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Chapter 2

Concepts of Capital Change, Capital Consumption and Capital Adjustment

BEFORE we can measure capital consumption we must define our concepts more explicitly. Capital consumption must be distinguished from total capital change and, specifically, from capital adjustment; the various alternatives of inclusion and exclusion and the multiplicity of concepts possible must be considered; and finally one concept must be accepted as a guide in the collection of data and as a criterion by which to judge their suitability for our purpose.

CONCEPT OF CAPITAL CHANGE

Fixed capital is the current value of durable goods. The capital resident in a particular durable good is equal to the present value of the series of future returns it is expected to yield. To compute a capital value in this way it is necessary to specify a moment in time, a series of expected services, their respective future values, and one or more rates of discount. The difference between the values of a capital good at two moments reflects changes in any one of the terms or coefficients in the measure of capital; it is therefore the most general expression of capital change.

The portion of this change in capital that is defined as capital consumption depends on the purpose or point of view. Capital consumption may be considered to be as broad as capital change, or narrower. Most broadly, capital consumption may be considered to be the decline in the present value

of a series of expected services, whatever the cause of this decline: changes in the subjective situation that always affects expectations, in the objective elements (such as physical deterioration or decline in the remaining life of capital goods), in prices, in interest rates. More narrowly, the influence of changes in certain of the elements may be considered irrelevant and their effects may be set to one side. The rate of discount, prices, or the current mood may be placed in the 'pound of *ceteris paribus*'. Changes in value due to interest accruals may be distinguished from those due to capital use *per se*. As an extreme case value changes arising from physical deterioration alone may be admitted as relevant. Or even of these, certain may be excluded, such as those arising from unanticipated accidents.

If the objective in mind is the determination of that part of capital change which may reasonably be charged against current income, that is, which should be included among the current expenses deducted from current gross receipts to arrive at the net results of current operations, capital consumption must be considered as narrower than the total decline in capital, the latter including also changes irrelevant to the measurement of the result of current operations. This is the objective adopted here. Capital changes other than capital consumption, namely, the remaining changes in capital, are then treated as adjustments of capital, rather than as capital consumption.

These distinctions, which are elaborated more fully below, are not confined to economic theory alone. They are found, explicitly or implicitly, in the accounts of business enterprises. The original price paid for a capital good determines only the present value that is assigned to the services expected to be yielded by the good.¹ Once time has elapsed the market price

¹ The expectation that more than cost will be returned in the use of a piece of equipment is not incompatible with the above assigned value. Part (sometimes all) of this excess is represented by the interest expected to be earned, the element of discount. Any anticipated profit exceeding this interest is im-

new no longer fixes the present value of this bundle of services. The process of valuation of capital goods becomes one within the business enterprise; it is not a market process. Even reproduction costs and scrap or salvage values merely bound the large area within which intra-enterprise judgment must be exercised. Changes in the number and time distribution of the services to be rendered, in price levels, and in discount factors must be considered. If these are ignored, as in fact they are in the use of the straight line depreciation charge based on original cost, this also implies a judgment of valuation.

DISTINCTION BETWEEN CHARGES ON CAPITAL ACCOUNT AND ON INCOME ACCOUNT

Each part of the bundle of services represented by a unit of capital goods—a machine, a building, a tool—is available at a different time. The total difference between the value of a capital good at the beginning and at the end of an accounting period measures not only the value of the service rendered during the fiscal period covered but also the change in the value of the other services.²

Here, then, is the first set of alternatives with which we are confronted in defining capital consumption. Shall we measure capital consumption by the value of the current services rendered by a capital good and used up in production, or by the *net* change in the value of a capital good, this being the difference between the value of the current services rendered and the change in the value of the future services to be rendered? For the purpose of determining the amount to be deducted from the current gross product to measure current net income, whether of a single firm or of the entire nation, the first is the more suitable. To allow also for those changes in the value of

puted to the enterprise as a whole (including intangible assets), not to the particular piece of equipment.

² Capital change measured in this way may sometimes be negative, that is, the value of the capital good may increase. This is obvious when the growth of a forest or the holding of a mine for later development is considered. The change in value represents, in these cases, net capital formation.

the total existing capital stock that do not arise from the using up of durable goods in current production would distort the measure of current income; for changes in the total value of capital may be enormous and may be either upward or downward. The more limited definition of capital consumption is also more suitable for measuring current net additions to the capital stock, i.e., savings. The concept of capital consumption as we shall use it, therefore, is narrower than the concept of net change in the value of a capital good. The latter includes, also, plus and minus items of adjustment, and (in the cases mentioned above) a certain amount of capital formation.³

Measures of the aggregate value of existing capital goods must allow for all changes in value. If changes in total capital are to be reconciled with the amount of current savings, it is necessary to build up a series of figures on capital gains or losses, that is, on capital adjustments.

The distinction between capital consumption, the current value of durable goods used up in production, and net capital change, which includes also the effect of changes in the value of the unused goods, is arbitrary in an important sense; for it depends on the time pattern of service that is envisaged and this implies a certain set of anticipations. These are as a matter of fact based on custom and business practice to a great extent. Declines in the stock of wealth arising from earthquake or war are losses "on capital account, not on income account".⁴ But "the line cannot be drawn precisely. It may vary between times and different places, between a country such as England, for example, and one in which earthquakes are familiar events, against which provision by insurance is usual."⁵

Here we come to another fork in the road. Shall the distinction between capital and income charges that is based on busi-

³ Not all economists would eliminate capital adjustments from the computation of net income or of savings. However, the consensus of opinion is in favor of this procedure. See the discussion in *Studies in Income and Wealth*, Vol. I.

⁴ A. C. Pigou, *The Economics of Welfare* (Macmillan, 1932), 4th ed., pp. 45-6.

⁵ A. C. Pigou, Net Income and Capital Depletion, *Economic Journal*, June 1935, p. 241.

ness practice and custom be accepted, or may purely economic criteria be used? To what extent may we deviate from the facts given us by business records? Logically, the measure of capital consumption in which we are interested is not a mere summation of business estimates, any more than national income is merely a summation of individuals' estimates of what their incomes are. From a practical point of view, however, the economist is not in a position to dispense completely with business estimates. We must accept certain of the 'objective' facts given us by business records and restrict ourselves to a modification of the figures or to a realization of the assumptions they implicitly involve. Because of lack of information the line drawn in business practice between capital and income charges must usually be accepted.⁶

Now that we have, by excluding charges on capital account, determined what is meant by 'used up in *production*', the question arises as to what is meant by 'used up in *current production*'. To this problem we now turn.

PROBLEM OF TIME ALLOCATION

The time allocation of costs arising from the use of capital goods presents several aspects which may be examined separately: the choice of charging expenditures on capital goods to expense upon the final retirement of the goods or on a basis of periodic depreciation estimates; the relation of obsolescence to the estimated life of capital goods; and the problem of time distribution over the life of capital goods. Each represents different sets of alternative ways for distributing these costs among various fiscal periods.

Expired life as a factor in capital consumption

Increasing age almost inevitably affects the capacity of a machine to render service. Any accompanying rise in maintenance

⁶ The fact that provision for exceptional types of loss are not made explicitly does not mean that they are completely ignored by business men. They may be taken into account through a general risk factor entering all business calculations and manifested by general contingency reserves and surplus and undivided profits.

and operating costs should therefore logically be taken into account in framing the time distribution of capital consumption. Whether increasing age *per se* is to affect measures of capital consumption is more of a moot point. Some economists question whether the element of life is to be considered. They assume, in other words, retirement accounting as the method of measuring capital consumption. Thus, Professor Pigou states that the contention that capital will be maintained intact simply by repairs and renewals alone "is not injured" if worn plant is technically of the same efficiency as new plant. "But, in so far as the efficiency of plant diminishes with age, the case is otherwise."⁷

To ignore the decline in remaining service life of durable goods in the accounts of concerns in which retirements and maintenance may appear sporadically would tend to defeat the essential objective of capital accounting, which is properly to allocate charges for capital consumed. It would make it impossible to avoid the distorting effects of chance accumulations of retirements and maintenance expenditures upon the computation of current net income. Nor is the objective attained if there is growth or decline in the amount of capital assets. Further, another purpose of capital accounting, to show the actual investment in capital assets, would not be fulfilled. If the decline in service life is ignored those economic measures in which capital consumption is involved will be distorted. In a growing economy the national income, one such measure, would be overstated. And if the economy grows at a changing rate, the error will not be constant. The error is most noticeable, however, when output and investment fluctuate.

Obsolescence as a factor in the life of capital goods

Granted that expired life is to be related to capital consumption, a question arises concerning the relevant life of capital goods. Is it the 'physical' life, or is it something shorter, the 'economic' life?

⁷ *The Economics of Welfare*, p. 38n.

Even on the postulate of a stationary state it is difficult to define physical life, for a machine is discarded before it actually crumbles away. Costs of operation and maintenance are relevant to the determination of the time when a capital good is discarded. Even in the absence of obsolescence a machine may suddenly become a pile of old iron, without any obvious or sudden change in its physical attributes. Consequently, even in a stationary state in which all factors affecting the efficiency of a machine, except its advancing decrepitude, are kept constant, economic life is the significant life for our purpose. The distinction between elements that are "actually standing in the capital stock"⁸ and elements that have been discarded rests upon the present value of the anticipated services to be derived from the various elements. Valuation thus affects the physical quantity of the stock of capital. Physical deterioration alone, not accompanied by a loss in value, is no evidence of capital consumption. The decay of an abandoned plow is of no economic importance.

In the world as we know it all other things do not remain the same. There are changes in prices and costs of complementary factors of production and of replacements. Competing machines spring up through advances in the arts. Demand for the services of particular pieces of capital equipment waxes and wanes. Obsolescence is ubiquitous. The economic efficiency of a machine, and the economic life that rests upon it, is related to the rate of obsolescence. The economic life of a machine, as forecast on the basis of its economic as well as physical attributes and conditions of use, is the life over which capital consumption must logically be allocated. Business men do not forget this in their calculations. As a matter of fact, business practice ignores the distinction between ordinary depreciation and obsolescence so far as the latter is normal, that is, predictable. And replacements, renewals, and repairs incurred through ordinary (that is, minor) changes in the arts and in demand are charged to current expense. It would therefore be

⁸ A. C. Pigou, *Economic Journal*, June 1935.

statistically impossible, even if logically possible or desirable, to eliminate the effects of obsolescence. But normal obsolescence at least is relevant to the economic measure of capital consumption.

Unanticipated obsolescence also is a cause of capital decline. But it is irrelevant to capital consumption defined as a charge against current income. Thus, renewals arising from large (unexpected) changes in the arts will appear in the records more often as retirements, surplus debits, or deferred debits, that is, as capital charges rather than as current charges. These we place among capital adjustments.

*Distribution of
capital consumption over the life of capital goods*

A common plan of distribution of the consumption of capital is the straight line basis. But other plans are possible and are in use. Distribution may be on a per unit of output basis. Increasing cost of repairs and operation, if any, may be allowed to affect the time distribution. If obsolescence is conceived of as occurring in a certain manner through time, this also may influence the time pattern of capital consumption. The allocation of the consumption of long-lived capital goods may be affected also by the element of interest. Which of these schemes shall we choose?

We are interested in determining the capital consumption that may reasonably be charged to current income. The criterion of reasonableness must rest, as in the distinction between charges on income account and on capital account, on the kind of expectations and anticipations—usually implicit—held by those making capital commitments. We assume that, at the time of investment, the possibility of cyclical changes in activity is not excluded from the calculations involved in the decision to invest. On this ground some kind of service-output allocation basis is most reasonable; for, if output is expected to vary from period to period, not the unit of time but the unit of output should be associated with the measure of capital

consumption. We are therefore not interested in measuring, for a given time period, the 'actual' wear and tear or the actual amount spent on the restoration of fixed capital. What we wish to do is to distribute the wear and tear that occurs during the entire life of a machine, whatever the actual time pattern of this wear and tear may be, among the units of output in whose production the machine assisted. The logic underlying this allocation scheme is similar to that underlying the time distribution of losses by fire. The 'actual wear and tear' by fire, whatever its distribution in time, is not allowed to affect the time distribution of provision for fire loss—the charge to current expense.

The fluctuations in depreciation charges on a given capital good arising from the service-output method of allocation should be superimposed on a rising secular trend, to take account of the element of interest. That is, if output is constant, depreciation charges should rise, the rate of rise depending on the rate of discount implicit in the original capital value.⁹ (For short-lived goods, or for long-lived goods if the aggregate quantity of capital goods is constant, this interest factor may be ignored: the secular trend may be assumed to be constant.) Here also the choice of the method of allocation must rest on what is believed to be the expectations of investors. We assume that the rate of return earned during every year of the life of an investment is taken by investors to be equal to the expected

⁹ An analogy will help make this clear. Suppose a 6 per cent bond, with a face value (= 'scrap value') of 1,000 dollars, is purchased for 2,000 dollars. Suppose, further, that the principal of the bond is payable in n years, where n is a very large number. It is clear that the yield of the bond is practically 3 per cent. At the end of the first year 60 dollars interest is received. Since the due date is far in the future the amortization required is practically zero. The gross income of 60 dollars is practically equal to the net income, and the rate of return is 3 per cent of book value. Let us now consider the situation at the end of the n th year. The gross income is still 60 dollars. But the net book value (after amortization) is now very close to par, approximately 1,029 dollars. If the rate of return on the book value of the bond is still to be 3 per cent (and this is logically desirable), the net income must be about 31 dollars; amortization in the n th year must be 29 dollars. That is, depreciation charges must have risen from almost zero in the first year to 29 dollars in the last year.

average rate of return on the investment. That is, we assume investors to suppose that (in the absence of changes in other elements in the situation) the rate of return is constant. This is the simplest assumption and one compatible with actual practices, as in accounting for investments in bonds, where 'other elements in the situation' do not obscure the logic of the accounting practice.

Our definition of capital consumption as the current value of durable goods *used up in* current production does not mean an identification of capital consumption with the 'actual' wear and tear during a given time period. The term *used up in* stands for an economic relation, not a physical one. For example, a machine may be purchased in one year with the definite object of being used in the next. Any wear and tear it suffers from exposure in the first year is then clearly ascribable to the output of the next year. The *entire* machine is *used up in* the output of the second year, despite any physical wear and tear it may have suffered in the first year.

In a sense the choice of the service-output method of allocation, or any other choice, must be arbitrary in a society characterized by fluctuations in volume of activity when the fiscal period is shorter than the period of fluctuation. On the ground that the probability of fluctuation in business is recognized the service-output allocation basis is logical. It happens to be logical also on the specific theory that equipment purchased to handle boom business will be used for boom business alone, and the costs incurred should therefore be charged to that business alone. However, if a business cycle is considered an organic unit, in which the errors of prosperity are conceived of as arising out of the entire cyclical process, the use of *any* method of allocation over annual fiscal periods is arbitrary; the cycle period is the logical fiscal period. More important than definitively to select one or another method of time distribution, however, is to realize that the currently accepted methods of allocation involve certain assumptions and theories of relation-

ship between capital consumption and output that color available measures of net income and of capital.

We have discussed the meaning of 'durable goods used up in current production'. We now consider what is meant by '*current value* of durable goods used up'.

PROBLEM OF PRICE CHANGES

To dissociate the quantity of capital from its value is peculiarly difficult. For if a quantity of capital can be conceived of at all, it is as a composite quantity, a bundle of units, each one of which relates to a different time period and is therefore incommensurable, simply as a quantity, with the others. Only as values can they be combined. The closest we can come to the aggregation of 'quantities' is by expressing them in terms of constant prices. But even then commensuration is on the basis of value.

If capital and capital consumption must be expressed in terms of value, what prices shall be used? Original cost prices are most common. But price levels change continually. Shall original costs be used when current prices deviate from them? Since it is the current value of goods used up that is relevant to the computation of net income, rather than original cost, we must express our measures of capital consumption in current prices. Expressed in current prices, capital consumption is more suited, for comparison with the current flow of new capital goods as priced at the time of purchase, than is capital consumption in prices derived from earlier time periods. Expressing the estimates of depreciation, etc., in current prices implies measuring the capital consumption represented as if price changes were reflected periodically on the books of business enterprises. This agrees with the general tenor of Professor Pigou's suggestion that "when any discarding has occurred, in order to make good the depletion of capital implied in it, that quantity of resources must be engaged which would suffice

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in actual current condition of technique to reproduce the dis-
carded element".¹⁰

The use of any kind of 'current' prices will avoid the mixing up, in our measures, of the prices determined in different time periods. But what particular set of current prices should be used? To the extent that there is a market for second-hand equipment, as there is for buildings, current prices of old equipment may exist. But these prices are not the prices we desire. While they reflect obsolescence and other relevant factors they reflect also certain irrelevant factors. The market (buying) price of an automobile one week old may be 10 or 20 per cent below original cost, but no charge for depreciation during the first week's operation should amount to 10 or 20 per cent of cost. Besides this important drawback there is another. The market in which prices of old equipment are determined is usually narrow. So small a proportion of the existing capital goods pass through it that the resulting prices are unreliable measures of the value of the bulk of the existing stock of capital goods. The same criticism applies here as to shares in business enterprises. The prices we must use are those of new equipment passing through the market.¹¹

If, for the purpose of time comparisons, it is desired to eliminate entirely the influence of changing prices, capital consumption may be expressed in constant prices, selected from some one year or period of years, or in purchasing power over a suitable group of commodities. The chief fault of the constant-price expression is its neglect of relative price changes. This is avoided by expression in terms of purchasing power. However, the latter method raises the vexing problem of selecting the bundle of goods by which purchasing power is to be measured. These alternatives will be examined more closely when the available statistics on capital consumption are brought together (Ch. 10).

¹⁰ *Economic Journal*, June 1935, p. 239.

¹¹ A serious difficulty arises from quality changes (Ch. 10).

CONCEPT OF CAPITAL CONSUMPTION

Capital consumption, then, is the current value of durable goods used up in production. It differs from the net change in the value of durable goods in that the net change includes also capital adjustments, changes 'on capital account'. Durable goods are used up in production not only when their 'efficiency' declines through wear and tear and obsolescence, but also when the length of their remaining life is reduced through wear and tear and obsolescence. The amount of durable goods used up in the production of a given period is a function of the output in that period. The relation is an economic one of anticipation and allocation, not a physical one of cause and effect. The value of durable goods used up in production is the current value, expressed in current prices. For purposes of time comparison, price changes may be eliminated by expressing the value of the durable goods used up either in terms of current purchasing power, or in constant prices.

This is the concept of capital consumption accepted in this volume. It is the concept that is suitable for use in determining the amount of capital consumption as a step in the measurement of national income and net capital formation. To help determine total changes in the nation's capital, this concept must be supplemented by one of changes 'on capital account'.

CONCEPT OF CAPITAL ADJUSTMENT

Among the changes on capital account are value changes arising from movements of price levels, changes in discount rates, extraordinary obsolescence, and catastrophic destruction. These we have called adjustments of capital. They are purely adjustments so far as the measurement of current capital consumption, of current net income, and of current savings, is concerned.

Certain of these adjustments, however, represent real declines in capital, real consumption from a long term view. Or they may represent real increases in social capital, such as those

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arising from the discovery of natural resources. These, though irrelevant to current computations, merit attention. We consider them in Part V.

Our concept of capital consumption differs from that underlying accounting records. Therefore an essential part of our task of measuring capital consumption is: first, to list the various ways in which capital consumption may be measured in practice in order that we may know where to look for our data; second, to compile the available figures that may be useful in constructing our measures; third, to discuss in detail the character of the underlying records that yield these figures and thereby get at their meaning for our purposes; fourth, to modify them so far as practicable, to adapt them to the concept outlined above. To this we now turn.