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Title	On the bases of separating fixed and variable costs
Sub Title	
Author	山口, 操(Yamaguchi, Misao)
Publisher	
Publication year	1965
Jtitle	Keio business review Vol.4, (1965.) ,p.57- 67
JaLC DOI	
Abstract	
Notes	
Genre	Journal Article
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AA00260481-19650000-03919640

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ON THE BASES OF SEPARATING FIXED AND VARIABLE COSTS

by

Misao Yamaguchi

1. The Theme of This Paper

In this paper we want to examine the bases of separating fixed and variable costs, used in three techniques of managerial accounting, namely variable budget, break-even analysis and direct costing, that appear to have been the major subjects of recent discussions. The characters of these three techniques in the scope of our problem may be summarized in brief as follows. Variable budget is used in the sphere of "department" or "responsibility center" aiming at cost control, especially with regard to the manufacturing overhead costs. Break-even analysis is applied to, so to speak, "profit center" such as factory, division, or enterprise "as a whole", to serve for short-range profit planning. Direct costing is employed samely for the purpose of short-range profit planning in the sphere of "segment" of total sales or "planning unit". As to variable budget the separation between fixed and variable costs requires to reveal the cost-volume relationship, while as for direct costing and break-even analysis the cost-volume-profit relationships must be made clear.*

It must be noticed, of course, to prevent misunderstanding that these definitions of characters are never conclusive ones. We fear the contrastings may have fallen into too much emphasis on particularities; we intend only to mention of their relative significance.

Here we shall examine what is concretely designated by the volume of activity, that makes the basis of separating fixed and variable costs. In this case we must question whether the concrete indexes of activity should be varied respectively with variable budget, break-even analysis and direct costing. Further it must be answered whether such indexes should be the production output, e.g., products, or the production input, e.g., labor hours or machine hours. Another related question is, either with output or input, whether

* This paper is the latter half part of the writer's article with the same title in the Mita Shogaku Kenkyu, vol. & no. 4. This paragraph summarizes conclusive findings in the former half.

they should be expressed in terms of dollar value or of physical units.

We assume in the following for simplicity's sake that costs can be devided into two parts; namely, fixed cost that remains unchanged independent of the volume of activity and variable cost that varies in direct proportion to the increase and decrease in the volume of activity, that is, proportional cost. This is an assumption of proportionality or linearity. To speak precisely, of course, there are other types of costs, such as progressive, degressive, and step cost. These costs, however, can be adjusted to linear moves if relevant range of operations is taken, and so we put aside these elements tentatively and assume the most simplified form of cost variability for our study.

2. *The Separation Bases in Variable Budget*

First we shall study the bases of separating fixed and variable costs with regard to variable budget. The cost to be separated here is the manufacturing overhead costs. And, the manufacturing overhead is such one that is "confined in terms of place", e.g., responsibility unit or responsibility center because the main purpose of variable budget is to control the manufacturing overhead costs in relation to someone's responsibility. Further it is also "confined in terms of time" with a costing period of one month. The object being such manufacturing overhead costs, the separation is intended to cast light upon cost-volume relationships purely for the aim of control and, therefore, from the standpoint of "standard" concept.

Thus, the activity indexes are determined by introducing the concept of "standard". Such "standard" concept has already been developed in connection with the direct materials and labor costs rather than with the manufacturing overhead costs under discussion. There, the standard has been seeked about how much the direct materials and labor costs should be to produce a unit of product or output. For that purpose, physical standards, namely standard materials quantity and standard labor hours, have been searched by scientific study, and then multiplying them by standard materials prices and labor rates, the standard cost input in terms of monetary value have been settled. The cost-volume relationships have been developed in the viewpoint of cost input reasonably necessary to produce an output, in other words, from the relation between monetary input and physical output.

The same idea, it seems, ought to be held also as to the manufacturing overhead costs. The idea of cost input reasonably necessary to produce an output appears to hold good also in this case. Regretfully, however, such input-output relationships are not clear about the manufacturing overhead costs. Rather, the "overhead" cost is so named just because such relations are indefinite, that is to say, cost input cannot be definitely identified to output.

However, such expression is not always conforming to the fact. To observe exactly it will be found rather unsquare. For, there are two major sorts of manufacturing overhead costs, namely overhead costs in production departments and those of service departments. As to production departments

the above expression may be appropriate. A cost is made overhead because it cannot be traced to any one output directly. But, this is not necessarily true as to service departments. The manufacturing overhead costs here are made overhead because they are incurred in service departments. But in relation to the output of service departments, it is not always right to say they cannot be clearly traced to output. The overhead costs in service departments can also be divided, in relation to the output of the service departments, into direct and indirect ones. As to the former the identification is possible as direct materials and labor costs in production departments already referred to. Only as for the latter direct relation with output cannot be recognized, again because it is indirect cost.

Although not without exception as has been just mentioned, with regard to the manufacturing overhead costs in general the input-output relationship cannot be ascertained, that is to say, the cost input per unit of output is difficult to determine.

Another factor causing a hardship to the standard setting of manufacturing overhead cost input per output unit is the existence of the fixed cost therein. The problem of separating fixed and variable costs is raised by the existence of two components, fixed and variable, of overhead costs, right by which the standard input of overhead cost per output unit becomes difficult to settle. An attempt to establish the input-output relationship by allocating the fixed component to each output unit will result in different average fixed costs per output unit according to the level of allocation basis, and so consistent determination of the standard input of manufacturing overhead cost per output unit is impossible. Such standard of overhead cost will be too loose when the volume of activity is large, and too tight when it is small. Conversely, of course, as the overhead cost involves variable element too, under a fixed budget that has fixed allowances of costs regardless of the activity level, the standard will be too tight or too loose according to the level of activity actually reached.

It may be well in theory that the particular, direct and functional cause-and-effect relationship of the manufacturing cost input with regard to each particular unit of output can be measured by marginal analysis. Actually, however, such measurement is extremely hard to make, and the calculation may be economically intolerable. So, such grasp ought to be abandoned.

Certainly, for these reasons, as regards the manufacturing overhead costs it might be impossible to determine the standard cost input reasonably necessary to produce an output. However, if the relation is to be grasped not with the cost input per output 'unit' but with the 'total' cost input for a 'total' output by a given responsibility unit in a given period, there exists doubtlessly some cause-and-effect relation as a matter of aggregate conformity. Provided such relation exists at least, we could say the standard cost input can be settled in such aggregate connection.

Thus, in variable budget the total input of standard manufacturing costs is to be determined in connection with the total output in a given period by each responsibility unit. It follows from this that the separation between

fixed and variable costs must be made taking output as the activity index.

But, though output is to be adopted for the basis of separation, it is a question whether adequate index of output is available. Where the production output of a responsibility unit is homogeneous, or, to speak of the most extreme case, where the output is of a single sort with the same specification, quality or style, the total output for one period is easy to compute. Total production output can be readily grasped with physical measures such as weight, volume, length or piece number. Here the physical measure of physical output is obtainable. Such physical output is the best index to explain the relation with cost input, conforming to the underlying concept of standard cost.[1)]

However, it is only rare case that the output of a responsibility unit is composed purely of a single sort of goods or services. So, we can next suppose a case where the output is of one sort but involves some differences of weight, quality or style. In such case simple addition by physical measure is impossible, but it may be possibly attempted to choose a sort of output as standard and into this physically to convert others with some slight differences, that is to say, to convert with "conversion rate" or "equivalent coefficient" assigned to each sort of output, in order to grasp the total volume of output.

Such physical conversion, however, is not always possible. Often the output of a responsibility unit is qualitatively so varied that inter-output conversion is unable. Then, instead of physical conversion, conversion by monetary value, being a more unitary measure, must be relied upon. That is to settle conversion coefficients in terms of monetary value. But, again here is undeniably another hardship.

Especially it is to be noticed with conversion, either physical or monetary, that the coefficient must be such one in which the relative ratio of necessary cost input is reflected. If, for example, an output requires a cost input 1.2 times larger than the standard one, such ratio must be reflected in the coefficient either physical or monetary. A coefficient simply based on the ratio in weight or market price does not conform to the purpose here.

Though output is desirable for the basis of separating fixed and variable costs, however, in some cases the measurement of output may be actually impossible. Furthermore, if monetary output is taken in place of physical output, such monetary standard will be more inadequate for the control purposes in production fields than physical one. In other words, even if some sense of cause-and-effect relation is recognizable between outputs and manufacturing overhead costs in the aggregate, such relation may be insufficient to utilize for direct and separate control of the overhead costs. The cost control in production fields is desirable to be founded on the standard physical 'input' such as standard materials quantity or direct labor hours, as is observed in the control of direct materials and labor costs. If output is adopted for the standard of control, even in case of physical output, it will be less convenient for physical control; still less monetary output can hardly be called a criterion

1) Shillinglaw, Gordon; "Cost Accounting: Analysis and Control", 1961, p. 226.

easily available for physical control.

For the control of direct materials and labor costs, it is true that the standard inputs of direct materials and labor are settled with respect to the unit of output. But once such standard input-output relationship is determined, the control is performed on the base of such physical input; that is, by converting output into input by "standard" rate. So, although similarly in the case of standard manufacturing overhead costs output is to be taken for the base, a question is whether output can be replaced by physical input near at hand that has, or can have, obvious relation with the manufacturing overhead costs.

Furthermore, where output is of heterogeneous nature, it is actually accompanied by substantial difficulty to draw a total volume or amount of output by means of conversion with physical or monetary coefficient. Rather, in such case, a more adequate index of activity might be obtained by finding physical input of more homogeneous nature, such as labor hours or machine hours, even if the output itself is heterogeneous.

Then, we must go into the study of input as the basis of separation.

A matter requiring utmost carefulness in replacing output with input is the pattern of variation of the manufacturing overhead costs. In the case of direct materials or labor cost, it may be reasonable to select direct materials quantity or direct labor hours respectively for the physical input base. But in the case of manufacturing overhead costs it is somewhat questionable that a single physical input index can be adequately selected for the separation basis, since within the overhead costs are involved indirect materials cost, indirect labor cost and others. In other words, there may be various cost elements involved, possibly some in direct cause-and-effect relation with labor hour input, some with materials input, and others with monetary input. So, in order to find the cost variability precisely, physical or monetary input index in the most direct relation to cost variability must be selected with respect to each particular item of the manufacturing overhead costs, or to each group of cost items that have similar causality and so relatively homogeneous functional relationship, and hence can be put under control of a same line.

In this context the physical or monetary input to be selected for the basis must be provided with the character of "norm" or "standard" in order to serve for controlling cost input. In other words, such physical or monetary input must have in itself a definite relation with output. The fundamental idea is the standard cost input reasonably necessary to produce an output. Replacing an output with physical or dollar input is made depending on such standard input-output ratio. Only when input has such connection with output, it can be the measure to control cost input. Here the cost-volume relationship presents itself as the relationship of cost input—physical or dollar input—output. And, through this process, if the output of a responsibility unit for a period is heterogeneous, a homogenization of output by physical or dollar input is effected at the same time.

Theoretically reasonable as it may be to set physical or dollar input measure with respect to each cost item or group of cost items, and efforts should

be so made, often it is unexpectable in practice to set plural input bases with regard to various items of overhead costs of one responsibility unit for one period, due to the complexity of, or for the economization and speediness of calculation.

Then, another possible way is to set a single input index for each responsibility unit. The most popular one of such index is, for example, direct labor hours or machine hours. In order to rely upon such single index, a question may arise how plural input measures can be converted into a single measure. However, such conversion between plural measures may be possible, utilizing their respective standard ratios relative to some common output. The conversion and replacement may be faced with considerable difficulty in actuals, but the recognition of such object of effort is essential.

Although the above observation is appropriate as to the manufacturing overhead costs in the production department and those in the service department which are indirect costs for the output of that department, some care is necessary as to such overhead costs that make direct costs for the output of the service department. Such direct costs may be controllable by output, similarly with the case of control of direct materials and labor in relation to the output of the production department. In short, the direct cost input in the service department is controllable on the basis of the output of that department.

Obviously such output of the service department has a functional relation with the output of the production department. Hence, provided the output volume itself of the service department ought to be controlled, such control should be made with regard to the production department which consumes such output, rather than with the service department producing such output. What is to be controlled in service department is the ratio of cost input as against the service output. Such output of service changes itself into input in the receiving department, and hence its volume itself is to be evaluated in the context of the output of the receiving department.

3. The Separation Bases in Break-Even Analysis

Next, we shall consider the bases of separating fixed and variable costs in break-even analysis.

Break-even analysis seeks to clarify the structure of profit, namely the cost-volume-profit relationships, with respect to so-called "profit center", such as factory, division, or enterprise as a whole.

A particularity here as compared with the case of variable budget is that not the relationship of cost to volume but that of cost and profit to volume must be made clear. It may be said that output is reasonable to take for the basis of separating costs here. For, in order to deal with profit, revenue, one determinant of profit, is determined by output or sales of output rather than by input.

Taking output for the activity index, an accompanying problem is how it should be designated, whether in physical or in monetary term. Of course where output is of homogeneous nature and hence relatively easy to designate

physically, physical output can be selected for the index. Generally, however, the output may be heterogeneous, and consequently for a unitary measurement a composite index by monetary designation, namely the basis of monetary output, may usually be employed.

Even when physical output can be taken for the activity index, so long as the break-even analysis concerns monetary values of profit, physical output must be converted into dollar output, and a supposition of sales price per output unit is necessary. In other words, output in monetary value must be indispensably taken into consideration. This makes another particularity as compared with the case of variable budget, though similarly output is adopted.

A most important problem regarding the case of break-even analysis is whether the separation of costs should be made by one-stroke separation with respect to the whole sphere or 'profit center', or by compiling up the results of separation executed individually in the subdivisions thereof.

To consider break-even analysis in connection with variable budget, since the separation between fixed and variable costs is being performed in each responsibility unit in variable budget, the compiling-up method utilizing the results may be practicable in break-even analysis. In this regard, however, cases are not the same according to the costing system employed, whether full costing or direct costing.

Where full costing is employed, cumulative transfer of fixed cost to variable cost possibly proceeds through the process of cost allocation to departments or products. There, variable cost is presented too large, and fixed cost too small. To obtain appropriate amounts of fixed and variable costs, the separation must be executed anew succesively tracing back to preceding departments.

Direct costing does not present such phenomenon. After the separation is made of fixed and variable costs in a responsibility unit or department, variable cost is charged to departments or products through allocation process while fixed cost is always excluded from such procedures and shown as a total amount. The total variable cost is shown as that of the final production department, only when all the output for sales is produced in this department.

For the purpose of break-even analysis, however, it is doubtful whether such pile-up of each particular fixed and variable costs is necessary, the costing system being either full or direct costing. Especially in the case of full costing, such separation tracing back to departments seems almost impossible. In substance break-even analysis depends upon various assumptions and is able to provide merely rough, broad figures of the profit structure of a profit center. So it is not necessary to work out anew laborious, time-taking detailed separation of costs. Instead, it is sufficient, being not worried by such backwardly successive works of separation, to separate total expenses covering the profit center where the analysis is applied into fixed and variable costs by one stroke. Even by this simple method the intention of break-even analysis will be well attained.

The compiling-up computation of individual fixed and variable costs for grasping total fixed and variable costs is difficult not solely for the reason

that it requires labor and time, especially as to full costing. Either in the case of full or direct costing, a problem of the unitary basis of separation may arise. In order to obtain the total by compiling up individual costs, the measure for separation in individual case and that in the whole must be entirely the same, or functional relationship between both must be firmly established. Provided, to speak generally, the separation in break-even analysis is made on the basis of monetarily-valued final output, the separation index to be used in particular phase must have close connection with the former. Suppose, for example, in boiler room the consumption of electric power by bucket conveyer for coaling stands in correlation with the volume of coaling, the volume of coaling with the volume of steam generating, and the volume of steam generating with the volume of rayon wool output in production department. The separation between fixed and variable costs at the phase of boiler room can have few relation with the separation at the whole profit center where break-even analysis is applied, unless such functional relationships are ascertained that a variation of one unit of rayon wool output would bring about what a change in the steam volume; the similar relation between the steam volume and the coaling volume, and the coaling volume and the electric power consumption by bucket conveyer. For the purpose of the cost control by variable budget at the boiler room it is these physical relations that must be obviously recognized, and in the light of "standard" physical relationships the cost efficiency is able to be criticized. For the purpose of break-even analysis, however, the recognition of such functional relationships must not be confined merely to a narrow segment, but be extended to the wide whole profit center. Doubtlessly the grasp of functional relationships between outputs and inputs throughout all phases of profit center is very difficult. Also for this reason, one-stroke separation with respect to total cost is to be considered.

Another point to be observed about the separation basis used in break-even analysis is, when the basis is monetary output, which is to be adopted, either the sales amount to be obtained by multiplying the sales volume of output by unit price, or the sales value of production to be obtained by multiplying production volume of output by unit price. The former may appear appropriate at a glance since, for break-even analysis, it is profit obtained from the sales of output that is primarily concerned. However, some care is necessary. When the sales amount is taken for the basis, and the costs which are matched with that sales revenue are charged off in the process of income determination, these costs are dealt for the most part as if they are variable costs. Especially cost of goods sold, which is first matched with the revenue in this income determination, is computed as though it is entirely a variable cost rightly proportionate to sales amount. But here is presented variable cost too large. Here is not reflected the true cost variability. A clear distinction should be made between the incurring of cost in production and sales activity and its charging off as the 'expenses' in the process of income measurement. The matter in question is not how expenses change with changes in sales volume. The primary aim is to explain the changes in costs following those in production and sales volume and to analize the effects that the cost

changes exert upon profit in the end. Then, a question follows how the fixed and variable manufacturing costs based on production volume and the fixed and variable selling costs based on sales volume are adjusted for a "common" measure.

The most simple way of this adjustment is to assume that products are instantly sold, and execute additions of fixed and variable, manufacturing and selling costs respectively. Such assumption may be applicable to those industries that cannot stock their products or services, for instance, electric power, transportation or other service businesses. But, to speak generally it is difficult to hold. Then, it may be replaced by another assumption that volumes of production and sales are equal, that is to say, finished goods inventories are always constant. This is just the assumption generally accepted for break-even analysis. However, in order to grasp an exact amount of profit by the analysis standing on such assumption, the average full cost, consisting of variable cost and allocated fixed cost, must be unchanged between the current and previous periods. Precisely a usual break-even analysis is unable to present the exact amount of profit, unless adjustments are made for the changes in that part of fixed and variable costs that are carried over to the next period as inventoried cost and for the overabsorbed or underabsorbed fixed cost.

The problem is the same also with the case of direct costing. But, there only the variable manufacturing cost is to be considered, without taking into account the amounts of fixed cost to be inventoried or of overabsorbed or underabsorbed fixed cost. As the time-lag between production and sales naturally exists here strictly speaking, even on the assumption that production volume equals sales volume, the rate of variable cost must be equal between periods, in order that the exact profit amount in direct costing is obtainable by way of break-even analysis.

4. The Separation Bases in Direct Costing

Lastly we must examine the separation bases with respect to direct costing.

Direct costing is intended to compute cost with respect to the so-called "segments", such as product lines, sales territories or classes of customers and so on, and to clarify the cost-volume-profit relationships therein. The computation is made separating fixed and variable costs, centering on variable profit or marginal profit, relying upon the idea of marginal theory and assuming a short period with unchanged operating capacity.

In direct costing the basis of separation must be the final output salable, because the sum-up of costs is actually made as to the products or output of the "segment", and secondly also here profit and hence the relation between sales revenue and matching costs are concerned. When the computation is made by product lines or the like the output for the purpose may be physical output, or monetary output to be obtained by multiplying physical output by its unit price. When it is operated on such segment that contains the changes in product mix, e.g. sales territories or customer classes, physical

output is employed to take them into account, but provided the product mix is constant monetary output is usable.

A problem concerning the separation basis for direct costing is how the practical procedure should be to grasp the cost variation. Here it is intended to clarify how the variations of costs and ultimately profit are to be caused by an increase and decrease of one unit in the production and sales volume of a product. One unit change in the production and sales volume of a product is to work effect on the costs of every department of a firm directly or indirectly. The aim of direct costing lies in grasping such variation of costs. In contrast to the rough, outline computation by break-even analysis, direct costing, for the very reason of being a costing, has to trace in detail the successive transfer processes of costs, beginning from their incurring to the ultimate products.

Then, the stage must be made clear where the separation of fixed and variable costs is performed. It is generally accepted that cost accounting is performed through three stages, that is, by elements, by departments, and by products. The recognition itself of such three stages might be possibly misleading. For, truely cost accounting is performed through these three stages as a matter of procedure, but in the actual with the incurring of a cost simultaneously the items of cost, the places where it incurs and the relation to output are determinable. Hence, for some costs easily attributable to output, e.g. direct materials cost, departmental costing can be often omitted. The problem lies in such cost item that has no definite relation with output, in other words, that has mere indirect relation with output. For an attempt to separate such cost into fixed and variable components, it must be a cost being confined with regard to time and place. As to time, it must be confined generally by the costing period. As to place, it must be restricted by cost department. A cost incurred in a given cost department in a given costing period is separated in relation to the output of that cost department in that costing period. In other words, the aggregate relation between costs and outputs is grasped with respect to a given department and period. To take up a cost item and separate it into fixed and variable components at the stage of costing by elements might be possible as regards direct cost, because the relation to output is obvious, but in general it is to be logically impossible with other cost items that must be separated. The costs to be separated could not be made definite, unless qualifications are put upon costs with regard to both cost department and costing period. To suppose that such separation is possible at the stage of elementary costing is based on an implicit and unconscious definitions of time and place, and hence that of the relation to output. Explicitly separation becomes possible first at the stage of departmental costing. By the stage of departmental costing, conditions for separation may be fulfiled by grasping variations of cost in relation with output.

For these reasons, in the case of direct costing it seems reasonable to make separation at the stage of departmental costing. Such cost separation at departmental costing may have a benefit that possibly it can be common with the cost separation in variable budget. Naturally some difference may

be lying between the two, because the cost variability in direct costing is based on final output while in variable budget it is based on departmental output. However, the commonness is possible because, for direct costing, the relationship of final output to intermediate or departmental outputs must be definitely grasped. In direct costing, such fixed and variable costs grasped on the bases of intermediate, namely semimanufactured and service outputs are successively transferred to the fixed and variable costs of final outputs. Hence, the convertibility between these outputs are absolutely indispensable, which could be overlooked as for break-even analysis. Functional relationships of semimanufactured and service outputs to final outputs must be determinable for direct costing.

As observed above, in direct costing the separation into fixed and variable costs is made on the basis of output with regard to the segment where the marginal profit is put on consideration. Such marginal profit is one per unit of physical output, or in relation to monetarily valued output. Yet the marginal profit is not always concerned with output. In some cases the marginal profit per input unit is calculated; for example, per unit of materials input or labor hours input. This is generally called the effective marginal profit. As has been already stated, direct costing is supposed to be a costing for, among other things, planning. In a planning process, bottleneck parts or restraint conditions must be first considered. When shortages of materials, labor or manufacturing equipment are making bottlenecks, the choice among product lines becomes naturally essential so that the largest marginal profit may be obtained per units of materials, labor or equipment. Such is the case where input must be introduced in direct costing. Of course, here again "standard" input-output relationship must be prescribed. The relationship must clarify how much profit will be born per input unit on the supposition of standard operating conditions and efficiency. But in conclusion such marginal profit per input unit is nothing but another expression of the marginal profit per output unit.

5. *Additional Remarks*

We have examined in this article the bases of separating fixed and variable costs with respect to three management accounting techniques including variable budget, break-even analysis and direct costing. On each of these techniques there remains many problems requiring each independent study. Various detail points are needing more preciseness and development as particulars.