with deflation. We said before, and repeat here, that deflation, though sometimes "caused" by the process of

shortening the investment period, aggravates this process considerably.[83]

31. *Immobility of factors and rigidity of costs.*—The immobility and specificity of capital goods—strengthening the resistance to adaptation and adjustment—has something to do with the durability of instruments and thereby with the investment period. But, as Professor Knight points out correctly, there is no definite relation between durability and the lack of adaptability.[84] And there is certainly not the least economic connection between investment period and the main force of resistance to adjustment: cost rigidity. Hence, with immobility of factors (human and produced) and rigidity of costs (labor and material) as the essential factors of the trouble, the period of investment would have no place in the analysis of depression.

If capital goods were mobile and perfectly adaptable there would be no unused plant capacity. And "if labor were mobile and wages flexible, no fixity in the capital structure would give rise to unemployment."[85] And yet, to explain unemployment (through wage stickiness) is one thing; to explain the business cycle is another. If wages were perfectly flexible there would perhaps be no sharp fluctuations in employment, but there would be fluctuations in wage rates instead. Why the perfectly flexible wage rates go up through some length of time and why they fall most heavily through some succeeding length of time—in other words, why there is boom and depression, and whether and why depression must follow the boom—would still remain open questions. For a theory of the business cycle, with no unemployment but wage fluctuations instead, the concept of the investment period would be as valuable a tool as it is for the theory of the business cycle with little wage flexibility and unemployment.

[83] To state this is by no means to advocate reflationary measures. Although they may offset hoarding and mitigate the difficulties connected with it, they may also interfere with, and actually delay, the necessary adaptations in the production structure.

[84] *Economic Journal*, March, 1935, p. 93; *Canadian Journal*, February, 1935, p. 21.

[85] Knight, *Economic Journal*, March, 1935, p. 94.