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## ON THE MARGINAL PRODUCT OF CAPITAL AND THE MARGINAL EFFICIENCY OF INVESTMENT

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### I

ATTEMPTS to apply the principles of marginal analysis to the theory of capital lead to many difficulties. While a good many of the difficulties are traceable to the heterogeneity of the many different things that are included in "capital," the more basic and more baffling of the difficulties would still be encountered even if capital were completely homogeneous. A more basic difficulty, which is obscured by the "index-number" problem raised by the heterogeneity of capital, comes to the surface if the heterogeneity of capital is taken out of the picture by one device or another. Perhaps the most tempting of such devices is the device of measuring the quantity of capital by its "dollar volume" or, in other words, by its *value*.<sup>1</sup>

<sup>1</sup> An interesting example of this procedure is to be found in Lloyd Metzler's "The Rate of Interest and the Marginal Product of Capital," *Journal of Political Economy*, LVIII (1950), 289-306, and "The Rate of Interest and the Marginal Product of Capital: A Correction," *ibid.*, LIV (1951), 67-68, where it logically leads to confusing conclusions such as that the benefit to society from an increase in capital is not measured by "the marginal product

### II

How unsatisfactory it is to measure the *quantity* of a factor of production by its *value* may be brought out most clearly by supposing the same procedure to be followed for any other factor of production. Let us suppose that we used this procedure in analyzing the effect of an increase in the supply of labor on its marginal product. The resulting fall in the wage (in the long-period equilibrium) would reduce the value of the previous supply of labor, and this reduction in the value of the previous supply of labor would have to be subtracted from the value of the additional labor which is the denominator of the fraction measuring the marginal product of labor. This would make the "corrected" marginal product of labor greater than it appeared before. If the decrease in the value of the

of social capital"; that the *social* marginal substitution between present and future consumption is measured not by the "marginal product of social capital" but by the "*private* marginal product of capital": and that in long-period equilibrium the marginal product of capital would be equal to the rate of interest only by accident.

previous supply of labor were equal to the value of the additional labor, the denominator would fall to zero and the "corrected" marginal product of labor would be infinite! And if the value of the total supply of labor should fall, that is, if the elasticity of demand for it were less than unity, the marginal productivity would be—should we say—greater than infinity or—should we say—negative? It clearly does not make any sense to proceed in this way.

Yet in the case of capital this procedure is most tempting. It may be defended as *natural*, since everybody measures his capital in dollars. It may be defended as *appropriate*, since the equilibrium (which is the long-term stationary equilibrium) is one in which everybody is just satisfied with the *value* of his capital stock in relation to his income so that he does not try to convert some of his income into capital or vice versa. It may be defended as *unavoidable*, since there is no other homogeneous measure for the heterogeneous collection of items that make up the capital goods that constitute the social capital. And most of all it can be defended as *essential* if the marginal product of capital is to be compared with the rate of interest. Only if capital is measured in the same units as the income yield is it possible to declare the marginal product to be so many points per cent per annum and see whether it is equal to, greater than, or less than the rate of interest. And yet the results of measuring capital by its value never turns out to be of any use for solving any problem.

### III

The essential trouble is clearly connected with the problem, or perhaps rather the conundrum, of measuring the quantity of capital in an economy and of comparing this measure for different sta-

tionary states. It has been stated that the difficulty arises from "the fact that it is impossible to find an invariant unit in which to measure the social quantity of capital" but that the "problem of measuring the quantity of capital is not an index-number problem . . . the problem . . . would exist even in the simplest economy in which all output consisted of a single type of consumers' goods."<sup>2</sup>

Nevertheless, in a profounder sense the problem *is* an index-number problem. An index-number problem arises whenever two (or more) different kinds of things have to be combined in a single measure. It is true that there is no index-number problem involved in measuring the quantity of capital if there is only one kind of capital good, but our problem would still be with us if there were only one kind of capital good and only one kind of consumption good. The measurement of the marginal product of capital still would involve measuring the capital and the consumption goods in the same units so as to obtain a pure number for the marginal product of capital that could be compared with the rate of interest. Unless this is done, the closest we could get to an expression of the marginal product of capital to compare with a rate of interest would be to say that "the marginal product of a hundred more units of capital would be five units of consumption goods per annum." But this would *not* mean a marginal product of capital of 5 per cent per annum, because the statement depends on the units that are used in measuring capital and on the units used in measuring consumption goods. We can get a measure to compare with a rate of interest only if there is a *single* unit for measuring both the capital goods and the consumption goods, and

<sup>2</sup> Metzler, "The Rate of Interest and the Marginal Product of Capital," *op. cit.*, p. 292.

this is essentially an index-number problem. The problem is *evaded* by measuring both capital and consumption in dollars, and it is evaded only with disastrous consequences for the validity of the analysis. The easy way out of taking the value of capital as the measure of its quantity is really no way out.

It is possible to eliminate the problem by sufficiently extreme abstraction. This is done most effectively by Professor Knight in his account of "Crusonia," which is conceived as "living on the natural growth of some perennial which grows indefinitely at a constant (geometric) rate, except as new tissue is cut away for consumption."<sup>3</sup> Here both the capital and the consumption are of the same kind of thing, so that there is a marginal product of capital of so many percentage points per annum which is comparable to a rate of interest and, in equilibrium, equal to the rate of interest. There can be no appreciation or depreciation of capital in terms of consumption, since they are both the same thing. There are no factors of production other than the stock of the perennial. The valuation of this as capital is nothing but the capitalization of the expected future income, discounted at the rate of interest. This comes to the same as the current flow of new growth on the perennial divided by the rate of interest. Thus if the rate of growth is 5 per cent per annum, so that 100 tons of the perennial becomes 105 tons in a year if none of it is cut away, and the accretion of new growth is at the rate of a million tons a year (so that this would be the total accretion if there were none cut away for a whole year), then the capital is twenty times the annual growth or income, or twenty million tons, and its

<sup>3</sup> Frank H. Knight, "Diminishing Returns from Investment," *Journal of Political Economy*, LIV (1944), 26-47; see *ibid.*, p. 30.

value is twenty times the value of the annual income.

If, then, there is an increase in capital, capital and income increase in exact proportion, while the rate of interest stays the same—remaining equal to the constant rate of growth. There being no change in the rate of interest, which in the system cannot change, there is no problem of any possible change in the valuation of the capital in terms of consumption goods.

#### IV

In the more common but less heroic abstractions that follow the Austrian fashion this method of avoiding the problem is not available. Labor is applied to a productive process illustrated by the maturing of timber, the quantity of capital corresponding to the period of time that elapses from the application of labor in planting the trees to the time when they are ready for the ax. With diminishing returns from lengthening the period, an increase in capital per worker, which goes with a longer period of production, must also be accompanied by a lower rate of interest in the new equilibrium equal to the lower *marginal* rate of growth. The existing capital (which consists of the standing trees) increases in value in terms of the product, timber, because its value is nothing but the discounted value of the timber it is going to yield, and the rate at which it is discounted is lower.<sup>4</sup> At the same time the capital *falls* in value relatively to the value of labor (or the

<sup>4</sup> It is true that the discounting will be over a longer period now, but this is more than offset by the greater yield of timber to be discounted, since the rate of growth diminishes continuously over the time by which the period of production is lengthened. The average rate of growth over this period must therefore be greater than the rate of discount because the latter is equal to that lowest rate of growth which is found at the end of the longer period.

wage) which must be higher in the new equilibrium to remain equal to the discounted value of its marginal product, the marginal product of labor being greater and the rate of discount less.<sup>5</sup>

The previously existing capital therefore increases in value in terms of the *output*, timber, and falls in value in terms of the *input*, labor. Should we consider this a capital gain or a capital loss? If we use consumption goods (here represented by the output of timber) as the measure of value, we must say that there is a capital *gain*. But, if we use *labor* as the measure of value, we must say that there is a capital *loss*. Where the final product is not timber but some further product made by timber in co-operation with direct labor, it is possible for the price of timber to fall so much in terms of the final product that the capital (which must increase in value in terms of timber) will fall in terms of the final product, so that there is a capital loss not only in terms of the input (labor) but also in terms of the final output (though not in terms of timber).

The classical economists, like the Austrians, used models in which labor is used to produce final products which are different from both the labor and the capital instruments, so that they, too, were unable to avoid the problem in the very neat manner available to Knight. But they had another way out. They would not reach the new long-period equilibrium as long as the wage remained above the subsistence level. The supply

<sup>5</sup> Again the discounting will be over a longer period, but, as was pointed out in the previous note, the additional growth over the extra period is at an average rate somewhere between the old rate of interest and the new lower rate of interest, so that it is greater than the new lower rate of interest, and the lengthening of the period *adds* to the increase in the discounted value of labor's marginal product that would result from a simple reduction of the rate of discounting.

of labor would increase until the marginal product of labor was no higher than in the original equilibrium. The additional capital would then all be used up in employing the addition to the laboring population in the same manner as before. There would be the same wage, the same rate of interest, the same period of production, and no appreciation or depreciation of the existing capital either in terms of consumption goods or in terms of labor or in terms of any intermediate product. Except for the scale of operations, and other possible complications caused by increasing scarcity of land which are not directly relevant to our immediate problem, everything is exactly the same.

The classical solution, however, does not succeed, as Knight's does, in showing equality between the marginal product of capital and the rate of interest, except in those formulations which seem to assume that the capital does in fact consist of consumption goods in some mystical "wages fund."

## V

It is of interest to see how Knight's model and the classical model fit in with the notion of a period of production corresponding to the quantity of capital or the degree of capital intensity.

These concepts have no place in Knight's scheme. An increase in the quantity of the perennial plant, brought about by failing to consume the whole of the growth, does not change the manner of production in any way whatever. Nothing is changed but the scale. The growth of the perennial plant being at a constant (geometric) rate, proportional to the quantity of it in existence, and the only input (in the stationary state) consisting of a decision not to consume more than the current accretion, the period of

production is completely arbitrary. The current growth may just as well be considered as due to the stock not being consumed five years ago as to its not being consumed a hundred years ago or to its not being consumed one second ago, so that the period of production concept is quite meaningless.

Another way of looking at this is to imagine the exponential curve that would correspond to the constant geometric rate of growth. At the rate of interest which is equal to this rate of growth (both being, say, 5 per cent per annum), it makes no difference which length of period one is supposed to use. It is as though we had a forest in which it made no difference what was the age of the trees cut down. Whether we cut down seedlings or mature trees or trees thousands of years old, as long as we did not remove more than a certain number of tons of timber each year, the forest would continue to give the same yield forever. In terms of Figure 1 it is as if the productivity curve  $\varphi(t)$  (which shows the amount of timber that can be produced per year by each worker as a function of the length of time the trees are permitted to grow) were an exponential curve like the interest curve  $v_0 t_0$  and coincided with it. Instead of there being an optimum period of production (or optimum age of trees for cutting) equal to  $Ot_0$ , where the discounted value of the timber is at a maximum, any period of production (that is, any age of tree for cutting) would be just as good as any other.

But as soon as we leave Knight's perennial and consider forests where it *does* make a difference at what age the trees are cut, the period of production does become relevant. And the same kind of thing, that is, the existence of many methods of production with different time dimensions and having different ef-

ficiencies, is true of all production outside of "Crusonia."

The essential difference between "Crusonia" and the Austrian model is that in "Crusonia" the miraculous perennial constitutes the *whole* of the productive resources. If *all* the factors of production were increased, there would be no reason for diminishing productivity or for any optimum quantity of capital (like that corresponding to  $Ot_0$  in Fig. 1).

In the Austrian model there is a sharp dichotomy between services whose

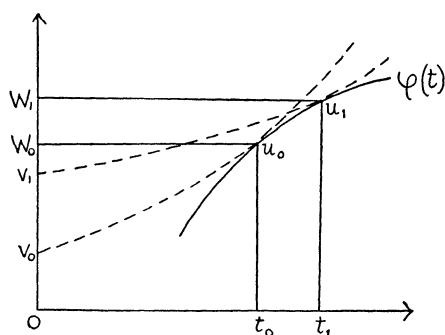


FIG. 1

sources of supply are fixed (the services of land) and services whose sources of supply may be increased or decreased (the services of capital). Land, being fixed in supply by definition, yields a fixed flow of services. The supply of laborers being determined by forces outside the province of pure economics (the classical assumption of perfectly elastic supply of labor at subsistence level having been abandoned), the supply of the services of labor is also a given flow. The relevant economic magnitudes are then the *flows* of these services of land and labor, on the one hand, and the *stocks* of accumulated instruments of production and other forms of capital, on the other hand. The flows of services are called "original factors" and are conceived of

as initiating production at the left of diagrams like Figure 1, while all the existing stocks of instruments, goods in process, inventories, and everything else, are nothing but the material incorporation of services provided in the past by the flow of original factors and destined to yield consumption services in the future just as the trees in the forest model consist, for economists, of the accumulated or congealed labor which has not yet yielded the final service represented by the consumption of timber.

In this model the capital is quite different from the land and the working population that between them yield the flow of original factors. Capital exists only because it is worth while to use productive processes which take time. The quantity of capital in existence corresponds strictly to the average period of production, a longer period of production meaning that there are more instruments, equipment, and inventories, all of them being essentially goods in process which are needed only because of the time delay that the technical process imposes between the application of the services of the "original factors" and the final consumption of the product.

If it were possible to increase in proportion and with equal ease all the sources of productive services—land and men as well as machines and stocks and equipment of all kinds—there would be no point in the distinction between capital and the sources of the "original factors of production." There would be no significance in the idea of a period of production and no place for any theory or, indeed, any consideration of capital. "Crusonia" would be a very satisfactory model. But in the real world, in contrast with "Crusonia," this is not possible.

On the other hand, the sharp distinction in the Austrian model between

*stocks* of capital goods and *flows* of original factors of production, with the stocks all freely producible and all needing continual replacement and the flows provided by a sphinx-like Nature which must be asked no questions, is also far from reality. Many things can be produced, which are then for all practical purposes permanent yielders of a service just like the purest form of pure land. There are services and stocks provided by "Nature" whose exhaustion is of the utmost importance. Most kinds of land are economically indistinguishable from produced capital of the purest "forest" type. "Crusonia" and the Austrian model are *both* extreme abstractions, in opposite directions, from the actual world in which we live.

## VI

What about the relationship between the rate of interest and the marginal product of capital in the different models we have considered? In "Crusonia" the question cannot even be asked, since there is no distinction between capital and other factors of production. All we have is the rate of growth, and this must be equal to the rate of interest. Nobody would give a higher rate of interest for a loan of the "economic substance" (which is both consumption good and source of future consumption goods) than he would suffer in reduced future yield from the perennial if he cut his present need from it; and nobody would accept a lower rate of interest than he could get by leaving the potential loan to increase on the vine.

But this is not really the marginal product of capital as we have been supposing it to be so far. It is the *marginal efficiency of investment*. What is involved is the sacrifice of present consumption for the sake of yield of income in the future (which in turn may be consumed or left on the vine

as further investment, indefinitely). If the perennial source of all good things were to be called "capital," and if there should be a miraculous increase in the quantity of the perennial, and if the rate of growth were unaffected, it would be appropriate to say that the marginal product of the additional capital was 5 per cent (or whatever was the rate of growth). But such supplemental miracles are not the normal order of events even in "Crusonia." The only and the continuing economic problem is to decide how much of the perennial to consume and how much to leave to grow for the future. This decision is one of *investment* or *disinvestment* and *never* one about capital.

In the Austrian scheme there is something that looks much more like an issue concerning capital. Given a production curve like  $\varphi(t)$  in Figure 1, there is at any rate of interest, say that represented by the exponential curve  $v_0u_0$ , a period of production like  $Ot_0$ , which is most appropriate and which maximizes the discounted marginal product of labor. If one is at such a point and the rate of interest is changed, say it is reduced to that represented by the exponential curve  $v_1u_1$ , the appropriate period of production is no longer  $Ot_0$  but  $Ot_1$ . But it is only in a long-period equilibrium that this point will be reached.

If the quantity of capital were miraculously increased to correspond to this longer period of production, the new equilibrium would be reached immediately. In the absence of such a miracle there can be no question of increasing the quantity of capital by the difference between the quantity in the first equilibrium and the quantity in the second equilibrium. There is simply no way of doing this.

If  $Ot_0$  is thirty-five years and  $Ot_1$  is

forty years, the minimum period in which the new equilibrium could be reached would be five years. But that would require miracle enough, for it would mean having the planting continue as usual with no cutting taking place at all for five years. During these five years the number of trees would be increased. Their age distribution would be raised from a range between zero and thirty-five years to a range between zero and forty years, the average age therefore increasing from half of thirty-five to half of forty. Since the crop of timber represents the total supply of consumption goods available for the society, this is impossible unless someone else is ready to maintain the economy for these five years of input without any output.

All that the economy can do is to *invest* a part of its income each year in increasing the stock of capital, the rate at which it *invests* not being indicated at all by the kind of analysis provided by the Austrian models.

Furthermore, there is no way of comparing the marginal product of capital with any rate of interest. We may know that having so many more trees of various ages in the forests permits the output of timber to be greater by so many board feet, but the additional stock of trees of different ages and the additional flow of board feet of timber are not of the same unit. So the relationship between them cannot be expressed in terms of a rate of return per annum that can be compared with a rate of interest. We can have a measure of the *marginal efficiency of investment*, since we can know by how much the sacrifice of so many board feet this year, by permitting the trees to be increased in number and age, will yield an additional future flow of board feet. This can be expressed as so many board feet per annum per hundred board feet cur-



rently sacrificed and so can be compared with a rate of interest. But there is no way of comparing a rate of interest with the marginal product of board feet yielded by additional trees.

## VII

In the real world, of which both "Crusonia" and the Austrian model are simplified abstractions in different directions, there can only be additional difficulties in the way of finding a marginal product of capital to be compared with any rate of interest. We may therefore say that in general there can never be any clear meaning in the comparison of the marginal product of capital with the rate of interest. What then becomes of our initial problem? Is the marginal product of capital equal or not equal to the rate of interest in long-run stationary equilibrium? This question cannot be answered and should not be asked. It is essentially meaningless, because no problems about capital can ever arise. All the problems that look like capital problems turn out to be investment problems.

The real problem is indeed the one that remains in Knight's "Crusonia" abstraction—namely, that of investment (and disinvestment)—and it is a solid advantage of that model that it abstracts away entirely from the pseudo-problems of capital. The Austrian model looks as though it shows a marginal product of capital, but a close inspection, say, of Figure 1, shows that the rate of interest does not apply at all to any relationship between trees and board feet but is applicable only at the margin at  $t_0$  or at  $t_1$ , where there is only a question of the sacrifice of board feet in the present for board feet in the future, that is, only a question of *investment*.

Even if we take the case of a shift from  $t_0$  to  $t_1$  by means of external help from

someone else, a Marshall Plan which increases the amount of capital, we are not helped. If we are *given* the additional trees of varying age, we have no measure of the marginal productivity of the additional capital that we can compare with any rate of interest. We have so many more trees of certain ages, and, as a result, we have a greater annual crop of timber, but we have nothing to compare with a rate of interest.

Even if we suppose that the Marshall Plan takes the form of someone from outside supplying us with the timber we need (that is, with our consumption goods), so that we are able for the five-year period to continue planting trees without cutting any timber, this will still not enable us to measure the marginal product of capital as a percentage per annum. The Marshall Plan benefits will have enabled us to *invest* the potential income or output day after day by refraining from cutting it down. But the denominator in the fraction is always timber or consumption and never trees or capital goods. So what we have is always a marginal efficiency of investment and never a marginal product of capital.

## VIII

In the *Economics of Control*<sup>6</sup> and in an earlier article on this subject<sup>7</sup> I suggested giving an exact meaning to the phrase "marginal product of capital," namely, the marginal efficiency of investment in long-period equilibrium when net investment is equal to zero. This seems to fit in with the Austrian usage and with diagrams like Figure 1, but I am not so sure now whether it was a good thing for the understanding and development of eco-

<sup>6</sup> (New York: Macmillan Co., 1944), chap. xxv.

<sup>7</sup> "Capital Investment and Interest," *Proceedings of the Manchester Statistical Society, 1936-37*, pp. 26-31.

conomic theory. It might be better to write off completely our investment in this phrase and to speak only of the marginal efficiency of investment.

### IX

In "Crusonia" there is never any change in the marginal efficiency of investment because the single economic substance, the magical perennial, has a constant geometric rate of growth. If all productive resources could be increased with equal ease, so that there would be no reason for changing their proportions, there would be no reason for expecting any departure from the constant marginal efficiency of investment that we find in Crusonia. Since there is reason to suppose that in the real world there *are* differences in the ease of producing the sources of different productive services, Knight, in the article referred to above, recognizes the reasonableness of expecting a diminishing marginal efficiency of investment or "diminishing returns from investment" if we assume a given state of knowledge and that investment is investment in "things." Knight, however, goes on to consider that, since all investment is for the future, a large part of it must be of an exploratory nature so that it might be considered an investment not in "things" but in knowledge. The knowledge so discovered will increase productivity, and this, he argues, may offset or more than offset the declining marginal efficiency of investment in "things" that would emerge if there were no new knowledge. There is therefore no presumption of a declining marginal efficiency of investment.

To clarify this, it is useful to consider more closely the meaning of the schedule of the marginal efficiency of investment. We may imagine it as a curve on a chart where the vertical axis measures the rate

of interest and the horizontal axis measures the rate of investment that would be undertaken at each rate of interest. In any given situation, with a certain existing constellation of the different capital goods in the economy and with a given knowledge of technical possibilities of production, the curve will slope downward from left to right because of the heterogeneity of factors of production which results in increasing costs of additional provision for the future in terms of sacrifice of the output of goods for current consumption. This phenomenon would be with us even if it were possible to produce every kind of source of productive factors, including land and people, with equal ease, or rather with equally increasing cost in terms of consumption goods sacrificed.

The negative slope would apply not only to the curve of marginal efficiency of investment in "things" but also to the curve of marginal efficiency of investment in "research," taking this in the widest sense of all expenditure that increases our knowledge of productive possibilities even if they are of the roughest kind that emerge from undertaking any risky investment and discovering whether it works or not. This does not mean that we can have any kind of reliable knowledge of the results that will come out of "research." It merely means that some "research" *seems* more promising than other "research" and that, because of the omnipresent heterogeneity, the allocation of resources for research runs up against increasing costs as resources have to be used whose apparent efficiency for research diminishes relatively to their apparent efficiency for the production of current output of consumption goods.

The effect of the increase in the quantities of the different kinds of capital goods (which accumulate as investment

continues) is to *lower the curve* of the marginal efficiency of investment. This is because the kinds of capital goods that can be produced more easily (relatively to those that can be produced only with greater difficulty or only in smaller quantities or which cannot be produced at all) come to be available in greater quantity, and so their usefulness diminishes. Further investment must therefore be applied either to making more of the things that are less useful or to making more of the things that are harder to make. For each *rate* of investment (measured on the horizontal axis) there is therefore a smaller rate of return, so that that rate of investment will be undertaken only if there is a lower rate of interest. This lowering of the curve of the marginal efficiency of investment is what is often meant by "diminishing marginal product of capital." The way in which the whole curve falls as a result of an increase in different proportions of most kinds of capital goods is not, however, anything that can be given a simple measure or number that can be compared with a rate of interest.

The acquisition of new knowledge by "research" (which includes, we must remember, all that is learned in the course of undertaking risky investments of all kinds) can never *diminish* our possibilities of getting future income out of any rate of present application of productive services for this purpose. But new knowledge can also increase our possibilities of producing current income (which always means income in the relatively near future) out of the same productive services. A given sacrifice of current income may therefore release *less productive services*, and their efficiency in producing more income in the (more distant) future may not have increased as much as their efficiency in producing current income. In

such a case new knowledge *will* have reduced the schedule of the marginal efficiency of investment by reducing the amount of future income made possible by a given sacrifice of current income.

Even if this never happened and new knowledge always increased the possibility of producing future income relatively to the possibility of producing current income, it would not follow that it would always raise the marginal efficiency of investment.

In the first place, the new knowledge may show that what looked like worthwhile investments are really not worth while. Such discoveries have the effect of *lowering* the curve of the marginal efficiency of investment. They may increase the *actual* return on investments, but they reduce the *supposed* or *expected* returns on which the schedule of the marginal efficiency of investment is inevitably based.

Second, we must consider *gross* investment rather than *net* investment. That is to say, we must include all replacement as part of investment. Even if all "research" were "positive," that is, uncovered new possibilities of producing for the future, and none of it merely deflated false expectations, this would merely mean that the *area* under the curve of the marginal efficiency of investment is increased.

If the new knowledge consists of finding better and easier ways of doing the old things, so that, instead of the old kinds of capital goods being replaced as they wear out, much better ones can be produced instead, the curve of the marginal efficiency of investment will be raised near the origin. There will be a very high rate of return on the replacement of old equipment by better new equipment. But there is likely to be a sharp limit to the rate at which this par-

ticular kind of investment can be carried on, especially if it is not felt desirable to increase very much the capacity of the industries affected. The very saving in resources which makes the new equipment better than the old may consist of reducing the amount of investment necessary. The curve would then drop very rapidly, so that the current rate of investment could be reached only by resorting to investments with a *lower* marginal efficiency of investment (*meI*) which would be undertaken only at a *lower* rate of interest. Such a possibility is shown in Figure 2, and it does not seem to be very far fetched. Indeed, it seems to me that this is implicit in Knight's remark that "it does not seem unreasonable to believe that . . . the only form of investment which has finally yielded any real return, to society or to the average individual, is the growth of knowledge, that the multiplication of things has not, on the whole, been profitable."<sup>8</sup>

### X

The marginal efficiency of investment is then a declining function of the rate of investment, which is indicated by its being drawn sloping down from left to right in Figure 2. Furthermore, the curve as a whole will tend to be lowered over time as the result of the accumulation of capital goods by continuing net investment. New knowledge may either raise or lower the curve, so that, although this *may* raise the curve enough to offset the effects of the accumulation of capital goods, there remains a general presumption that the schedule of the marginal efficiency of investment will fall over time. This implies a falling rate of interest if a given rate of investment and employment (such as full employment) is to be

<sup>8</sup> *Op. cit.*, p. 41.

maintained in the short-period equilibria which we must assume to be approximated over time. This, in turn, raises the question of how the decline in the rate of interest affects the values of capital assets and whether it might not thereby bring about a divergence of social benefit from private benefit in the investment

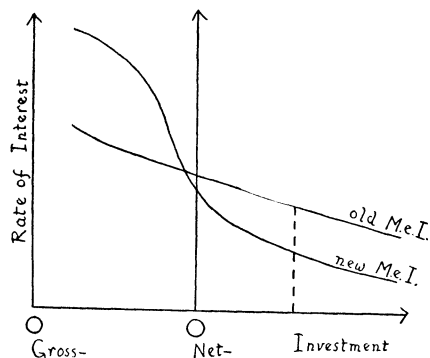


FIG. 2

activity that gives rise to the whole process; so that, in the absence of a counteracting public policy, there might not be more investment or less investment being undertaken than is socially desirable.

### XI

At lower rates of interest the sources of productive factors will tend to be more valuable relatively to the final or consumption goods, since the value of the former is given by the discounted value of the final consumption goods that the services they provide are expected to produce; and the rate of discount is less. The value of the total supply of *all* the sources of productive services *must* be greater, because it is simply the discounted value of the total output of consumption in the future. It is obtained by simply dividing the current income of the economy by the rate of interest, and we now have a larger current income to be

divided by a smaller rate of interest. There is an inevitable capital gain.

In the real world, however, the most important source of productive services is not supposed to be subject to pecuniary calculation of capital gain or loss, because it consists of human workers, the calculation of whose value in terms of expected earning power is considered impious. It is therefore possible that the remaining sources of productive services, the existing nonhuman productive equipment, the capital and the land, could suffer a capital loss rather than a capital gain if they were increased sharply relatively to the human resources, and had a very low substitutability for them, so that the fall in the value of their services would more than overcome the benefit from the reduction in the rate of interest at which their services were discounted. This is easy to suppose for some special kinds of capital equipment which are displaced by other kinds of equipment as a result of the investment. Although it is not impossible, it seems most unlikely that this could happen to the total of all capital goods and land. But even if this should happen, it would not be relevant for our purpose.

We are here concerned with the possible benefits or damages that investors may bring to other members of society through their investment. In the cases where calculations of capital value are socially respectable, that is, in the cases of land and of capital equipment, expected earnings are capitalized, and capital gains or losses are seen to emerge. In the case of human beings expected earnings are not capitalized, and we do not speak of capital gains or losses in the value of the human beings concerned or of the families that are going to produce income-earning human beings in the future. But the benefits or damages are just

as real whether the capitalizations are calculated or not. We must really consider the effect on *all* the sources of all the productive services in the economy, and so we must say that there is a net social benefit from the investment that would show itself as a capital *gain* if we did capitalize all the future earnings at the lower rate of interest. This seems to show that there is a divergence between private and social benefit from private investment, the social benefit being greater than the private benefit.

## XII

It may be worthwhile to consider in another way the effects of the reduction in the rate of interest. As far as actual loans are concerned, there is no net gain. The lenders lose on account of receiving a lower rate of interest just as much as the borrowers gain from having to pay less interest. The benefit to all owners of property whose value has increased because the future earnings are discounted at a smaller interest rate lies in their knowledge that they can borrow more and more easily if they want to and in the satisfaction and the additional feelings of security that this knowledge gives them. In the case of land and of marketable capital equipment this benefit shows itself in an increased valuation of the capital—in a capital gain. In general, however, the capital gain cannot be consumed, since there is no corresponding increase in consumption goods available. One man can consume his capital gain only to the extent that he can persuade another to sacrifice consumption in exchange for some of his capital. But everybody can enjoy the additional feeling of security, good luck, or even an illusion of good judgment in putting himself in a position where he was able to win the capital gain. This kind of benefit is also

available to the worker who is now able to borrow more money and more easily on the basis of his expected future earnings; and, as long as workers in general do not try to exercise that possibility they can enjoy the benefit in the same way that the capitalist can enjoy his capital gain, although the imperfection of the credit market seriously curtails his additional powers of borrowing, just as they curtailed his original powers of borrowing.

My conclusion is that investment, in so far as it lowers the rate of interest, gives rise to a social benefit that is not taken into account by the investor, and to that extent the social benefit is greater than the private benefit. It would therefore be socially desirable to provide some additional inducement to get the investor to invest more than he does.

### XIII

But why should the act of investment be credited with the *reduction* in the rate of interest that increases the value of capital resources? Does not rather an increased eagerness to invest result in a *higher* rate of interest that is necessary to prevent the increase of investment from bringing about inflation?

What we have here is the difference between the increase in schedule of the marginal investment or the *desire* to invest and an increase in actual investment. An increased desire to invest results in a higher rate of interest being necessary if there is a satisfactory level of effective demand to begin with, and the inflationary pressure that would be caused by the increased investment is checked by the method of raising the rate of interest. In this case there will be practically no increase in investment, since the way the higher rate of interest pre-

vents the inflationary effect is by preventing the additional investment from taking place.

But in so far as some additional investment does take place, this lowers the curve of the marginal efficiency of investment in succeeding periods and makes it necessary for a lower rate of interest to rule if the same level of effective demand is to be maintained. What we can say, therefore, is that an increase in the schedule of the marginal efficiency of investment has the effect of raising the rate of interest and therefore of lowering the values of capital assets. Any activity therefore which has the effect of raising the schedule of the marginal efficiency of investment, such as research leading to capital-using inventions or discoveries, has a side effect that is socially harmful in its causing the value of capital assets to be reduced by the increase in the rate of interest necessary for the prevention of excessive effective demand. To the extent that this effect is not taken into consideration by those engaged in such activities, it is in the social interest to discourage activities that tend to raise the schedule of the marginal efficiency of investment.

But, with any given set of opportunities for investment, additional investment can take place only if there is a decrease in consumption that sets free the resources needed for the investment. It is therefore an increase in thriftiness that must take place if there is to be an increase in investment. Such an increase in thriftiness will *lower* the rate of interest in the short period in which the increase in thriftiness actually operates, for without such a reduction in the rate of interest there would be nothing to induce the additional investment to take the place of the reduced consumption in maintaining the level of income. The extra invest-

ment uses up some of the opportunities for investment in following periods, so that a lower rate of interest is needed to maintain the level of investment. If the propensity to consume remains low in the following periods, there is an additional reason for a lower rate of interest; and, if there has been a continuing increase in the level of productivity and the level of income that corresponds to full employment (or the other level of effective demand that is being maintained), still more investment is needed to correspond to the greater volume of saving that would be called forth, and there is still another reason for having a lower rate of interest. All these indications then point in the same direction: to a lower rate of interest being made necessary by an increase in thrift. It is therefore to the increase of *thrift* that our corrective measures should be directed rather than to the activity of investment. An increase in thrift makes it necessary for the rate of interest to be lowered. This increases the value of capital assets, and that is a benefit to the owners of the capital assets—a benefit that the exercisers of the thrift have not taken into account. It is there-

fore desirable, in the social interest, that *thrift* should be encouraged beyond the point to which the private interests of the savers would lead them.

It is perhaps desirable to end this article by stressing once more that this conclusion has validity only in an economy where full employment (or some other given level of employment) is being maintained. (It does not matter whether it is maintained by conscious government activity or in any other manner.) Only if the level of economic activity is somehow being maintained does greater thrift necessarily result in more investment, so that the effects of the additional investment, the reduction in the rate of interest and the appreciation of capital assets, can be properly attributed to the increase in thrift. If the level of economic activity is not being maintained and we have unemployment or the danger of unemployment, we are in the “upside-down” economy where thrift is socially harmful; and if we are in an inflation there are other reasons, much more important than those we have been considering, for reducing effective demand—by increasing thrift or in any other way.