

## Chapter 11

# THE MARGINAL EFFICIENCY OF CAPITAL

### I

When a man buys an investment or capital-asset, he purchases the right to the series of prospective returns, which he expects to obtain from selling its output, after deducting the running expenses of obtaining that output, during the life of the asset. This series of annuities  $Q_1, Q_2, \dots Q_n$  it is convenient to call the *prospective yield* of the investment.

Over against the prospective yield of the investment we have the *supply price* of the capital-asset, meaning by this, not the market-price at which an asset of the type in question can actually be purchased in the market, but the price which would just induce a manufacturer newly to produce an additional unit of such assets, i.e. what is sometimes called its *replacement cost*. The relation between the prospective yield of a capital-asset and its supply price or replacement cost, i.e. the relation between the prospective yield of one more unit of that type of capital and the cost of producing that unit, furnishes us with the *marginal efficiency of capital* of that type. More precisely, I define the marginal efficiency of capital as being equal to that rate of discount which would make the present value of the series of annuities given by the returns expected from the capital-asset during its life just equal to its supply price. This gives us the marginal efficiencies of particular types of capital-assets. The greatest of

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these marginal efficiencies can then be regarded as the marginal efficiency of capital in general.

The reader should note that the marginal efficiency of capital is here defined in terms of the *expectation* of yield and of the *current* supply price of the capital-asset. It depends on the rate of return expected to be obtainable on money if it were invested in a *newly* produced asset; not on the historical result of what an investment has yielded on its original cost if we look back on its record after its life is over.

If there is an increased investment in any given type of capital during any period of time, the marginal efficiency of that type of capital will diminish as the investment in it is increased, partly because the prospective yield will fall as the supply of that type of capital is increased, and partly because, as a rule, pressure on the facilities for producing that type of capital will cause its supply price to increase; the second of these factors being usually the more important in producing equilibrium in the short run, but the longer the period in view the more does the first factor take its place. Thus for each type of capital we can build up a schedule, showing by how much investment in it will have to increase within the period, in order that its marginal efficiency should fall to any given figure. We can then aggregate these schedules for all the different types of capital, so as to provide a schedule relating the rate of aggregate investment to the corresponding marginal efficiency of capital in general which that rate of investment will establish. We shall call this the investment demand-schedule; or, alternatively, the schedule of the marginal efficiency of capital.

Now it is obvious that the actual rate of current investment will be pushed to the point where there is no longer any class of capital-asset of which the marginal efficiency exceeds the current rate of interest. In other words, the rate of investment will be pushed to the

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point on the investment demand-schedule where the marginal efficiency of capital in general is equal to the market rate of interest.<sup>1</sup>

The same thing can also be expressed as follows. If  $Q_r$  is the prospective yield from an asset at time  $r$ , and  $d_r$  is the present value of £1 deferred  $r$  years *at the current rate of interest*,  $\Sigma Q_r d_r$  is the demand price of the investment; and investment will be carried to the point where  $\Sigma Q_r d_r$  becomes equal to the supply price of the investment as defined above. If, on the other hand,  $\Sigma Q_r d_r$  falls short of the supply price, there will be no current investment in the asset in question.

It follows that the inducement to invest depends partly on the investment demand-schedule and partly on the rate of interest. Only at the conclusion of Book IV will it be possible to take a comprehensive view of the factors determining the rate of investment in their actual complexity. I would, however, ask the reader to note at once that neither the knowledge of an asset's prospective yield nor the knowledge of the marginal efficiency of the asset enables us to deduce either the rate of interest or the present value of the asset. We must ascertain the rate of interest from some other source, and only then can we value the asset by 'capitalising' its prospective yield

## II

How is the above definition of the marginal efficiency of capital related to common usage? The *Marginal Productivity* or *Yield* or *Efficiency* or *Utility* of Capital are familiar terms which we have all frequently used. But it is not easy by searching the literature of economics to

<sup>1</sup> For the sake of simplicity of statement I have slurred the point that we are dealing with complexes of rates of interest and discount corresponding to the different lengths of time which will elapse before the various prospective returns from the asset are realised. But it is not difficult to re-state the argument so as to cover this point.

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find a clear statement of what economists have usually intended by these terms.

There are at least three ambiguities to clear up. There is, to begin with, the ambiguity whether we are concerned with the increment of physical product per unit of time due to the employment of one more physical unit of capital, or with the increment of value due to the employment of one more value unit of capital. The former involves difficulties as to the definition of the physical unit of capital, which I believe to be both insoluble and unnecessary. It is, of course, possible to say that ten labourers will raise more wheat from a given area when they are in a position to make use of certain additional machines; but I know no means of reducing this to an intelligible arithmetical ratio which does not bring in values. Nevertheless many discussions of this subject seem to be mainly concerned with the physical productivity of capital in some sense, though the writers fail to make themselves clear.

Secondly, there is the question whether the marginal efficiency of capital is some absolute quantity or a ratio. The contexts in which it is used and the practice of treating it as being of the same dimension as the rate of interest seem to require that it should be a ratio. Yet it is not usually made clear what the two terms of the ratio are supposed to be.

Finally, there is the distinction, the neglect of which has been the main cause of confusion and misunderstanding, between the increment of value obtainable by using an additional quantity of capital in the *existing* situation, and the series of increments which it is expected to obtain *over the whole life* of the additional capital asset;—i.e. the distinction between  $Q_1$  and the complete series  $Q_1, Q_2, \dots Q_r, \dots$ . This involves the whole question of the place of expectation in economic theory. Most discussions of the marginal efficiency of capital seem to pay no attention to any member of the series except  $Q_1$ . Yet this cannot be

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legitimate except in a static theory, for which all the  $Q$ 's are equal. The ordinary theory of distribution, where it is assumed that capital is getting *now* its marginal productivity (in some sense or other), is only valid in a stationary state. The aggregate current return to capital has no direct relationship to its marginal efficiency; whilst its current return at the margin of production (i.e. the return to capital which enters into the supply price of output) is its marginal user cost, which also has no close connection with its marginal efficiency.

There is, as I have said above, a remarkable lack of any clear account of the matter. At the same time I believe that the definition which I have given above is fairly close to what Marshall intended to mean by the term. The phrase which Marshall himself uses is 'marginal net efficiency' of a factor of production; or, alternatively, the 'marginal utility of capital'. The following is a summary of the most relevant passage which I can find in his *Principles* (6th ed. pp. 519–520). I have run together some non-consecutive sentences to convey the gist of what he says:

In a certain factory an extra £100 worth of machinery can be applied so as not to involve any other extra expense, and so as to add annually £3 worth to the net output of the factory after allowing for its own wear and tear. If the investors of capital push it into every occupation in which it seems likely to gain a high reward; and if, after this has been done and equilibrium has been found, it still pays and only just pays to employ this machinery, we can infer from this fact that the yearly rate of interest is 3 per cent. But illustrations of this kind merely indicate part of the action of the great causes which govern value. They cannot be made into a theory of interest; any more than into a theory of wages, without reasoning in a circle... Suppose that the rate of interest is 3 per cent. per annum on perfectly good security; and that the hat-making trade absorbs a capital of one million pounds. This implies that the hat-making trade can turn the whole million pounds' worth of capital to so good account that they would pay 3 per cent. per annum net for the

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use of it rather than go without any of it. There may be machinery which the trade would have refused to dispense with if the rate of interest had been 20 per cent. per annum. If the rate had been 10 per cent., more would have been used; if it had been 6 per cent., still more; if 4 per cent. still more; and finally, the rate being 3 per cent., they use more still. When they have this amount, the marginal utility of the machinery, i.e. the utility of that machinery which it is only just worth their while to employ, is measured by 3 per cent.

It is evident from the above that Marshall was well aware that we are involved in a circular argument if we try to determine along these lines what the rate of interest actually is.<sup>1</sup> In this passage he appears to accept the view set forth above, that the rate of interest determines the point to which new investment will be pushed, given the schedule of the marginal efficiency of capital. If the rate of interest is 3 per cent, this means that no one will pay £100 for a machine unless he hopes thereby to add £3 to his annual net output after allowing for costs and depreciation. But we shall see in chapter 14 that in other passages Marshall was less cautious—though still drawing back when his argument was leading him on to dubious ground.

Although he does not call it the 'marginal efficiency of capital', Professor Irving Fisher has given in his *Theory of Interest* (1930) a definition of what he calls 'the rate of return over cost' which is identical with my definition. 'The rate of return over cost', he writes,<sup>2</sup> 'is that rate which, employed in computing the present worth of all the costs and the present worth of all the returns, will make these two equal.' Professor Fisher explains that the extent of investment in any direction will depend on a comparison between the rate of return over cost and the rate of interest. To induce new investment 'the rate of return over cost

<sup>1</sup> But was he not wrong in supposing that the marginal productivity theory of wages is equally circular?

<sup>2</sup> *Op. cit.* p. 168.

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must exceed the rate of interest'.<sup>1</sup> 'This new magnitude (or factor) in our study plays the central rôle on the investment opportunity side of interest theory.'<sup>2</sup> Thus Professor Fisher uses his 'rate of return over cost' in the same sense and for precisely the same purpose as I employ 'the marginal efficiency of capital'.

### III

The most important confusion concerning the meaning and significance of the marginal efficiency of capital has ensued on the failure to see that it depends on the *prospective* yield of capital, and not merely on its current yield. This can be best illustrated by pointing out the effect on the marginal efficiency of capital of an expectation of changes in the prospective cost of production, whether these changes are expected to come from changes in labour cost, i.e. in the wage-unit, or from inventions and new technique. The output from equipment produced to-day will have to compete, in the course of its life, with the output from equipment produced subsequently, perhaps at a lower labour cost, perhaps by an improved technique, which is content with a lower price for its output and will be increased in quantity until the price of its output has fallen to the lower figure with which it is content. Moreover, the entrepreneur's profit (in terms of money) from equipment, old or new, will be reduced, if all output comes to be produced more cheaply. In so far as such developments are foreseen as probable, or even as possible, the marginal efficiency of capital produced to-day is appropriately diminished.

This is the factor through which the expectation of changes in the value of money influences the volume of current output. The expectation of a fall in the value of money stimulates investment, and hence employment generally, because it raises the schedule of the

<sup>1</sup> *Op. cit.* p. 159.

<sup>2</sup> *Op. cit.* p. 155.

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marginal efficiency of capital, i.e. the investment demand-schedule; and the expectation of a rise in the value of money is depressing, because it lowers the schedule of the marginal efficiency of capital.

This is the truth which lies behind Professor Irving Fisher's theory of what he originally called 'Appreciation and Interest'—the distinction between the money rate of interest and the real rate of interest where the latter is equal to the former after correction for changes in the value of money. It is difficult to make sense of this theory as stated, because it is not clear whether the change in the value of money is or is not assumed to be foreseen. There is no escape from the dilemma that, if it is not foreseen, there will be no effect on current affairs; whilst, if it is foreseen, the prices of existing goods will be forthwith so adjusted that the advantages of holding money and of holding goods are again equalised, and it will be too late for holders of money to gain or to suffer a change in the rate of interest which will offset the prospective change during the period of the loan in the value of the money lent. For the dilemma is not successfully escaped by Professor Pigou's expedient of supposing that the prospective change in the value of money is foreseen by one set of people but not foreseen by another.

The mistake lies in supposing that it is the rate of interest on which prospective changes in the value of money will directly react, instead of the marginal efficiency of a given stock of capital. The prices of *existing* assets will always adjust themselves to changes in expectation concerning the prospective value of money. The significance of such changes in expectation lies in their effect on the readiness to produce *new* assets through their reaction on the marginal efficiency of capital. The stimulating effect of the expectation of higher prices is due, not to its raising the rate of interest (that would be a paradoxical way of stimulating output—in so far as the rate of interest rises, the



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stimulating effect is to that extent offset), but to its raising the marginal efficiency of a given stock of capital. *If* the rate of interest were to rise *pari passu* with the marginal efficiency of capital, there would be *no* stimulating effect from the expectation of rising prices. For the stimulus to output depends on the marginal efficiency of a given stock of capital rising *relatively* to the rate of interest. Indeed Professor Fisher's theory could be best re-written in terms of a 'real rate of interest' defined as being the rate of interest which would have to rule, consequently on a change in the state of expectation as to the future value of money, in order that this change should have no effect on current output.<sup>1</sup>

It is worth noting that an expectation of a future fall in the rate of interest will have the effect of *lowering* the schedule of the marginal efficiency of capital; since it means that the output from equipment produced to-day will have to compete during part of its life with the output from equipment which is content with a lower return. This expectation will have no great depressing effect, since the expectations, which are held concerning the complex of rates of interest for various terms which will rule in the future, will be partially reflected in the complex of rates of interest which rule to-day. Nevertheless there may be some depressing effect, since the output from equipment produced to-day, which will emerge towards the end of the life of this equipment, may have to compete with the output of much younger equipment which is content with a lower return because of the lower rate of interest which rules for periods subsequent to the end of the life of equipment produced to-day.

It is important to understand the dependence of the marginal efficiency of a given stock of capital on changes in expectation, because it is chiefly this depend-

<sup>1</sup> Cf. Mr Robertson's article on 'Industrial Fluctuations and the Natural Rate of Interest', *Economic Journal*, December 1934.

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ence which renders the marginal efficiency of capital subject to the somewhat violent fluctuations which are the explanation of the trade cycle. In chapter 22 below we shall show that the succession of boom and slump can be described and analysed in terms of the fluctuations of the marginal efficiency of capital relatively to the rate of interest.

### IV

Two types of risk affect the volume of investment which have not commonly been distinguished, but which it is important to distinguish. The first is the entrepreneur's or borrower's risk and arises out of doubts in his own mind as to the probability of his actually earning the prospective yield for which he hopes. If a man is venturing his own money, this is the only risk which is relevant.

But where a system of borrowing and lending exists, by which I mean the granting of loans with a margin of real or personal security, a second type of risk is relevant which we may call the lender's risk. This may be due either to moral hazard, i.e. voluntary default or other means of escape, possibly lawful, from the fulfilment of the obligation, or to the possible insufficiency of the margin of security, i.e. involuntary default due to the disappointment of expectation. A third source of risk might be added, namely, a possible adverse change in the value of the monetary standard which renders a money-loan to this extent less secure than a real asset; though all or most of this should be already reflected, and therefore absorbed, in the price of durable real assets.

Now the first type of risk is, in a sense, a real social cost, though susceptible to diminution by averaging as well as by an increased accuracy of foresight. The second, however, is a pure addition to the cost of investment which would not exist if the borrower and lender were the same person. Moreover, it involves in part

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a duplication of a proportion of the entrepreneur's risk, which is added *twice* to the pure rate of interest to give the minimum prospective yield which will induce the investment. For if a venture is a risky one, the borrower will require a wider margin between his expectation of yield and the rate of interest at which he will think it worth his while to borrow; whilst the very same reason will lead the lender to require a wider margin between what he charges and the pure rate of interest in order to induce him to lend (except where the borrower is so strong and wealthy that he is in a position to offer an exceptional margin of security). The hope of a very favourable outcome, which may balance the risk in the mind of the borrower, is not available to solace the lender.

This duplication of allowance for a portion of the risk has not hitherto been emphasised, so far as I am aware; but it may be important in certain circumstances. During a boom the popular estimation of the magnitude of both these risks, both borrower's risk and lender's risk, is apt to become unusually and imprudently low.

### v

The schedule of the marginal efficiency of capital is of fundamental importance because it is mainly through this factor (much more than through the rate of interest) that the expectation of the future influences the present. The mistake of regarding the marginal efficiency of capital primarily in terms of the *current* yield of capital equipment, which would be correct only in the static state where there is no changing future to influence the present, has had the result of breaking the theoretical link between to-day and to-morrow. Even the rate of interest is, virtually,<sup>1</sup> a

<sup>1</sup> Not completely; for its value partly reflects the *uncertainty* of the future. Moreover, the relation between rates of interest for different terms depends on expectations.

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*current* phenomenon; and if we reduce the marginal efficiency of capital to the same status, we cut ourselves off from taking any direct account of the influence of the future in our analysis of the existing equilibrium.

The fact that the assumptions of the static state often underlie present-day economic theory, imports into it a large element of unreality. But the introduction of the concepts of user cost and of the marginal efficiency of capital, as defined above, will have the effect, I think, of bringing it back to reality, whilst reducing to a minimum the necessary degree of adaptation.

It is by reason of the existence of durable equipment that the economic future is linked to the present. It is, therefore, consonant with, and agreeable to, our broad principles of thought, that the expectation of the future should affect the present through the demand price for durable equipment.