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Volume Title: The Relation of Cost to Output for a Leather Belt Shop

Volume Author/Editor: Joel Dean

Volume Publisher: NBER

Volume ISBN: 0-87014-447-2

Volume URL: http://www.nber.org/books/dean41-1

Publication Date: 1941

Chapter Title: Memorandum on Costs in Relation to Output

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Chapter URL: http://www.nber.org/chapters/c9259

Chapter pages in book: (p. 53 - 72)

Memorandum on

COSTS IN RELATION TO OUTPUT

C. Reinold Noyes

THIS study by Joel Dean undertakes the empirical examination, in a single sample, of the relation of costs to output in the 'short run' (i.e. fixed capacity). The subject is approached in the light of the current theory of costs and is therefore aimed incidentally to constitute, so far as it reaches, a test of the validity of that theory. In the course of reading and rereading the manuscript I have repeatedly been reminded of some of the major problems that inevitably arise and must be dealt with before empirical studies of costs can lead either to new generalizations of value or to an adequate test of the generalizations that have been arrived at by more theoretical analysis.[1] Though the presentation of these problems is not entirely relevant to this particular study, the editor of the *Technical Papers* has asked me to outline them for publication in the same number under the disguise of a Director's comment.[2]

I

The first problem is the scientific delimitation of costs. That is a problem in classification, pure and simple. But classification of what? What is the nature of a cost? Is it a concept; is it a calculation; or is it a kind of event which occurs in economic life? I am inclined to think that a realistic economics (empirical) must deal only with objective events— acts and relations. If this is the nature of a cost, then, for the purpose of classification, a criterion must be agreed upon according to which there is to be selected from all economic events those which are to be classified as costs; for the classification does not exist in nature. The criterion is a matter of choice—of scientific utility—and there is no 'right' and 'wrong' about it. But, once the class is defined, then scientific precision requires

[1] In the field of national income, Kuznets, like his predecessors, was faced with similar problems. There the data are made available in certain classifications. It was necessary to construe, to modify and to complete these classifications before the figures represented the actual economy. Then it was necessary to 'reconcile' these classifications with those of theory. His forthcoming work proves that it is possible to bring comparative order out of such chaos; but it is far from an easy task.

[2] As a matter of fact they take the form of an examination of the National Bureau's project and its method of attack, rather than one of this particular study. Also the scope of the memorandum has been considerably enlarged as a result of discussion with the National Bureau's staff.

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that all events of that kind, without exception, must be included and all others excluded. At the border line that becomes a difficult, if not arbitrary, decision, as is true of all other scientific classifications. Nevertheless, away from the disputable border line cases, once the criterion is adopted, the question of inclusion or exclusion of individual events does become a question of 'right' and 'wrong' (in the sense of correct and incorrect). The first step, then, is to achieve a consensus of scientific opinion as to the nature of a cost. Then we come to the question of the boundaries to be set to the classification—its criterion. If they are events, are costs to be limited to those events which occur in connection with factors of production; if so, exactly what are the factors of production which give rise to costs; when or under what conditions do they do so; if not so limited, what events or other entities besides such factors are to be included? The mere fact that these questions have been answered in a certain way by theoretical economics, or are naturally answered in a certain way under a particular institutional set-up, or are conventionally answered in a certain way by business accounting, proves nothing. For an empirical science an attack on this problem *de novo* is a prerequisite.

If costs are to be limited to those events which occur in connection with factors of production, it is necessary at the start to establish a distinction between (1) the factors of production themselves, as the physical materials and activities, or the mental activities, from the *use* (application) of which product actually results, (2) the human efforts and sacrifices which are involved not only in putting factors to use but often, as well, in merely making them available for use (real costs in the usual sense), and (3) the compensation in money or its equivalent which is paid in order to induce the making available or the putting to use of such factors, plus other institutional charges (money costs). These three aspects of the process of production—the technical, the real and the institutional (or accounting)—or these several disparate sets of entities, must be sharply differentiated and treated separately, for they do not necessarily or usually conform to each other either in scope, in magnitude or in timing. In the first aspect, we view the process of production at a purely technical level; the factors are agencies from which product results; when no product is resulting the factors are inactive—not producing.[3] Thus, if costs are to be delimited to occurrences at this level, they only arise when the factors are active—in other words, as the costs of specific current product. In the second aspect, efforts and sacrifices seem to be real costs when and as they are made. Therefore, in the case of plant and machinery, for instance,[4] since the efforts and sacrifices which constitute the costs may

[3] This is the aspect in which the 'law of the proportioning of factors', or of diminishing (etc.) returns, treats the process. It is also the aspect in which we speak of 'productivity'.

[4] Or even, under certain conditions, labor and materials made available but not employed (see below).

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begin to be made long before the factors are used or even when they never will be used, the costs are regarded as accumulating until the factors occasioning them come to be used. Then they, too, become costs of specific current product; but since they cannot become actual costs of product unless product results, they must, if no product results, be treated as what we call losses (i.e. economic waste). In the third aspect costs, strictly speaking, arise (are incurred) under our institutional set-up only when a contractual or imposed liability becomes 'fixed and absolutely owing'. As we shall see, this may never occur as to some factors; it may occur as to others before or after the factors are used or even without their ever being used; it may occur in other cases without the existence of a true factor at all; finally it may occur as to some factors because one sets up a purely nominal liability to oneself with regard to them, with or without reference to their use. It is true also of the third aspect that costs may have to be accumulated for the reason that they cannot be treated as costs of product, until or unless product results, and that they must be converted into losses, if no product results.

The discrepancies between these three aspects create the chief part of the problem of delimitation of costs, if costs are confined to factors. They preclude the possibility of effective results if, in one place, cost studies treat the subject in terms of factors *used,* in another in terms of factors *made available,* and in a third in terms of contractual and imposed liabilities.[5] They require that we make up our minds in advance either to choose one aspect and stick to that throughout, or that we combine all three of them, by a process of 'reconciliation' or adjustment of their discrepancies, into a scientific model which, being a combination of all, differs from each. If we choose to do the latter the adjustments and reconciliations must be defined in detail. As has been suggested above, the discrepancies in timing between these three aspects may be adjusted by accumulation when the factor is not active. But that, of course, changes the magnitude as well.[6] The other discrepancies, scope and resulting magnitudes, are not to be adjusted so easily.

Examination, first, of the possibility of using the third aspect—in effect, the books of account—as the sole basis of classification, will not only demonstrate how inadequate it is, but will also serve to suggest some of the detailed discrepancies which, if the alternative of a combina-

5 As an example of the universal exigencies of scientific method, though in a totally different connection (the definition of functional localization in the cerebral cortex), I quote the following from a leading scientist: "If these two terms do not embody precise and consistently employed conceptions, no hypotheses based upon them are likely to be valid".

6 For example, a machine in use one-third of the time, is in the first aspect, only a cost during that part of the time. The rest of the time it is inactive and therefore not a causative agent. But in the second, and frequently in the third, aspect it is a cost all the time. As a cost, it must be accumulated during the two-thirds of the time it is idle. Then that cost must be applied during the time it is producing—the only time there is product of which it can be a cost. As a result the cost in the last two aspects is three times that in the first.

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tion were to be adopted, would require to be resolved. Starting with the initiation of a productive enterprise the first step is the financing of the plant and equipment. To the extent that this is done with borrowed money (bonds and notes) or to the extent that the land, or the land and buildings, or even the machinery, is leased, a contractual cost is incurred which is usually a recurrent liability without regard to the use of the factors and even if they are never used.[7] On the other hand, to the extent that this is done by equity financing (capital and surplus) no contractual cost is incurred. Yet the factors are made available to the same extent by either means; the real cost involved is presumably the same; and when the plant is used there is no difference in the effect on product. Is this discrepancy to be corrected for at all? If so, should it be corrected for by imputing as a cost an amount equal to pure interest plus risk premium on the capital and surplus? Then what should that rate be? On that basis the cost will be quasi-contractual and therefore regardless of use. Or should the actual net earnings on the equity (profit), if any, be treated as this cost? If there are no net earnings should such financing be regarded as costless? If these earnings are large, should only a part of them be treated as cost and the balance be regarded as 'differential profit'? Without imputation, since the cost must then be based on earnings in some respect, it will arise only if the plant and equipment are used and will probably be somewhat proportional to the extent of that use.

Taxes are imposed liabilities and therefore money costs as to which, strictly speaking, no factor is involved. Or, if you prefer to regard the services of government as a factor, it will at least be agreed that the taxes are not levied in proportion to such services rendered. They will either exceed or fall short of the active factors supplied. Are all taxes, nevertheless, costs? Corporation income and excess profits taxes are levied entirely on the net earnings (profits) and therefore on the equity only. Are they costs, if no cost is imputed to the equity? If such cost is imputed, are these taxes additional costs or only an abstraction from the imputed cost? Property taxes, as costs, are, like interest on borrowed money or rent, payable regardless of use. On the other hand, income taxes, as costs, can only arise if there is net income to the equity and will therefore be somewhat proportionate to use of plant and equipment. Excise taxes, as costs, will be strictly proportionate to use of plant—that is, to output.

In America, depreciation on owned plant or equipment, like all other reserves, takes the form of a liability assumed to oneself. In France it frequently takes the form of a contractual, though contingent, liability for the return of capital to the *actionnaire*. On the first basis replace-

[7] When machinery is leased, the cost to the hirer sometimes takes the form of a royalty on output. On the strictly institutional basis (third aspect) that would be all that it would be necessary to consider.

ments can be made without refinancing; on the second they cannot. If it is set up on the first basis, depreciation is treated as a cost; if on the second, since it is only a charge against profits, whether or not it is a cost depends on whether or not profits are treated as a cost. In America, 'straight line' depreciation becomes a cost without regard to use. Yet, as Dean points out, the intensity of use is an important determinant of the time for replacement. Certainly the operation of a plant on three shifts uses it up much faster than when it is operated on one shift. Should a correction be made to cover this, so that a part, at least, of this cost is proportionate to use? If so, what is to be done about depreciation included in the rental or hire of plant and equipment which is usually a contractual liability without regard to use?

In all these cases we note that the strictly contractual costs, and also those which are imposed or assumed, or which may be imputed, in fixed amounts by reason of the existence of the plant, go on regardless of use. If we look beneath the institutional basis, most of them seem to rest on the fact that the real costs involved are occasioned in making the factor or factors available for use rather than merely in putting them to use. That suggests the possibility of adopting the second aspect—the real— as the sole basis of our criterion. How well will that serve; or what discrepancies does that show up, if it is to be combined with the others? It is clear, at once, that we would not be applying this criterion to equity financing unless we accepted imputed interest upon it regardless of use; nor could we apply it at all to corporation income taxes or to strict use depreciation, neither of which can occur when there is no use. Moreover adoption of that criterion would raise the question whether labor and materials, available but unused (unemployed and unbought) are not, under certain conditions, also costs. This point of view as to labor, at least, was suggested years ago by J. M. Clark.[8] It is true that the real costs of the plant are irrevocably incurred when it is made available. Machines, when idle, cannot be taken home by the creditors or owners, enjoyed as consumer's goods during idle hours, and then brought back to work in the morning. But is that not sometimes true of labor as well? Short time employment usually ties up the whole of the worker's time. He cannot secure other employment for the rest of his available time. And the local reserve of labor which makes itself available always, and which is required at high rates of operation but not required at low rate operation, comes rather close to being on the same basis as the portions of the plant which may remain idle except when things are going full blast. If we were to adopt the 'real' criterion, the merely institutional fact that, at present, this loss falls on the worker while that of the machinery furnished by creditors falls upon the productive enterprise would be beside the mark.

[8] *Economics of Overhead Costs* (University of Chicago Press, 1923).

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This possible criterion for the delimitation of costs encounters another difficulty as well. A certain part of the capacity of a plant may represent surplus capacity, in the sense that the rate of operations never, or almost never, rises to the point at which it is put to use. It may be 'socially unnecessary', as the theorists say, or nearly so. The same may be true of local labor waiting for employment at a coal mine which will never again be operated. Where is the line to be drawn between plant capacity which is needed, if only for peak loads, and that which represents economic waste? Where is the line to be drawn between economically needed local reserves of labor and obstinate immobility?

From the foregoing it is evident that not much attention needs to be given to the questions that would arise if the first aspect—the technical one—were chosen as the sole criterion. Too much would have to be ignored to make that possible. Nevertheless, it will be equally evident that its relation to the other aspects, in connection with the second problem to be considered, has a vital bearing on the whole subject.

If costs are not to be limited to factors of production in use, or available for use, for the production of specific product, at what boundary shall we set the limit? The question has already been raised with reference to some non-factor elements which are institutionally imposed upon the individual productive enterprise, such as those in the form of taxes in excess of the value of government services rendered. We might have included those in the form of 'damages' for injury to others. But why stop there? Why not include all so-called social costs, all 'disservices' and 'discommodities', even those whose incidence is upon other individuals or enterprises?[9] If the latter, then the corporation without net income should be charged, upon our scientific books, for its share of those government services of which it receives the benefit but for which it is hardly taxed at all, and the overburden of the rest should be lightened. In addition, all 'damages' to other producers, or to consumers, should be assessed and included in our estimates. Something like this ambitious program is called for if we are to test the validity of the more ingenious branches of the theory of costs.

On the other hand, it may prove to be more conducive to effective economic analysis to draw some line between those costs which may be defined as *costs of production*, because they are unalterably enforced by the environment and the available techniques—the factor-costs—and all other costs. It might be convenient to divide these other costs into two sub-classes. The first might be called 'social charges' and would include all items not technically essential to—not strictly causative of—production, but with which it is determined, nevertheless, to make production chargeable, either because they institutionally are, or analytically should

[9] The incidence of 'social costs' must, of course, ultimately rest upon some individual or individuals. They cannot alight upon a Germanic super-entity.

be, so charged. An example of such a class is unemployment insurance.[10] The second might include all those costs which may be incident to (consequences of) production and yet not causative of, or necessary to, product and which are neither institutionally nor analytically charged to production but fall elsewhere. Such are, for instance, failing efforts to discover new natural resources, abortive experiments, etc. Personally I should regard all this sub-class as costs converted into losses. For this reason they might be called 'social losses'.[11] Such a discrimination would make the empirical problem far more manageable; for to these non-productive costs there literally is no logical limit. The criterion adopted for them could then be independent of that for the true costs of production. And they could be studied separately.

Whatever criterion of costs—or of the three subdivisions of costs—is chosen, after careful consideration of the scientific utility of the system of classification, then, so long as that criterion remains scientific usage, all events (or other entities) included in the definition must be treated as costs. I know of no science whose fundamental classifications are 'different for different purposes' (see below). That kind of impressionistic methodology strikes me as a-scientific. However tentative and subject to improvement the classification may be, it remains, as long as it is in use, fixed and absolute by definition.

II

The second problem which, it seems to me, has to be squarely faced before empirical cost studies can be more than reproductions of current cost accounting methods or reflections of the concepts of a somewhat unrealistic theory, is the problem of the allocation of costs. Having determined what events (or other entities) are to be included under the rubric, costs, and whether these are limited to what I have called strict costs of production, or are to include more or less of 'social charges' and 'social losses', there remains to be determined precisely what specific batches of product are to be charged with these costs, or how these costs are to be distributed over the actual product. Again the fact that these questions

10 Some of these 'social costs' are relics of an English classical point of view, imported into American theory but never indigenous here—the idea that the sustenance of labor is a cost of production. That is true only if labor is 'an instrument of production'. Such a view is foreign to the American atmosphere. Here the sustenance of labor, like that of all of us, is an expenditure of income. It may take the form of a diversion (redistribution) of the income of others. But it is not a cost of production.

It should be noted that unemployment insurance abuts on and may be partly used for that real cost of labor held available for use which was mentioned above. Which part is a cost of production and which a 'social charge'?

11 Perhaps we should enlarge this category to cover the ground outlined by Pigou (*Economics of Welfare*, Part II, Ch. IX; Macmilian, 3d ed., 1929). Thus we would have in this category the algebraic sum of uncompensated services and of undischarged disservices, both ways, in so far as the net fell on others.

are treated in a certain way in accounting practice or in the theory of costs is not sufficient to settle the procedure for scientific purposes. But, unlike the first problem, this one is not a matter of classification; nor is it subject to any arbitrary rule in border-line cases. Instead, at least so far as strict costs of production are concerned, any scientific solution must rest upon an effort to determine in detail the actual facts of economic causation in the production process—what it is that produces—in terms of the relation between specific individual factors and specific batches of product—that is, the facts of the technical aspect already alluded to. For this purpose it seems to me that it is necessary to recognize more clearly, as the basis for views about production, that the technological process, in its widest sense,[12] is the medium through which product comes into being as the real consequence of its real causes. There is no product without sufficient cause. We have, then, to attribute it to its real causes. That attribution incidentally determines what items are to be included in its costs of production. Such a task is as difficult as is the explication of all other phenomena. Nevertheless it is a problem that exists in real terms only at the technical level. Its solution, or approximate solution, at that level is final for economics. On that basis the particular costs of production of a particular batch of product must be accepted as technical data. They cannot be assorted to taste; they cannot be ruled in or out on institutional grounds; they cannot be treated as relative to the points of view of various schools of thought. They are facts which are 'given' and which can only be revealed by observation and inference.

III

If, now, the most fundamental characteristic of this technical aspect of costs—the fact that factors are not producing when they are not actually in use—is to be envisaged in the empirical attack on costs, there will be required, I think, a re-examination of the notion of capacity, the various degrees to which it is *used* (rate of operation) and its potential limit (capacity, in the strict sense). And this for the reason that these categories have not been envisaged (in theory) in the technical aspect—'productivity' —but rather in the real or the money cost aspects. Since this question lies at the root of the relation of costs to output in the short run, it will be appropriate to consider it briefly before taking up the general problem of allocation of costs. The concept of capacity usually refers only to plant and equipment (machinery) , not to labor, materials, etc. That is, plant and equipment are treated as the strategic factor in capacity.

12 That is, including every step to the point where consumption begins. Since this includes the process of distributing the product, it is a somewhat larger category than the technical process of fabrication alone.

And this, presumably, because this factor usually has to be made available in advance—sometimes long in advance—whereas it is somewhat naively taken for granted that other factors will be provided as wanted. Since capacity, then, relates chiefly to size of plant and size and number of machines, in terms of their output, it is primarily a physical, or technical, and not a financial, or accounting, magnitude. We do not speak of a plant with a million dollar capacity, but of one with the capacity of a million units of product. Furthermore, capacity and rate of operation both have to do with the production process in its technical aspect only. They are quantitative categories expressing the potential (capacity) or actual (rate of operation) *use* in production of a single factor—or, if you prefer, an unchanged complex of factors (plant). It follows that neither is capable of being used, in its raw state, as a magnitude in cost analysis.

Having identified the actualities represented by these terms we may look around us at existing (unchanged) physical plants (buildings and machinery). We see that most of these are capable of operating all the way between an absolute minimum (shut down) and some maximum (capacity), yet to be defined. As the rate of operation is increased from the minimum it may change in any one, or any combination, of at least four dimensions; (1) the number of parallel production lines or duplicate machines actually in *use* (Dean's 'segmentation'); (2) the number of days per week the plant is operated; (3) the number of hours per day it is operated; (4) the speed, within their possible limits, at which each machine is run. When any single machine is not operating, it is idle. So is the plant space which houses it. But all equipment requires to be shut down for rehabilitation of one sort or another (cleaning, refilling, repairing, headway between trains, etc.). This part of idle time may not represent the same ratio to operating time at different proportions of full time operation or even along the several different dimensions of increase. But for each machine, independently of each other, there is operating and repair time, which are essential to production, and idle time (strictly) which is non-productive. When a machine (and its plant space) is strictly idle it is not a factor of production in *use*.

As the rate of operations is increased along any of the first three dimensions mentioned above, the initiation of the process constitutes the application of idle labor (more men, more hours or more shifts) to idle machines (and plant space). Plant is no more a factor in *use* when it is shut down at night than is the workman when he is asleep; nor when it is shut down several days in the week; nor when a 'segment' of it is not needed for the current rate of operation. Although, when the increase is along the third dimension above, the addition of a second or a third shift of labor brings in *different* men, whereas the operations are on the *same* machines, the actual use of the machines remains exactly

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proportionate to the actual use of labor, just as it does in the first or second cases. For instance:

1 Shift   Men working 8 hours   Machines operating $\frac{1}{3}$ time—idle $\frac{2}{3}$ time
2 Shifts Men working 16 hours Machines operating $\frac{2}{3}$ time—idle $\frac{1}{3}$ time
3 Shifts Men working 24 hours Machines operating full time—idle 0 time

There is not inherent in these ways of increasing the rate of operations any change in the proportioning of factors used. That is true also of the fourth dimension, speed-up. Then the time of use of neither machines nor men is changed. Therefore, in all cases, the ratio of man-hours to machine hours may remain the same. Generally speaking, I believe it will be found that, in modern industry, once the plant is built and equipped, its techniques are fixed and thereafter, without change in plant, there is no inherent [13] change in the proportion between the labor and the machinery actually *used*. True, techniques of different scale (and therefore different proportioning) may exist in the same plant to care for orders of different size (e.g. job and rotary presses); or a part of the plant may still retain an obsolete technique (and therefore different proportioning) to care for occasional surplus demand (e.g. beehive and by-product coke ovens). But no general change of proportioning with increased rate of operation can be deduced from exceptional and varying conditions such as these. It appears likely that, in modern technology, any law of proportioning of factors or its underlying law of diminishing productivity ceases to operate once the plant is built and equipped. Thereafter the general case seems to be that rate of operation determines the quantity of a uniform compound of factors which is actually *used*, and the absolute limit of capacity is reached when all of the strategic factor (plant and machinery) is operated at maximum speed and none is strictly idle for any of the 168 hours in a week.[14]

While casual observation suggests that this view of rate of operation and of capacity covers a good deal of the ground,[15] only wide-ranging empirical studies of the way factors are actually combined in use and full exploration of the possibility that there are other dimensions in which rate of operations can increase will adequately determine the actual technical facts. Casual observation is not scientific evidence. It merely suggests a lead to follow up. Nevertheless, it does warrant the suspicion that, in dealing with these entities, the theory of costs has been fundamentally defective.

[13] That is, no other than casual or fortuitous changes.

[14] This definition of capacity contains the implication that the rate of operation rarely reaches capacity anywhere. That is a fact, but it is hardly recognized in theory, particularly in the theories of competition. The shorter the period taken the more often would capacity be reached; the longer, the less often.

[15] Certain exceptions will be noted later.

IV

To resume consideration of the second problem we may note first that, however difficult an adequate scientific attack on the problem of allocation may prove, there is one point with reference to it which is perfectly clear and free from quandary. No costs, however delimited, can be allocated at all—can become costs of product, as we put it above—unless there is product to which to allocate them.[16] That has two corollaries. The first is that any costs which do not lead to product must be charged off as *losses* (economic waste). The second is this: If it is decided to include in the class, costs, any which run regardless of use of the factor —by reason solely of making it available—then, during the time these factors are not in use, the costs must be accumulated as long as there is a justifiable expectation that the factors will lead to product, and they must be charged to the product when there is product. There is, of course, no other way to allocate them. But, if there is no such expectation or if the expectation eventually proves false, then the original and the accumulated costs, if any, must also be charged off as losses (economic waste).[17] Thus, immediately or ultimately, the destination of costs which are not allocated is into the category of losses. It seems to me that this is an issue upon which economic theory, or at least the theory of costs, has reneged.

Among the contractual and imposed costs to which business accounting has limited itself, it distinguishes those which are incurred for general operation (which it supposes are only to be allocated to specific product upon some more or less rational but arbitrary plan) and those which are incurred directly for specific batches of product. On the other hand, economic theory (cost theory) has generally used the purely mathematical distinction between fixed and variable costs—between those which are unaffected by changes in the rate of operation within a fixed capacity and those that vary directly with that rate. As Dean has pointed out, these two pairs of classifications do not fully conform to each other. Most overhead accounts are only in part fixed and contain to a greater or less extent a variable element. However, the mathematical distinction seems to conform more closely than the accounting one to ours between costs, however delimited, which run regardless of use of the factors—or in so far as they do so—and costs which arise only as and when the factors are used. If it is decided to include within the delimitation of

16 This is the obverse of the technical axiom given at the beginning of the previous section—that factors of production are not producing when they are not actually in use.

17 And there they end up in the company of the afore-mentioned 'social losses'. Or, if it were decided to include these 'social losses' among the costs, they would then have to be allocated to definite product. If that process did not make the money value of the costs exceed the price then these 'social losses' would be covered. If it did exceed the price, the excess would go over into the loss category in the way described below.

costs any which run regardless of use of the factors, these seem necessarily to belong to that extent in the category of fixed costs. As a result, it would follow from our corollary that, when there is no product (plant shut down), these fixed costs must be accumulated. If they are ever to become costs of product, they can only become so when and if there is product. When the plant opens up, we have seen that its rate of operation may increase along any one, or any combination, of at least four different dimensions. As the rate is stepped up, increments of output are added, per period. The question then arises whether these fixed costs—those accumulated from the past and those current for the period—should become costs of product for the whole output at each stage in the increasing rate of operation or only for certain of the increments? In other words, it appears that their classification as fixed costs does not automatically determine their allocation.

The theory of costs has dealt with this question, though from a somewhat different angle. Taking as the marginal costs of an increment of output only the so-called variable costs—that is, those which are only incurred as the factors are used (including, of course, increases of overhead)—which the increased rate of operation necessitates, it has treated these as if they constituted the whole cost of the increment. Now, by definition, it is necessarily true that the marginal (or incremental) cost of each increment is the whole *extra* cost involved. But is it the whole cost? If so, is the marginal cost the whole cost of each increment starting from zero output? Then fixed costs could never become costs of product. If not, then at what point. working backward in the stripping off of successive increments, is one (or more) of the earlier ones to be found as to which fixed costs become part of the cost of product? Shall this or these bear the entire fixed costs? What if they fail to cover them? Or, on the other hand, are marginal costs to be considered the whole cost only of those increments beyond that rate of operation at which fixed costs have been fully covered? If so, that rate of operation can only be determined after it is decided what costs are to be treated as running regardless of use—that is, after the question of delimiting costs has been settled. In the extreme case in which all earnings on capital might be treated as costs, such a rate of operation would have to be at capacity. I have never seen these several questions examined. But, until the logical contradictions they point to are resolved, this theoretical treatment of fixed costs seems to reduce itself to an absurdity. Furthermore the whole point of view is incompatible with the fundamental technical facts of economic causation. If economic factors are used, they cannot be treated as if they were unused—as if they resulted in no product. They contribute toward product and are therefore costs. Recognizing the facts of economic causation, if we are to limit the application of fixed costs to any particular early increments of product or to those of which the difference between

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total extra cost and total price is sufficient to cover the fixed costs, the rule resolves itself into this: For any given rate of operation less than capacity, the cost of providing that part, or time, of the plant, etc., which is not then needed *is* to be charged against the product upon which it *is not* used; and, conversely, it *is not* to be charged against the product upon which it *is* used, when and if an increasing rate of operation requires it. Finally, if under this method of allocation fixed costs are not covered, a loss results. But, since scientific allocation must recognize the contribution of all factors actually used, there is no reason whatever to concentrate this loss upon the fixed costs. Rather the loss consists of a proportionate part of all the constituent categories of cost which were properly allocable; for all such costs are costs of product whether or not the price of the product covers the aggregate of them.

A modification of this viewpoint of cost theory sometimes crops up in a different form. It is said that there are "different costs for different purposes".[18] The implication is that the allocation of costs of production is not a matter of fact but a matter of discretion. But, though this leads to certain oddities and aberrations in allocation, it has really no bearing upon our subject. It is chiefly loose language or loose thinking; for what is meant is that, under various contingencies which may arise in connection with the processes of production, decisions by those responsible may be made without taking account of all costs or even with reference to one or two categories only. That does not alter the facts of costs. It does not make the items ignored or forgotten any the less costs. It is merely a way of concentrating attention on the strategic factor in the case. If I have a machine which is demonstrably responsible for an abnormal quantity of rejects, the only costs I compare are the rejects per period against the costs of a new machine per period. In doing so I do not eliminate or even disregard all other costs. I merely limit the number of those to be considered with reference to — because they may be changed by — that particular decision.[19]

[18] Because J. M. Clark has been quoted at me in the discussion of the first draft of this memorandum, I use here the heading of the ninth chapter of his *Overhead Costs*. But what he actually says in that chapter, particularly on pp. 175-6, seems to be approximately what I am saying. He has his "total economic cost". If his chapter heading had read, 'Differently assorted and partial aggregates of costs to be considered for the purpose of different decisions', it would have better represented what he seems to be driving at. It would have been more precise, but it would also have been precious. Therefore we can hardly criticize his phraseology.

[19] Clark's examples are of much wider scope and include *ex ante* with *ex post* more obviously than does mine. Of his, some (1, 2, and 3) are decisions as to what costs to incur; some (6 and 7) as to what costs to discontinue; some (3, again, and 9) as to what costs already incurred are to be charged off as losses; and some (5, 8 and 6 and 7 again) as to what costs are to be accumulated with the possibility (as always with accumulation) that they may ultimately have to be charged off as losses. His number 4 is the only one which concerns delimitation of costs. But that is for all purposes, not merely for some.

In making a decision between two alternatives (say shutting down *vs.* running) the costs may differ. There are occasions in economic life, as indicated below, when only the difference need

As a matter of fact marginal, or variable, costs constitute a particular assorted and partial aggregate of costs which may, upon certain occasions, be the only costs to be considered in arriving at a particular decision. Such occasions constitute, therefore, special cases of the foregoing. So far as I have observed, marginal costs may constitute the strategic factor to bankrupts, in process of being discharged from fixed costs: to 'entrepreneurs', owning their own plant, who have given up all idea of recovery on their investment and who therefore disregard fixed costs;[20] to the management, if they want to know how much they can earn to apply upon uncovered fixed costs, or as increased profit, by incurring a little extra (marginal) cost; [21] or to economists afflicted with diagrammitis.[22] But since marginal cost represents the whole cost only when the non-earning investment is, or is treated as, lost (no longer 'socially necessary') it is of little general interest either to empirical or to theoretical economics.

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It would appear that, if fixed costs, accumulated and current, are ever to become costs of product, and are never to be treated as not costs of the product upon which the corresponding factors are actually used, they must either be averaged over all product, whatever the rate of operation, or some more refined method of allocation must be devised by which those arising from each specific part or time of the plant are applied only

be considered. The concept of opportunity cost has treated these occasions as if they were universal; it has led, in effect, to the consideration of that difference only. It has blindly ruled out all costs common to both alternatives. But this makes a general rule out of an exception; and it assumes a free supply of economic energy of which only the direction of the application is supposed to be of concern to economics. In algebra one can cross out elements which appear identically on the two sides of an equation. But one cannot derive the equation without them, nor deny that they are elements. The notion that there is a difference between 'short-run' and 'long-run' costs, in any other sense than that the quantities of factors actually used may vary with the rate of operation, and with different techniques (capacity), seems to me almost as bad scientific thinking. A true cost of production, when it occurs, is an absolute and inescapable fact which economics should not gloze over.

[20] On the basis of this special institutional set-up, which was common at his time, Marshall (and his school) established a generalization which never applied to reality as a whole and now hardly applies at all.

[21] Probably the commonest form of pressure to increase production arises from the need to do so in order to cover contractual costs. Then only the difference between price and extra costs is considered. In other words there is no incentive to increased production, if it is foreseen that only extra costs will be covered.

[22] Diagrammitis is a neurosis which causes the patient to suffer illusions as to the meaning of diagrams. In this case the representation of the average and marginal cost curves is on a plane which is a cross section of time. The illusion consists in regarding the representation as historical, or as also historical, which it is not. All the costs contained within (subtended by) any part of the average curve are recurrent (continuous) costs for that rate of operation. If tomorrow one is to increase the rate, and thereby the area subtended, that does not mean that the recurrent (continuous) fixed costs of tomorrow have already been covered by the output of yesterday.

to the specific lots of product upon which that part or time is actually used. Adoption of the first method, which is used almost universally in business accounting, would result in the usual so-called average-cost method of allocation. That, then, would be the only cost per unit to be considered or determined. At least in those cases in which fixed costs are a large part of total costs, cost per unit would then probably always decline as rate of operation was increased up to capacity.

A possible alternative and more refined method is available and has been adopted in part by the public utility companies. This, too, was mentioned by J. M. Clark. It is based on the facts as to increasing rate of operation within the limit of capacity that were discussed earlier in this memorandum. The way it works out is more easily demonstrated when the increased rate of operation is accomplished along the first of the four dimensions mentioned — namely, duplicate lines of production or machines. Under this method the plant is divided into successive 'segments' depending on the rate of operation that is necessary to bring each into use. The whole of the fixed cost arising from each 'segment' over a year, or even a cycle, is then spread over its own output only, during the year or cycle. Thus in the daily, seasonal, and cyclical fluctuations of output the fixed costs of those 'segments' of the plant which are used always, even at the minimum rate of operation, are distributed over the largest output; those of the 'segments' used less often over less output; those of the 'segments' used only at the peaks are concentrated on a small occasional output; and the costs of any 'segments' never used cannot become costs of product at all. The last automatically become losses. As a result, each of these 'segments' of the total capacity, which is only added in turn as the rate of operation is increased, necessarily shows a higher fixed cost per unit of product than its predecessor. And this because, during the day or year or cycle, its fixed cost is spread over a smaller output. Such a method of allocation would work out in the opposite way from the average cost curve. Instead of a declining element of fixed cost per unit, as output increases, which the average curve inevitably shows, this method of allocation would show a rising element of fixed cost per unit from increment to increment, probably curving upward very steeply as capacity is neared.

This method would probably require an imputation of fixed cost to the whole plant and equipment regardless of how it was financed. To treat each 'segment' as giving rise partly to fixed (contractual) and partly to variable (if earned) cost would be too complicated; and to treat the most used 'segments' as giving rise to fixed and the less used ones to variable costs would be an unjustifiable discrimination. One cannot identify the kind of general financing with particular portions of the plant and equipment financed. Since this method would be applied, at least in part, to costs which are contractual or imputed liabilities whether the factors

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are used or not, but would not treat them as costs of product until or unless the factors were used, the costs of most 'segments' would have to be accumulated, some of them over a long period. As such, while actually fixed, they would be treated as variable costs in their allocation. So far as allocation was concerned there might be no fixed costs. Even those which run regardless of use and have to be accumulated would be regarded as, what they really are, the costs of making available, at all times, factors which are only needed for the higher rates of operation. This is the justification of the method, that the several successive 'segments' composing the whole capacity are only put to use — and therefore the costs of each only become costs of product — when the rate of operation includes each one in turn.

It is a little more difficult to make clear how this method would work in cases of changes of rate of operation along either of the time dimensions only. In practice, it is perhaps inapplicable in such cases. But for purposes of scientific analysis it might be useful there as well. When a plant operates only one shift a day, then two-thirds of its costs which run regardless of use would be accumulated. If the rate of operation were stepped up to two shifts, then one-half the then accumulated fixed costs plus one-third of the current fixed costs would be charged to the product of the second shift. Similarly with a third shift, which would bear the balance of the accumulated, plus one-third of the current. fixed costs. The same system could be applied as the rate of operations increased in number of days a week. The point that is confusing here is the difficulty of conceiving the analogue of 'segmentation' along the time dimensions. When the rate of operation is low, the surplus capacity may be left wholly unused. That takes the form of 'segmentation'. But when the changes take place only along the time dimensions. the result of low operation may be that the whole plant is used for a smaller part of the time. In the first case, during reduced operations, some of the plant is idle all of the time — the idleness being concentrated. In the second case, during reduced operations, all of the plant is idle part of the time — the idleness being distributed throughout. The existence of surplus capacity is obvious to the naked eye in the first case, and its costs are readily isolated from the rest. The existence of surplus capacity is not so obvious in the second case, and its costs can only be calculated. Nevertheless, so far as rate of operations in proportion to capacity is concerned, the two are exactly analogous. It is precisely as justifiable, in the usual situation, to allocate the accumulated costs of the unused time of the whole plant to that increment of output only which appears when the rate of operations requires full time operation, as it is to do so with a 'segment' which is not used at all except when the rate of operations approaches capacity. In fact, normally unneeded capacity along the time dimensions has no more warrant than that in the space dimension ('segmentation'), unless there

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are actual outputs the increments of which will entirely support the costs of making it available.

There are at least two situations in which the application of this method would be impossible or incorrect. Examination of them also permits a qualification of my rough generalization in regard to capacity and rate of operation — a qualification postponed to this point in order to kill two birds with one stone. But neither exception covers as wide a range as might at first appear. The first exception is this: In a *few* types of production certain of the conglomerate of factors required have to be provided in a fixed quantity regardless of the scale of output. Such, for instance, is the right of way and the single track of a railroad. That is not true, however, of any of the other major items of a railroad's plant. The number of other tracks, the size of yards, the size of stations, the amount and size of equipment are all determined by the capacity desired. Nor are there many other examples of the fixed quantity type. The length of a hydro-electric dam is fixed; but not its height or its flowage rights or the number and size of turbines. The second exception is this: In numerous instances plant and equipment must always remain idle a part of the time, not because they represent true excess capacity at a particular rate of operation, but because at certain times of the day, or of the week, or of the year there is no demand for the product and the product cannot be stored. This is true chiefly of service industries — retail stores, theatres, restaurants, hotels, skating rinks, 'bowls', etc. To a certain degree strictly specialized seasonal labor (e.g. baseball professionals) comes in this category. Since by reason of their nature these factors have to be provided all of the time but by reason of the nature of the product they can only be used part of the time, the costs of idle time must be accumulated and allocated to the product produced when in use. Strictly speaking there is excess capacity here, too. But it is unusable. Therefore, it is an inescapable burden upon intermittent demand.

I am not necessarily recommending this method of allocating fixed costs, but am merely using it to demonstrate that there is more than one possible and plausible way of doing so — among which this way, at least, treats them as variable (or marginal). At any rate it appears that before one attempts to measure the relation of costs to output in the 'short run', one must settle the question of the allocation of fixed costs. The assumptions either that they do not exist, or that they have somehow already been covered, or that they represent a total or partial loss, are neither safe nor sensible bases from which to start empirical analysis. In many cases, whether one finds declining or rising unit cost, as the rate of operation is increased, will depend entirely on how this question is settled; for, in modern industries, these fixed costs, if admitted, constitute so large an element of costs that their allocation one or the other way would

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blot out the effect of any changes in costs which are incurred only as factors are used — variable or marginal costs, in the usual sense.

It is necessary to note, however. that the problem of allocation is not limited to that of fixed costs. It extends as far as one makes it extend by the decision as to the delimitation of costs. Once admitted to that classification no cost can be ignored. If one follows the technical criterion, either a cost is allocated to product of which it seems to be a contributing cause, or it is charged off as a loss because it has not contributed to product. And this regardless of whether industrial managers have included or excluded it. That might suffice as a basis for the allocation of costs of production, strictly speaking. But it would not suffice for what we have called 'social charges' and 'social losses'. There the problem is not one of causation; for 'social charges' are arbitrarily imposed and consist, by definition, of the portion of such imposed costs which does not correspond to factors of production and therefore is not causative of product. And 'social losses' are, also by definition, consequences not causes of production. They are incidents — deductions from the value of product by reason of 'disservices' and 'discommodities'—and they fall elsewhere.[23] The question as to which specific batches of product should be chargeable with the individual costs in these categories is a most complex one. Nevertheless if they are included in the class. costs, this question is, at the same time, included in the problem.

VI

The study of the behavior of costs which are conceived to run only as the factors are used — the marginal or variable costs, in the usual sense — is also of interest for itself. In numerous instances they still represent the preponderant element. It would be worth while to determine whether, and if so when, there is any change in the proportioning of factors with increasing rate of operation within a given capacity. But this could only be discovered by studies of operation in terms of quantities of factors used per unit of product, not in terms of money costs, even deflated ones. It would also be worth while to determine, also in terms of quantities of factors used per unit of product, whether, for any other reason, there is anything in such a supposition as Mrs. Robinson's: "that in the short period marginal costs begin to rise at a fairly low level of output, as a result of the limitation [*sic*] of plant and organization, and in any case there must always be some level of output at which they begin to rise".[24] Finally, it would be worth while to learn, by comparing money costs with quantities of factors used as the rate of operation is increased. whether

[23] But where is often the question. Is a 'bad debt' a cost or a loss? If it is a cost, of what product is it a cost?

[24] *Economics of Imperfect Competition*, p. 50.

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and why this ratio increases or decreases. It might be found that such changes, if they occur, occur differently according as the rate of operation is increased along one or another of the dimensions described. Perhaps such changes would all be found to depend on special conditions or circumstances and to be subject to no generalization. When reducing operations one plant may retain men according to seniority while another retains the most efficient. Thus when the first increases operations it may re-employ more efficient workers, while the second employs less efficient. If a small increase of rate of operations is wanted, overtime pay may be required, while a larger increase may justify a night shift at regular (lower) pay. On the other hand, the money costs of night shifts may be higher on account of increased light and heat as well as from lower efficiency caused by dislike of night work. Floating labor, least often employed, is probably the least efficient. Yet it is usually the source of supply for labor when the rate of operation is stepped up to its higher ranges. Fear of the loss of jobs may increase efficiency; an active demand for labor may decrease it. For this and other reasons the pattern may be different in the several different phases of the business cycle.[25] Speeding up of operations, or the carelessness of prosperity, may increase the wastage of material; but full operation may make possible its more economical use. And so on.

However, if those costs which are institutionally incurred only as the factor is used are to be studied by themselves, all of them must be included, whether the study is in terms of factors used or in terms of money. If earnings on capital stock and surplus are not imputed as a fixed cost, then they must be included on some basis as a variable one. Variable taxes (income and excise) and variable depreciation (if any) must appear. Account must be taken of the increased working capital required to carry larger inventories and accounts receivable when output increases. This may be provided by short-term borrowed money and therefore form a contractual, though not a fixed, cost. Increased inventory requires increased insurance. Increased operations require more heat, light and power. Perhaps the overhead salaries include contractual bonuses for larger sales and output. Perhaps, with increased output, more salaried employees are required.

The exploration of all these variations is well worth while, and it is quite within the possibilities that there might be disclosed thereby regularities in the behavior of this portion of costs which neither the practicers nor the preachers have suspected. But the subject cannot be explored by studies of gross costs taken from the books of account; for these do not distinguish between (1) higher or lower prices of factors (incapable

25 Some cyclical regularities of this kind were suggested in W. C. Mitchell's earlier work on business cycles, published by the University of California Press in 1913, Part III of which has been reprinted under the title: *Business Cycles and Their Causes.*

of being deflated), (2) differences in efficiency of factors not due to change in rate of operation, and (3) differences, if any, in quantity (or efficiency) of factors used which are regularly associated with changes in rate of operation. And only the last are of interest in this connection. Furthermore the gross money costs may conceal more variations (rising or falling elements) than they expose. Variations in one direction at the price of factor level may offset variations in the opposite direction at the quantity of factor level, etc. Only intensive field work with a most refined technique of measurement is likely to yield results of sufficient solidity to establish new or amend old generalizations as to the relation of this particular, and sometimes minor, type of costs to output.

VII

In these remarks it is far from my purpose to discourage efforts to establish by empirical studies truly scientific generalizations as to the relations of costs to output, or, for that matter, as to the other relations of costs — to prices, to technique, and to the available natural resources. On the contrary, I consider this subject of costs to be perhaps the most potentially fruitful field that offers itself to real economic tillers of the soil. My only object is to call attention to the arduous job of clearing, draining, ploughing, harrowing and sowing that must be done before it is going to be worth while to bring out the reaper.