THE
QUARTERLY JOURNAL
OF
ECONOMICS

FEBRUARY, 1936

THE MYTHOLOGY OF CAPITAL

> With every respect for the intellectual qualities of my opponent, I must oppose his doctrine with all possible emphasis, in order to defend a solid and natural theory of capital against a mythology of capital.—E. v. Böhm-Bawerk, Quarterly Journal of Economics, vol. xxi/2, February 1907, p. 282.

SUMMARY

I. Professor Knight's argument, 199.— II. On some current misconceptions: 1. The investment periods and technological progress, 204; 2. They refer to factors, not products, 205; 3. The aggregate of such periods cannot be reduced to an average, nor is measurability essential, 206; 4. The periods refer always to the future, never to the past, 208; 5. The concept does not depend on a distinction between original and produced means of production, 209; 6. Nor is it only the original means of production whose investment periods can be changed, 209.— III. Professor Knight's criticism based on a misunderstanding, 210.— IV. His own position prevents him from giving any explanation of how the limitation of capital restricts the increase of output, 213.— V. An erroneous assertion following from his fundamental position: the value of capital goods when interest disappears, 222.— VI. Problems of capital and "perfect foresight," 225.

I

Professor Knight's crusade against the concept of the period of investment[1] revives a controversy which attracted much attention thirty and forty years ago but was not satis-

1. The following are the main articles in which Professor Knight has recently discussed the problem in question, and to which I shall refer in the course of this article by the numbers given in square brackets [ ]:

[1] Capitalist Production, Time and the Rate of Return. Economic Essays in Honour of Gustav Cassel, London 1933, pp. 327–342.

[2] Capital Time, and the Interest Rate. Economica (new series), vol. i, No. 3, August 1934, pp. 257–286.

factorily settled at that time. In his attack he uses very similar arguments to those which Professor J. B. Clark employed then against Böhm-Bawerk. However, I am not concerned here with a defense of the details of the views of the latter. In my opinion the oversimplified form in which he (and Jevons before him) tried to incorporate the time element into the theory of capital prevented him from cutting himself finally loose from the misleading concept of capital as a definite "fund," and is largely responsible for much of the confusion which exists on the subject; and I have full sympathy with those who see in the concept of a single or average period of production a meaningless abstraction which has little if any relationship to anything in the real world. But Professor Knight, instead of directing his attack against what is undoubtedly wrong or misleading in the traditional statement of this theory, and trying to put a more appropriate treatment of the time element in its place, seems to me to fall back on the much more serious and dangerous error of its opponents of forty years ago. In the place of at least an attempt of analysis of the real phenomena, he evades the

[3] Professor Hayek and the Theory of Investment. Economic Journal, vol. xlv, No. 177, March 1935, pp. 77–94.

In addition, certain other articles by Professor Knight which bear closely on the subject and to some of which I may occasionally refer may also be mentioned.

[4] Professor Fisher's Interest Theory: A Case in Point. Journal of Political Economy, vol. xxxix, No. 2, April 1931, pp. 176–212.

[5] Article on Interest, Encyclopaedia of Social Sciences, vol. viii, 1932, pp. 131–144.

[6] The Ricardian Theory of Production and Distribution. The Canadian Journal of Economics and Political Science, vol. i, No. 1, February 1935, pp. 3–25.

The classical "Austrian" position has recently been ably and lucidly restated and defended against Professor Knight's criticism by Professor Fritz Machlup in an article, "Professor Knight and the 'Period of Production,'" which appeared, together with a Comment by Professor Knight, in the Journal of Political Economy for October 1935. But this as well as Professor Knight's answer to Mr. Boulding (The Theory of Investment Once More: Mr. Boulding and the Austrians, in the last issue of this Journal) reached me too late to refer to them in the body of the article. But one or two references to these latest publications have been added in footnotes where I refer to the Comment and the Reply to Mr. Boulding with the numbers [7] and [8] respectively.

problems by the introduction of a pseudo-concept devoid of content and meaning, which threatens to shroud the whole problem in a mist of words.

It is with profound regret that I feel myself compelled to dissent from Professor Knight on this point, and to return his criticism. Quite apart from the great indebtedness which all economists must feel towards Professor Knight for his contributions to economic theory in general, there is no other author with whom I feel myself so much in agreement, even on some of the central questions of the theory of interest, as with Professor Knight. His masterly expositions of the relationship between the productivity and the "time-preference" element in the determination of the rate of interest[2] should have removed, for all time I hope, one of the worst misunderstandings which in the past have divided the different camps of theorists. Under these conditions anything which comes from him carries great weight, particularly when he attaches such importance to it that he tries "to force his views on reluctant minds by varied iteration." It is not surprising that he has already gained some adherents to his views.[3] But this only makes it doubly necessary to refute what seems to me to be a series of erroneous conclusions, founded on one basic mistake, which already in the past has constituted a serious bar to theoretical progress, and which would threaten to balk every further advance in this field, if its pronouncement by an authority like Professor Knight were left uncontradicted.

This basic mistake — if the substitution of a meaningless statement for the solution of a problem can be called a mistake — is the idea of capital as a fund which maintains itself automatically, and that, in consequence, once an amount of capital has been brought into existence the necessity of

2. Cf. particularly articles [4] and [5] quoted above.

3. Cf. H. S. Ellis, Die Bedeutung der Productionsperiode für die Krisentheorie, and P. Joseph and K. Bode, Bemerkungen zur Kapital- und Zinstheorie, both articles in Zeitschrift für Nationalökonomie, vol. vi, 1935. R. Nurkse, The Schematic Representation of the Structure of Production, Review of Economic Studies, vol. ii, 1935. S. Carlson, On the Notion of Equilibrium in Interest Theory, Economic Studies, No. 1, Krakow, 1935.

reproducing it presents no economic problem. According to Professor Knight "all capital is normally conceptually, perpetual,"[4] "its replacement has to be taken for granted as a technological detail,"[5] and in consequence "there is no production process of determinate length, other than zero or 'all history,'"[6] but "in the only sense of timing in terms of which economic analysis is possible, *production and consumption are simultaneous.*"[7] Into the reasons why the capital maintains itself thus automatically we are not to inquire, because under the stationary or progressive conditions, which alone are considered, this is "axiomatic."[8] On the other hand it is asserted that "making an item of wealth more durable" or "using a longer period of construction,"[9] i.e. lengthening the time dimension of investment in either of the two possible ways, is only one among an "accurately speaking, infinite number" of possible ways of investing more capital, which are later even described as "really an infinite number of infinities."[1] According to Professor Knight, "what the Böhm-Bawerk school's position amounts to is simply selecting these two details which are of the same significance as any of an infinity of other details"[2] while in fact "additional capital is involved in very different ways for lengthening the

4. [2], p. 259; a few pages later (p. 266) the treatment of capital once invested as "perpetual" is even described as the "realistic" way of looking at the matter.

5. [2], p. 264. At one point Professor Knight does indeed say that "the most important fact requiring clarification is the nature of capital maintenance" ([3], p. 84). But instead of the patient analysis of how and why capital is maintained, which after this we feel entitled to expect, we get nothing but a concept of capital as a mystical entity, an "integrated organic conception" which maintains itself automatically. Professor Knight does not actually use the word "automatic" in this connection, but his insistence on the supposed fact that the replacement of capital "has to be taken for granted as a technological detail" can hardly have any other meaning but that it needs no explanation in economic terms and is, therefore, from the point of view of the economist "automatic."

6. [3], p. 78, cf. also [8], p. 64.

7. [2], p. 275.

8. [3], p. 84.

9. [2], p. 268.

1. [2], p. 270.

2. [2], p. 268.

cycle and for increasing production without this lengthening."[3] "Time is one factor or dimension among a practically infinite number, and quantity of capital may and does vary quite independently of either of these time intervals."[4]

Against this I do indeed hold that, firstly, all the problems which are commonly discussed under the general heading of "capital" do arise out of the fact that part of the productive equipment is non-permanent and has to be deliberately replaced on economic grounds, and that there is no meaning in speaking of capital as something permanent which exists

3. [3], p. 81.

4. [6], p. 82. An attempt to clear up by correspondence at least some of the differences between us has only had the effect of making the gulf which divides our opinion appear wider than ever. In a letter written after reading an earlier draft of the present paper, Professor Knight emphasizes that he "categorically denies that there is any determinate time interval" "which elapses between the time when some product might have been obtained from the available factors and the time the product actually accrues." This can hardly mean anything more than either that no postponement whatever of consumption is possible, or at least that, once such a postponement has taken place, it is impossible to use for current consumption any of the factors which would be needed to maintain or replace the capital goods created by the first investment. I find it difficult to believe that Professor Knight should want to assert either. Quite apart from the fact that such statements would, as it seems to me, stand in flagrant contrast to all empirical evidence, the contrary has been asserted by Professor Knight himself as the first of "the three empirical facts that form the basis of a sound theory of capital." This, in his words ([2], p. 258), is "the simple 'technological' fact that it is possible to increase the volume (time rate) of production after any interval by the use during that interval of a part of existing productive resources — in large part the *same* resources previously and subsequently used for producing 'current consumption income' — to produce, *instead* of current consumption income, instruments of agencies of various sorts, tangible or intangible, which when produced become 'productive' of *additional* current income. This activity or process we call *investment*." (In giving permission to quote the above sentence from his letter Professor Knight adds: "It would induce to clearness to add that it is my view that the interval in question approaches determinateness as we impose stationary or given conditions in a sense so rigid that such an expression as 'might have been obtained' loses all meaning." I am afraid this explanation leaves me more perplexed than ever. As I have tried to show in the last section of this paper, all Professor Knight's former argument *against* the concept of a determinate investment period depends exactly on the most rigid static assumptions of this kind.)

apart from the essentially impermanent capital goods of which it consists. Secondly, that an increase of capital will *always* mean an extension of the time dimension of investment, that capital will be required to bring about an increase of output only in so far as the time dimension of investment is increased. This is relevant, not only for the understanding of the transition to more capitalistic methods, but equally if one wants to understand how the limitation of the supply of capital limits the possibilities of increasing output under stationary conditions.

This is not a dispute about words. I shall endeavor to show that, on the one hand, Professor Knight's approach prevents him from seeing at all how the choice of particular methods of production is dependent on the supply of capital, and from explaining the process by which capital is being maintained or transformed, and that, on the other hand, it leads him to undoubtedly wrong conclusions. Nor does this discussion seem necessary solely because of the objections raised by Professor Knight. In many respects his conclusions are simply a consistent development of ideas which were inherent in much of the traditional treatment of the subject,[5] and which lead to all kinds of pseudo-problems and meaningless distinctions that have played a considerable rôle in recent discussions on the business cycle.

II

Before I can enter upon attempting to refute Professor Knight's assertion, it is necessary to dispose of certain preliminary matters. There are certain ideas which Professor Knight and others seem to associate with the view I hold but which in fact are not relevant to it. I do not want to defend these views but rather to make it quite clear that I regard them as erroneous. Practically all the points to which I now call attention were either implicitly or explicitly contained in

5. For an effective criticism of related earlier views cf. particularly F. W. Taussig, Capital, Interest and Diminishing Returns, in this Journal, vol. xxii, May 1908, pp. 339–344.

that article of mine which Professor Knight attacks.[6] As he has chosen to disregard them, it is necessary to set them out in order.

(1) It should be quite clear that the technical changes involved, when changes in the time structure of production are contemplated, are *not* changes due to changes in technical knowledge. The concept of increasing productivity due to increasing roundaboutness arises only when we have to deal with increases of output which are dependent on a sufficient amount of capital being available, and which were impossible before only because of the insufficient supply of capital. This assumes in particular that the increase of output is not due to changes of technical knowledge. It *excludes* any changes in the technique of production which are made possible by new inventions.

(2) It is not true that the periods which it is contended are necessarily lengthened when investment is increased are periods involved in the production of a particular type of product. They are rather *periods for which particular factors are invested*, and it would be better for this reason if the term "period of production" had never been invented and if only the term "period of investment" were used. To give here only one example: it is not only conceivable, but it is probably a very frequent occurrence that an increase in the supply of capital may lead not to a change in the technique of production in any particular line of industry, but merely to a transfer of factors from industries where they have been invested for shorter periods to industries where they are invested for longer periods. In this case the periods for which one has to wait for any particular type of product have all remained unaltered, but the periods of investment of the factors that have been transferred from one industry to another have been lengthened.[7]

6. On the Relationship between Investment and Output, Economic Journal, June, 1934, cp. particularly p. 212, note 1, and p. 226 for point (2), p. 217 for (3), p. 210, note 1, and p. 227 for (4), p. 230, note for (5), and p. 228 for (6).

7. A similar case is that where an addition to the supply of capital makes it possible to employ factors (say labor) which before were

(3) *It is not proposed, and is in fact inadmissible, to reduce the description of the range of periods for which the different factors are invested to an expression of the type of a single time dimension such as the average period of production.* Professor Knight seems to hold that to expose the ambiguities and inconsistencies involved in the notion of an average investment period serves to expel the idea of time from capital theory altogether. But it is not so. In general it is sufficient to say that the investment period of some factors has been lengthened, while those of all others have remained unchanged; or that the investment periods of a greater quantity of factors have been lengthened than the quantity of factors whose investment periods have been shortened by an equal amount; or that the investment period of a given quantity of factors has been lengthened by more than the investment period of another equal amount has been shortened. It is true that in some cases (e.g. when the investment period of one factor is shortened, and at the same time the period for which a greater quantity of another factor is invested is lengthened by a smaller interval) the determination of the net effect of the changes of the investment periods of different factors in

unemployed. The first question to ask here is how exactly is it that an increase of capital makes their employment possible. We shall have to assume that without this capital the marginal product of this labor would have been lower than the wage at which they would have been willing to work. In what sense can it now be said that an increase of their marginal product is conditional upon more capital becoming available, i.e. why was it impossible, without this increase of capital, to employ them in the more productive processes? I cannot see that the necessity of previous accumulation can mean anything but an increase of the periods for which either the factors immediately concerned, or some other factors employed in providing the former with equipment, are invested.

In the traditional exposition of the theory of roundabout production this case, where only total capital, but not necessarily capital per head of those employed, has been increased, has been taken account of by saying that the average period of production (i.e. the average period for which the labor actually employed is invested) will only increase when capital per head increases, but will remain constant when capital is increased by an extension of its "labor dimension" instead of its "time dimension." Altho this mode of expression is sometimes useful, I think it has to be abandoned together with the concept of the average period of production.

different directions raises problems which cannot be so easily answered. But the concept of the average period, which was introduced mainly to solve this difficulty, does not really provide a solution. The obstacle here is that the reinvestment of accrued interest has to be counted equally as the investment of an amount of factors of corresponding value for the same period. In consequence the only way in which an aggregate of waiting can be described, and the amount of waiting involved in different investment structures can be compared, is by means of a process of summation, in the form of a double integral over the function describing the rates, at which the factors that contribute to the product of any moment are applied, and at which interest accrues.

It should, however, be especially noted that the assertion that it is conceptually possible to conceive of the aggregate capital of a society in terms of possible waiting periods does not mean that *the total period of production* (or the aggregate of all periods of production) of an economic system is necessarily *a phenomenon capable of measurement.* Whether this is the case (and in my opinion it is very unlikely) is altogether irrelevant for the problem at issue. What is essential is solely that whenever a change occurs in any part of the economic system which involves that more (or less) capital is used in the industry or industries concerned, this always means that some of the factors used there will now bring a return only after a longer (or shorter) time interval than was the case in their former use. As Professor Knight himself rightly says, "the rate of interest which determines the value of all existing capital goods is determined exclusively at the *margin of growth*, where men are comparing large, short segments of income flow with thinner streams reaching out to the indefinite future."[8] It is at this margin of growth (of every indi-

8. [2], p. 278. Cp. also [8], p. 45. The disagreement here concerns the question whether it is true that men directly and irrevocably exchange "short segments of income flow" against "thinner streams reaching into the *indefinite* future" or whether it is not essential to take into account that the immediate result of the sacrifice of present income is an equally limited income flow of a different time shape which must be clearly defined as regards size and shape in order to make it possible to

vidual firm and industry) where the extensions of investment occur and where the decisive question arises whether the productivity of investment is a function of time and whether the limitation of investment is a limitation of the time we are willing or able to wait for a return.[9]

(4) It is quite erroneous to regard propositions concerning the greater productivity of roundabout methods as depending upon the possibility of identifying the contribution of the "original" factors of the remote past. In order to be able to give an intelligible description of a continuous stationary process in which factors are invested at any one moment, some of whose products will mature at almost any later moment, one of two methods is possible. Either we can concentrate on all factors invested in any one interval, and relate them to the stream of product derived from it. Or we can concentrate on the product maturing during a short interval, and relate it to the factors which have contributed to it. But whichever of the two methods we select, in all cases *only the future time intervals* between the moments when the factors are, or will be invested, and the moment when the product will mature are relevant, and *never the past periods* which have elapsed since the investment of some "original factors." The theory looks forward, not back.[1]

decide in the particular case whether the sacrifice is justified. And this limited income stream which is the result of the first investment becomes a permanent income stream only by an infinite series of further decisions when the opportunity of consuming more now and less in the future has to be considered every time. By jumping directly to the desired result, the permanent income stream, Professor Knight slurs over so much that is essential for an understanding of the process that any use of his concept of capital for an analysis of the rôle of this capital in the course of further changes becomes quite impossible.

9. As Professor Knight now admits "that in so far as any single investment, negligible in size in comparison with the economic system of which it is a part, represents things consumed and reproduced in a regular cycle, the quantity of capital in that investment does bear a mathematical relation to the length of the cycle" and that in this connection some of his "previously published statements have been too sweeping," there is perhaps some hope that ultimately some sort of agreement can be reached along these lines. (Cf. [7], p. 627.)

1. In so far as Professor Knight's aim is merely to drive out the remnants of a cost-of-production theory of value which still disfigure

(5) It is equally erroneous to regard the theory as depending on any distinction between "original" or "primary" and produced means of production. It makes no fundamental difference whether we describe the range of investment periods for *all* factors existing at the beginning of the period,[2] or whether we just describe the range of periods for which those services of the permanent factors are invested that only become available for investment at successive moments as they accrue. I think it is more convenient to use the second method, and to describe the investment structure by what I have called the investment function of the services of these permanent factors. But whether this distinction — which is based on the fact that some of the productive resources have to be deliberately replaced, while others are regarded as not requiring replacement on economic grounds — is accepted or not, in no case is a distinction between "primary" or "original" and "produced" means of production necessary in order to give the concept of the investment function a definite sense.

(6) Last and closely connected with the preceding point, it is not necessarily the case that all "intermediate products" or "produced means of production" are highly specific, and

many expositions of the theory of capital (cf. [8], p. 45) I am all with him. But while I fully agree that there is no necessary connection between the present value of capital and the volume of past investment, I do maintain that there is a very close connection between the present and anticipated future values of capital on the one hand and the periods for which resources are invested at present on the other.

2. A peculiar confusion in this respect occurs in the article of Miss Joseph and Mr. Bode quoted above (p. 174) where it is asserted that if all existing productive resources were taken into account, the period of production would "of course" become *zero*. It is true that the impossibility of drawing a fundamental distinction between the "original factors" and the "intermediate products" is one of the considerations which invalidate the construction of an "*average*" period of production. But whether we describe the investment structure by an expression representing the rate at which the product of all resources existing at any one moment will mature during the future, or by an expression representing the rate at which the marginal additions will mature which are due to the services of the permanent factors applied at that moment, is merely a difference of exposition. As will be easily seen, the former is simply the integral of the latter and can be represented by the area of the figure which is bounded by the investment curve which represents the latter.

that in consequence any change in the investment structure can only be brought about by investing the "original" factors for longer or shorter periods. This seems frequently to be implied in analysis which follows Böhm-Bawerkian lines. But of course there is no reason why it should be true. The periods for which non-permanent resources are being invested are as likely to be changed as the periods of investment of the services of the permanent resources.[3]

III

Most of the critical comments in Professor Knight's articles are due to misunderstandings of one or more of these fundamental points. But while each of them seems to be the source of some confusion, probably none was in this respect quite as fertile as number two. The idea that lengthening the process of production must always have the result that a particular kind of product will now be the result of a longer process, or that a person who invests more capital in his enterprise must therefore necessarily lengthen the period of production in this business, seems to be at the root of his assertion that capital can be used otherwise than to lengthen the time dimension of investment, as well as of his statement that I have practically admitted this.

As a proof of the former contention Professor Knight cites a single concrete example, taken from agriculture. "Taking population as given," he writes,[4] "raising *more* plants of the *same* growth period will also require more 'stock,' but *will not* affect the length of the cycle, while the *addition* to total production of varieties of *shorter* growth, say yielding two har-

3. It is perhaps necessary, in order to forestall further misunderstandings, to add as point (7) the main conclusion of the article of mine which Professor Knight attacked. It is that the periods of investment are not in all cases given as technical data but can in many instances only be determined by a process of value-imputation. This is particularly true in the case of durable goods, where the technical data only tell us how long we have to wait for a particular unit of its services, but not to what share of the factors invested in it this unit has to be attributed. This attribution, however, involves an imputation purely in value terms.

4. [3], p. 81.

vests per year instead of one, will involve an increase of capital while *shortening* the average cycle." Unfortunately Professor Knight only adds that "additional capital is involved in very different ways for lengthening the cycle and for increasing production without this lengthening," but does not tell us how exactly the additional capital is used for increasing production otherwise than by lengthening the period for which some resources are invested. If he had stopped to inquire he would soon have found that even in the cases where his quite irrelevant "cycle" of the particular process remains constant, or is actually shortened, additional capital will be used in order to invest some resources for longer periods than before, and will only be needed if this is the case.

As Professor Knight has not stated why, in his example, either of the two new methods of cultivation will only be possible if new capital becomes available, it will be necessary to review the different possibilities which exist in this respect. Changes in technical knowledge must clearly be excluded and apparently Professor Knight also wants to exclude changes in the amount of labor used, altho it is not quite clear what the assumption "taking population as given" exactly means. If it is to mean that the quantity of all labor which contributes in any way to the product is assumed to be constant, and to be invested for a constant period, it is difficult to see how, with unchanged technical knowledge, they should suddenly be able to raise more plants and to use more capital. There seem to be only three possibilities, and all of them clearly imply a lengthening of the period for which some of the factors are invested.

(1) It may be assumed that the additional capital is used to buy instruments, etc., which are now made by people who were before directly employed in raising the crop;

(2) or it may be used to buy instruments to be made by people who before were employed to produce something else and have been attracted to making instruments, and thereby contributing to the output in question, by the new capital which has become available for the instruments;

(3) or that the additional capital is used to employ additional people.

Case (1) clearly contradicts the assumption that the periods for which the units of the given labor forces are invested are not lengthened, since the amount of time that will elapse between the making of the instrument and the maturing of the crop will clearly be longer than the period which elapses between the direct application of labor in raising the crop and its maturity. Cases (2) and (3) seem to be in conflict with the assumption of constant population. But in these cases, too, an increase of stock in society will only take place if the labor drawn to this particular line of production from elsewhere is now invested for a longer period than before. (I take it for granted here that additional capital means capital newly saved, and not merely transferred from elsewhere, since nobody, of course, wants to contend that a mere transfer of capital from one line of industry to another, which is accompanied by a similar transfer of the labor for whose investment the capital is required, need lead to an extension of the period for which any resources are invested.) Only if the labor which is now drawn to the process in question has before been invested for shorter periods than it will either in producing agriculture implements (case (2)), or in directly raising the crop (case (3)), will its diversion to the new use cause a temporary gap in the stream of consumable income, which will fall short of the value of the current services of the factors of production, and therefore require some saving or "new capital."

In Professor Knight's second case, that of additional production of shorter duration, he has again neglected to state why this should only become possible if additional capital becomes available. For the same reasons it seems to me to follow that this new production can be dependent on a new supply of capital coming forward only if the other factors required have before been invested for shorter periods.[5]

Evidently this example in no way proves that a case is conceivable where additional capital is used without having the effect of lengthening the investment period of some factor

5. I am afraid I am unable to see to what case the sentence in the same paragraph beginning with "in the third case" refers.

Yet this example is the only thing in Professor Knight's article which even attempts a demonstration of his main thesis.

The same failure to see the point here involved at all leads Professor Knight also to misinterpret completely a statement of my own, and to describe it "as very nearly a 'give away,' " while in fact it simply refers to this case, where the lengthening of the investment structure is brought about not by lengthening any particular process (choosing a more time-consuming technique in the production of a particular product) but by using a greater share of the total factors of production than before in the relatively more time-consuming processes. What I actually said was, that a fall in the rate of interest would lead to the production of a greater quantity of durable goods, and that — explaining this further — "more goods (or, where possible, more durable goods) *of the kind* will be produced simply because the more distant part of the expected services will play a greater rôle in the considerations of the entrepreneur and will lead him to invest more on account of these more distant returns." Even if this statement was not very fortunately phrased[6] it should have been evident to anyone who has ever made an effort to understand the different ways in which extensions in the time dimension of investment may take place that it referred to the case where the periods for which particular factors are invested is being lengthened in consequence of their transfer from a less to a more capitalistic process of production. The production of more goods of the same (relatively durable) kind *does* therefore mean a change in the investment function for society as a whole in the direction of lengthening the time dimension of production.

IV

More serious than these misunderstandings about what the "period of production" analysis implies is the failure to see

6. My meaning would have been expressed better if, instead of speaking of the production of more goods of the kind, I had said "a greater quantity of the relatively more durable goods will be produced," or "goods of still greater durability made in place of those produced before."

that without such an analysis no answer whatever can be given to the fundamental question: how the limitation of the available capital limits the choice among the known methods of production. This question is closely connected with the further problem, whether, and in what sense, the non-permanent resources existing at any one moment can be regarded as one homogeneous factor of determinate magnitude, as a "fund" of definite size which can be treated as a given datum in the sense in which the "supply of capital" or simply the "existing capital" is usually treated.

It is necessary first to say a few words about the reason why it is only in connection with the non-permanent resources that the problems which can properly be called problems of capital arise. The very concept of capital arises out of the fact that, where non-permanent resources are used in production, provision for replacement of the resources used up in production must be made, if the same income is to be enjoyed continually, and that in consequence part of the gross produce has to be devoted to their reproduction. But the fact that it may be regarded as the "normal" case that people will do so, with the aim of obtaining the same income in perpetuity, does not mean that therefore capital itself becomes in any sense perpetual. On the contrary the very problem of capital accounting arises only because, and to the extent that, the component parts of capital are not permanent, and it has no meaning, in economic analysis, to say that apart from the human decision, which we have yet to explain, the aggregate of all the non-permanent resources becomes some permanent entity. The problem is rather to say how the existence of a given stock of non-permanent resources makes possible their replacement by newly produced[7] instru-

7. I am afraid I feel compelled to disregard the special meaning which Professor Knight wants to attach to the term production. A concept of production which would compel us to say that a man engaged in the production of some instrument which is to replace some similar existing instrument, and which at some time in the future will contribute to the satisfaction of a desire, either produces not at all or produces not the final product in whose manufacture the instrument he makes is actually used, but a similar product which is consumed at the moment when he applies his labor to the instrument, seems to me an absurd abuse of

ments, and at the same time limits the extent to which this can be done.[8] And this raises the question in what sense these different capital goods can be said to have a common quality, a common characteristic, which entitles us to regard them as parts of one factor, one "fund," or which makes them to some extent substitutable for each other. What creates the identity which makes it possible to say that one capital good has been effectively replaced by another one, or that the existence of the one makes its replacement by another possible? What is that medium thru which the substance, commonly called capital in the abstract, can be said to be transformed from one concrete form into another? Is there such a thing, as is implied in the habitual use of terms by economists? or is it not conceivable that the thing which they all have in mind is that condition affecting the possibilities of production which cannot be expressed in terms of a substantive quantity?

Altho Professor Knight rather overstresses the case where a stock of capital goods is maintained by the preservation or replacement of the same items, his assertion that capital is permanent is of course not based on this assumption. The crucial case on which its meaning must be tested, and the

words. But it is on this "concept" and nothing else that the assertion that production and consumption are simultaneous is based (like J. B. Clark's theorem of the "synchronization" of production and consumption).

8. On the general subject of the amortization of capital Professor Knight is not only rather obscure but his different pronouncements are clearly inconsistent. In [2], p. 273 he writes: "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.* This additional flow of consumable services is ordinarily treated as a replacement fund, but *is available for consumption or for reinvestment* in any form and field of use at the will of the owner." But in [3], p. 83, in order to support his thesis about the perpetuity of capital, this periodic liquidation is denied: "It cannot now escape observation that 'capital' is an integrated, organic conception, and the notion that the investment in a particular instrument comes back periodically in the form of product, giving the owner freedom to choose whether he will re-invest or not, is largely a fiction and a delusion."

only case where the question arises whether capital as something different from the individual instruments is permanent at all, is the case where capital goods that are worn out are replaced by capital goods of a different kind, which in many cases will not even help to produce the same services to the consumer but will contribute to render altogether different services. What does the assertion that the capital is permanent mean here? It must evidently mean more than that there will always be some capital in existence. If it has any sense it must mean that the quantity of capital is kept constant. But what is the criterion which determines whether the new capital goods intended to replace the old ones are exactly their equivalent, and what assures us that they will always be replaced by such equivalent quantities?

To these questions Professor Knight provides no answer, but, altho admitting that he has no exact answer, postulates that the idea must be treated as if it had a definite meaning if we are to get anywhere. "The notion of maintaining any capital quantitatively intact" he writes,[9] "cannot be given exact definition; but this limitation applies to all quantitative analysis in economics, and the notion itself is clear and indispensable, and measurement, even, is fairly accurate."

Now, as I have tried to show in considerable detail in another place,[1] the notion of maintaining capital *quantitatively* intact, far from being either clear or indispensable, presupposes a behavior of the capitalist-entrepreneurs which under dynamic conditions will sometimes be impossible and rarely reasonable for them to adopt. To assume that under changing conditions capital will be maintained constant in any quantitative sense is to assume something which will never happen and any deductions derived from this assumption will therefore have no application to anything in the real world.

In some places[2] Professor Knight does, it is true, come

9. [3], p. 90. Footnote.

1. The Maintenance of Capital. Economica, August 1935.

2. [3], p. 86, note: "Wealth, which is identical with capital, can be treated quantitatively only by viewing it as capacity to render service." Also [2], p. 267: "As long as capital is maintained by replacing the

somewhat nearer a realistic assumption by stating that what people aim to maintain constant is not some physical or value dimension of capital, but its "capacity to render service."[3] But even accepting this assumption it proves in no way that people will also always be capable of maintaining this capacity to render service, and, what is more important, it does not in any way help us to explain in what way this "capacity to render service" is limited, why and how it is possible to transfer it from one concrete manifestation in a capital good into another one. It still leaves us with the impression that there is a sort of substance, some fluid of definite magnitude which flows from one capital good into another, and it gives us no indication of the set of conditions which actually at any given moment allows us to maintain output at a particular figure.

The fact that we possess at any one moment, in addition to those natural resources which are expected to render services permanently without any deliberate replacement, an amount of non-permanent resources which enable us to consume more than we could if only the former were available, will help us to maintain consumption *permanently* above this level only if by investing some of the services of the permanent resources for some time they will bring a greater return than they would have given if they were used for consumption when they first became available. If this were not the case no existing quantity of "capacity to render service" in a non-permanent form would enable us to replace it by some new instruments with the same capacity to render service. We

capital goods, *if* their life is limited, by others of any form with equal earning capacity in imputed income . . . "

3. Professor Knight, however, by no means consistently adheres to this view. The idea that the quantity of capital which is to be regarded as "perpetual" is a quantity of value occurs again and again. He says, for example, that "there is 'of course' no product yielded by an agency until after full provision has been made for maintaining it, or the investment in it, intact, *in the value sense.*" ([2], p. 280.) And similarly, a few pages later (p. 283): "New investments represent additions to all the investment previously made in past time. The amount of such investment cannot indeed be stated quantitatively in any other way than as the capitalized value of existing income sources under existing conditions."

might spread the use of the services of these non-permanent factors over as long a period as we like, but after the end of this period no more would be available for consumption than could be obtained from the current use of the permanent services.

That actually we are able to replace the "capacity to render service" represented by the non-permanent resources, and by doing so maintain income permanently higher than what could be obtained from the permanent services only, is due to the *two* facts: first, that the existence of the non-permanent resources allows us to forego for the present some of the services of the existing resources without reducing consumption below the level at which it might have been kept with the permanent resources only, *and*, second, that by investing certain factors for some time we get a greater product than we would have otherwise got from them. Both these factors, the extent to which any given stock of non-permanent resources enables us to "wait" and the extent to which investment enables us to increase the product from the factors invested, are variable. And it is for this reason that only a very detailed analysis of the time structure of production, of the relationship between the periods for which individual factors have been invested and the product derived from them, can help us to understand the forces which direct the use of the current resources for the replacement of capital.

By stressing this relationship the period-of-production analysis (and to some extent already the older wage-fund and abstinence theories) introduced an element into the theory of capital without which no understanding of the process of maintenance and transformation of capital is possible. But the idea was not sufficiently worked out to make it quite clear how exactly the existence of a given stock of capital goods affected the possibilities of renewed investment. The Böhm-Bawerkian theory in particular went astray in assuming, with the older views that Professor Knight now wants to revive,[4] that the quantity of capital (or the "pos-

4. [8], p. 57: "The basic issue is the old and familiar one of choice between two conceptions of capital. In one view, it consists of 'things'

sibility to wait") was a simple magnitude, a homogeneous fund of clearly determined size. The particular assumption made by Böhm-Bawerk and his immediate followers, which may have some justification as a first approximation for didactic purposes, but which is certainly misleading if it is maintained beyond the first stage, is that the existing stock of capital goods corresponds to a fixed quantity of consumer's goods and is therefore, on the further assumption of a given rate of consumption, uniquely associated with a definite total or average waiting period which it makes possible. The basis of this assumption was apparently the idea that every existing capital good was completely specific in the sense that it could be turned into only one particular quantity of consumers' goods by a process which could in no way be varied. On this assumption any present stock of capital could, of course, be regarded as equivalent to one, and only one, quantity of consumers' goods which would become available over a fixed period of time at a predetermined and invariable rate. This simplified picture of the existing stock of capital representing a "subsistence fund" of determined magnitude which would provide a support for a definite period and therefore enable us to undertake production processes of a corresponding average length is undoubtedly highly artificial and of little use for the analysis of more complicated processes.

Actually the situation is so much more complicated and requires a much more detailed and careful analysis of the time element because any existing stock of capital goods is not simply equivalent to a single quantity of consumers' goods due to mature at definitely fixed dates, but may be turned by different combinations with the services of the permanent factors into a great many alternative streams of consumers' goods of different size, time-shape and composi-

of limited life which are periodically worn out or used up and reproduced; in the other, it is a 'fund' which is maintained intact tho the things in which it is invested may come and go to any extent. In the second view, which of course is the one advocated here, the capital 'fund' may be thought of as either a value or a 'capacity' to produce a perpetual flow of value."

tion. In a sense, of course, capital serves as a "subsistence fund," but it is not a fund in the sense that it provides subsistence for a single uniquely defined period of time. The question which of the many alternative income streams which the existing stock of capital goods potentially represents shall be chosen will depend on which will best combine with the services of the permanent factors which are expected to become available during the future — best in this context meaning that it will combine into a total stream of the most desired time-shape. The rôle of the existing capital goods in this connection is that they fill the gap in the income stream which would otherwise have been caused by the investment of resources which might have been used to satisfy current needs. And it is only by making their investment for these periods possible that those resources will yield a product sufficient to take the place of the products rendered in the meantime by the already existing capital goods. *But there is no other "identity" between the now existing capital goods and those that will take their place than that the results of current investment*, which leads to the creation of the latter, *dovetail with one of the potential income streams*, which the former are capable of producing, into a total income stream of desired shape. And what limits the possibility of increasing output by investing resources which might serve current needs is again nothing but the possibility of providing in the meantime an income "equivalent" to that which will be obtained from the investment of current resources. ("Equivalent," strictly speaking, means here, not equal, but sufficiently large to make it worth while to wait for the increased return that will be obtained from the invested resources because of their investment.)

It should be clear that an analysis of this effect of the existence of capital goods on the direction of the investment of current resources is possible only in terms of the alternative time structures of production which are technically possible with a given equipment. What makes this analysis so particularly difficult, yet the more necessary (and at the same time lets the traditional approach in terms of an aver-

age investment period appear so hopelessly inadequate except as a first approach), is the fact that the existing capital goods do not represent a particular income stream of unique shape or size (as would be the case if it consisted of goods which were completely "specific") but a great number of alternative contributions to future income of different magnitude and date. Nothing short of a complete description of these alternative time-shapes can provide a sufficient basis for the explanation of the effect of the existence of the capital goods on current investment and, what means the same thing, of the form and quantity of the new capital goods that will replace the old ones.

In this article no positive attempt can be made to provide the technical apparatus required for a real solution of these problems. Apart from the particular aspect which I have discussed in the article which Professor Knight attacked, this task must be reserved for a more systematic study. I may mention that most of the serious difficulties which this analysis presents are due to the fact that it has to deal largely with joint-product and joint-demand relationships between goods existing at different moments of time. For the present discussion the task has been only to demonstrate why such an analysis of the time structure is necessary and why no description of capital in terms of mere quantity can take its place. The main fault of the traditional analysis in terms of the period of production was that it tried to argue in terms of a single time dimension in order to retain the connection to the conventional but misleading concept of capital as a definite fund. But it has at least the merit of stressing that element in terms of which the real relationship can be explained.

All the other attempts to state the assumptions as regards the supply of capital in terms of a definite fund and without any reference to the time structure, whether this is attempted by postulating given quantities of "waiting," or "capital disposal,"[5] or a "subsistence fund," or "true capital," or

5. It is not surprising that Professor G. Cassel, to whom we owe this particular version of the mythology of capital, should now have joined

"carrying powers," are just so many evasions of the real problem of explaining how the existence of a given stock of capital limits the possibility of current investment. Without such an analysis they are just so many empty words, harmful as the basis of that noxious mythology of capital which by creating the fiction of a non-existing entity leads to statements which refer to nothing in the real world. And the concept of capital conceived as a separate factor of determinate magnitude which is to be treated on the same footing with "land" and "labor" belongs to the same category.[6] It is no better to say, as Professor Knight did at an earlier stage, that "time as such" is a factor of production,[7] since no definite "quantity" of time is given in a way which would enable us to distribute this "fund" of time in alternative ways between the different lines of production so that the total of "time" used will always be the same. But it is certainly much worse to attempt, as Professor Knight does now, to eliminate time entirely from the analysis of the capitalist process of production. This inevitably prevents him from giving any answer to the question how the limitation of capital limits the possible size of the product and why and how capital is maintained, and compels him to treat this as a datum. And, as we shall see in the next section, it also leads him into positive errors about the function of interest.

V

How the neglect of the fundamental fact that capital consists of items which need to be reproduced, and that these

forces with Professor Knight. Cf. his book On Quantitative Thinking in Economics, Oxford, Clarendon Press, 1935, p. 20.

6. If, as seems generally to be the case, one can never be certain that one will not be carried away occasionally by the construction of a quantitatively fixed "fund" which undoubtedly attaches to the term capital, it would probably be advisable to follow Professor Schumpeter's suggestion and avoid the use of the term altogether. (Cf. article Kapital, in Handwörterbuch der Staatswissenschaften, 4th ed., 1923, vol. v, p. 582.)

7. [4], p. 198: "It has long been my contention that the best form of statement to indicate the essential fact on the technical side is simply to say that time as such is a factor of production—the only really distinct, homogeneous 'factor,' as a matter of fact."

serve as capital only in so far as and to the extent that their existence is a condition for taking advantage of more productive time-consuming methods, led to the most erroneous conclusions is well illustrated by Professor Knight's remarkable assertion that "the rate of interest could be zero only if all products known, empirically or in imagination, into the creation of which capital in any way enters, were free goods."[8] This statement seems to me to be about as plausible as if it were asserted that the price of air could fall to zero only if all commodities in the production of which the presence of air were an indispensable condition were free goods. Clearly, unless one of several factors coöperating in the production of a number of goods can be substituted for the others without limit, the fact that this one factor becomes a free good will never mean that the product itself must become a free good. In the case in question, however, not even the capital *goods* need become free goods in order that the rate of interest may fall to zero. All that is required is that the value of the services which depend on the existence of a certain capital good be no higher than the cost of reproduction of a good that will render the same service or, what amounts to the same thing, than the value in their alternative current uses of the services of the factors of production required for this reproduction. There is no reason why, in order that this may come about, these services should also become free goods.

I do not, of course, contend that a fall of the rate of interest to zero is an event in the least likely to occur at any future time in which we are at all interested. But, like all questions of what is *probable*, this is altogether irrelevant for theoretical analysis. What is of importance are the conditions under which this would be possible. Now if a condition were reached in which no further lengthening of the investment periods of individual resources (either by lengthening the process or by increasing the durability of goods in which they are invested) would lead to a further increase of output, new savings could not help to increase output. In the usual terminology the marginal productivity of capital would have

8. [2], p. 284.

fallen to zero because no more satisfaction would depend on a particular capital good ("stored up labor") than would depend on the quantity of labor and other products which are needed to replace it. So long as any of the factors required for this purpose remain scarce, the capital goods themselves and *a fortiori* the final consumers' goods made with their help will also remain scarce. And there can be no doubt that this point where further accumulation of capital would no longer increase the quantity of output obtainable from the factors used in its production, even if almost infinitely distant, would still be reached long before the point where no satisfaction whatever would be dependent on the existence of these factors.

It is not difficult to see how Professor Knight's habit of thinking not only of capital in the abstract but even of particular capital goods as permanent has led him to his peculiar conclusion. Permanent goods which can be produced — if there is such a thing, namely a good which is expected not only to last forever physically, but also to remain permanently useful — stand in this respect in a somewhat exceptional position. The value of such a good expected to render permanently useful services would at a zero rate of interest necessarily be infinite so long as its services have any value at all, and goods of this kind would therefore be produced until the value of the services of one more unit would be zero. And until the services of these goods had become free, there would be a demand for capital for producing more and the rate of interest could not fall to zero. The person making a final investment of this kind, bringing the value of the services down to zero, would of course find that he had made a mistake and lost his investment; and the demand for capital for this purpose would stop when it became known that the investment of one further unit had this effect.

But even if the value of the permanent goods should have to fall to zero in order that the rate of interest may become zero also, this does, as shown above, by no means imply that the value of the non-permanent goods should also have to fall to zero. On each good may depend no more utility than

can be had from the current use of the factors required for its reproduction, but the value of such goods will still be equal to that utility.

In concluding this section it may be pointed out that there is, of course, a very important reason why in a changing world the rate of interest will never fall to zero, a reason which Professor Knight's assumption of the permanence of capital would exclude, namely, that in a world of imperfect foresight capital will never be maintained intact in any sense, and every change will always open possibilities for the profitable investment of new capital.

VI

There remain a number of points of not inconsiderable importance which, however, if this article is not to grow to disproportionate size, can be touched upon but shortly. Perhaps the most interesting is the suggestion, which occurs here and there in Professor Knight's articles, that all his deductions about the nature of capital are based on the assumption of perfect foresight.[9] If this is to be taken quite seriously it would represent a main addition to the older Clarkian doctrine of the permanence of capital and to some extent also justify it. It would do so, however, at the expense of restricting its validity to a sphere in which problems of capital in the ordinary sense do not occur at all and certainly deprive it of all relevance to the problems of economic dynamics. But since Professor Knight's purpose is, *inter alia*, to demonstrate that my analysis of certain types of industrial fluctuations is based on a fallacy in the field of the theory of capital it can evidently not be his intention to base all his argument on this assumption. Hence it seems worth while

9. Cf. particularly [2], pp. 264 (n.2), 270, 273, and 277. In his latest articles ([7] and [8]) Professor Knight seems however inclined to concede that the period of production analysis has some limited application to static conditions most rigidly defined, and is inapplicable under dynamic conditions! Are we to understand that Professor Knight now wants to abandon all that part of his earlier criticism which was based on the most extreme static assumptions imaginable, i.e., on the assumption of perfect foresight?

to explore shortly the question what problems of capital still exist under such an assumption.

If we assume that perfect foresight has existed from the beginning of all things, a question of how to use capital as a separate factor of production would not arise at all. All processes of production would have been definitely determined at the beginning and no further question would arise of how to use any of the instruments created in the course of the process which might be used for other purposes than those for which they were originally intended. If indeed there are natural non-permanent resources in existence at the beginning, a "capital problem" might arise in connection with the original plan.[1] But once this original plan is made and so long as it is adhered to, no problem of maintenance, replacement or redistribution of capital, nor indeed any other economic problem, would occur.

Economic problems of any sort, and in particular the problem how to use a given stock of capital goods most profitably, arise only when it is a question of adjusting the available means to any new situation. In real life such unforeseen changes occur, of course, at every moment and it is in the explanation of the reaction to these changes that the existing "capital" is required as a datum. But the concept of capital as a quantitatively determined self-perpetuating fund does not help us here in any way. In fact, if the justification of this concept lies in the assumption of perfect foresight it becomes clearly inapplicable, since a "factor" which remains in any sense constant only if complete foresight is assumed cannot possibly represent a "datum" on which new decisions can be based. As has been shown, it would be erroneous to assume that this given "factor" is given as a definite

1. It might be mentioned, incidentally, that this would not be a problem of the preservation of natural resources in the usual sense, i.e., of preservation of the particular resource, but only of its replacement by some produced means of production which will render services of equivalent value. This applies equally to the practical problem of the preservation of exhaustible natural resources where it is by no means necessarily most economical to extend their life as far as possible rather than to use their amortization fund for the creation of some new capital goods.

quantity of value, or as any other determinate quantity which can be measured in terms of some common unit. But while the only exact way of stating the supply condition of this factor would be a complete enumeration and description of the individual items, it would be hasty to conclude that they have no common quality at all which entitles us to class them into one group. This common quality of being able to substitute to some extent one item for another is the possibility of providing a temporary income while we wait for the services of other factors invested for longer periods. But, as we have seen, no single item represents a definite quantity of income. How much income it will yield and when it will yield it depends on the use made of all other goods. In consequence the relevant datum which corresponds to what is commonly called the supply of capital and which determines for what period currently factors will be expediently invested is nothing but the alternatively available income streams which the existing capital goods can produce under the new conditions.

It would be difficult to believe that Professor Knight should for a moment have really thought that the concept of capital as a self-maintaining fund of determinate magnitude has any application outside a fictitious stationary state if he had not himself — at least at an earlier date — clearly recognized that the problems of capital fall largely outside the framework of static analysis.[2] In view of these utterances it would seem unlikely that he should now take pains to develop a concept which is valid only on the most rigidly "static" assumptions. The emphasis which he now places on the complete mobility of capital certainly conveys the impression that he wants to apply his concept to dynamic phenomena. It is at least difficult to see what other purpose this emphasis can serve, because certainly nobody has ever doubted that where all the future is correctly foreseen and

2. [4], p. 206: "The one important difference between price analysis in the case of interest and that of ordinary prices arises from the fact that saving and investment is a cumulative process. It is a phase of economic growth, outside the framework of the conventional 'static' system, unfortunately so called."

always has been so no problem of mobility of capital will arise. And altho he qualified his statements about the mobility of capital by the assumption of complete foresight[3] this does not prevent him from disparaging the value of any reasoning based on the limitations of the mobility of capital under dynamic conditions. This attitude is not very far from the assertions sometimes found in the literature that apart from "frictions" invested capital ought to be regarded as completely mobile between different uses (presumably without any loss in value), and that "any theory that is based on partial immobility of invested capital is essentially a frictional one."[4] This clearly assumes the existence of a separate substance of capital apart from its manifestation in concrete capital goods, a "fund" of a mystical quantity which cannot be described or defined but which, if Professor Knight has it his way, is to have a central position in our analytical apparatus. It has the somewhat questionable advantage that there is no way of deciding whether any statement about this quantity is true or false.

F. A. v. HAYEK

UNIVERSITY OF LONDON

3. [2], p. 270.
4. H. Neisser, "Monetary Expansion and the Structure of Production," Social Research, vol. I/4, November, 1934.