11-10-1975

Traceability, Corrigibility, and Sterilization of Managerial Accounting Allocations

Arthur L. Thomas

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TRACEABILITY, CORRIGIBILITY, AND STERILIZATION OF
MANAGERIAL-ACCOUNTING:
SOME TENATATIVE CONCLUSIONS

by
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McMaster University, Canada
November 10, 1975

[Introductory note: Arthur L. Thomas received a BA in philosophy from Cornell University and an MBA and PhD in accounting from Cornell University and the University of Michigan, respectively. He is the author of four books and numerous articles on accounting topics. One of the two books from which this paper stems was honored by the AICPA as a notable contribution to the accounting literature.

A New York State CPA, Ontario CA, and Fellow in Accounting Researchers International Association, he is a Professor of Accounting at McMaster University in Canada and a member of the editorial board of Abacus.

In Dr. Thomas' lecture, he will discuss allocations in accounting, which he feels are ubiquitous. Financial accounting's allocations generally suffer from a logical defect of incorrigibility that renders them arbitrary. Those of managerial accounting fall into two classes:

1. Aggregations of two or more costs to single cost objects. Whenever each cost is traceable to one (and only one) cost object, these allocations are legitimate and create no theoretical difficulties.
2. Allocations of individual costs to two or more cost objects. These are usually incorrigible and illegitimate. Although such allocations can sometimes be rendered harmless by a process designated as sterilization, managerial accountants should cease perpetrating them.

The lecture will conclude with a survey of possible explanations for the popularity of such arbitrary managerial allocations in practice.]

To be able to explain a variety of phenomena consistently by a simple theory is what we struggle to attain in theory construction. (1)

I plan to describe a few central themes of a research project begun early last summer but unlikely to reach completion before 1977. As the title indicates, my remarks will be tentative. I emphasize this because although my role will be to sound positive, it's almost certain that some of these remarks will prove, in hindsight, to have been mistaken or, at least, misleading.

Your role, if you will be so gracious, is to raise objections -- yet to be forgiving if I temporarily persist in what may seem to be folly. Stanislavsky, the famous director, maintained that to act well one must first suffer. Similarly, to theorize well one usually must first err.

Throughout what follows, I'll use relatively simple, deterministic models. For these illustrate the
principles to be discussed quite as well as complex, probabilistic models would, while saving time. As far as I can tell, relaxing these simplifications would not affect the conclusions that we'll reach -- though, of course, you're invited to question this, too. (2)

In a recent article that summarizes research done for the American Accounting Association, (3) I claim that defense of allocations made in financial accounting depends on one's being able to calculate the contributions individual inputs make to the firm's productive processes, that such calculations inevitably are incorrigible, and that therefore financial accounting's allocations are incorrigible, too. The technical term *incorrigible* is one used by logicians, and here signifies that these calculations and allocations can neither be verified nor refuted and that, in consequence, any one is just as good as any other.

These calculations and allocations are incorrigible because most business inputs *interact* -- that's to say, they generate more output working together than they would separately. It can be demonstrated that in the presence of interaction any attempts to isolate portions of output as contributions of individual inputs are as meaningless as attempts, say, to attribute portions of an athlete's success to his or her individual organs: legs, lungs, etc. The article illustrated these claims by describing a process of manufacturing sourdough bread.

Anthony replied to a preliminary draft of this article as follows:

I must agree with you that if the problem is to "specify the individual contributions of the inputs," then it is an incorrigible problem. If, however, one considers a different, but nevertheless important, problem, then it is possible to make some reasonable statements about how to allocate costs, statements that certainly are better than the assertion that one calculation is just as good as any other.

This problem is that of measuring the cost of a cost objective. In this problem, cost measures the amount of resources used for the cost objective. The resources themselves are physical quantities -- for example, ounces of flour, hours of labor services, and equipment used in making the sourdough bread. Cost measures these amounts in monetary terms so that they can be aggregated. The governing concept -- which I think is a practical, defensible concept -- is that the full cost of a cost objective is the sum of its direct costs plus an equitable share of costs that are common to two or more cost objectives.

With this concept we can measure quite closely the cost of the materials and the labor, and we can measure approximately the cost of the equipment that is applicable to one loaf of bread. If our purpose is to measure cost so that each customer will pay an equitable amount for the loaf of bread that he buys, no reasonable person would argue that the customer who buys the first loaf should pay the total cost of the equipment, while the customer who buys the second loaf should pay nothing for the equipment used to make it. There could, of course, be arguments about the appropriate amount of depreciation, but it could not be said that each calculation is as good as any other. (4)

This evening, I'll try to reply to these comments by Anthony and clarify the circumstances in which allocations of costs to cost objectives are theoretically legitimate, and explore characteristics that render certain illegitimate managerial-accounting allocations preferable to others. During the latter discussion I'll expand a concept of *sterilized* allocations, introduced in earlier research, and will explore the issue of allocations' corrigibility in more detail than was possible in the article cited. Finally, though it wasn't written as such, this paper serves as a reply to Anthony's recent article on cost allocation. (4a)

**ALLOCATIONS OF TRACEABLE COSTS**

In this section I'll argue that whenever an input is traceable to an output allocation of its cost to that output's cost is legitimate and corrigible. Unfortunately demonstrating this requires introducing a few
Productive Relationships

Let's begin by defining a *productive relationship*, \( Y = g(Z_1, Z_2, \ldots Z_k, \ldots Z_m) \), between a particular output, \( Y \), and a set of inputs, \( Z_1, Z_2, \ldots Z_k, \ldots Z_m \), as one in which the output would have been physically different (in quantity or kind) had any of these inputs not been available to the production process that generated it -- in short, a productive relationship is what a lay person would call a cause-effect relationship. The detection such differences requires two things that, for brevity, will be assumed (since these assumptions don't affect the analysis): first, standards of what characteristics the output, \( Y \), should possess to *be* \( Y \), and second, standards of materiality, for deciding what differences are significant.

Traceability to Different Levels

All of a firm's costs are traceable either to waste or to its outputs at some level of activity aggregation. This can be seen by beginning at a high level of aggregation, then entertaining progressively more and more detail. The following discussion, which assumes that the firm is a manufacturer, is organized in the manner of a flowchart.

*Level 1* Productive or waste. First, we might ask of any cost that the firm has incurred during its lifetime to date: Is there a productive relationship between the related input and any of the firm's lifetime-to-date administrative, selling, or factory outputs?

*Yes*: The cost is *traceable* to the firm's total lifetime-to-date outputs.

*No*: (That's to say, these outputs would have been what they were without the firm's incurring these costs): These costs should be classified as waste.

*Level 2* Year. If *Yes*, is there a productive relationship between the related input and the firm's outputs in any one (and only one) year?

*Yes*: The cost is traceable to the firm's total outputs during that particular year.

*No*: The cost isn't traceable to this level.

*Level 3* Administrative, selling, or factory. If *Yes*, is there a productive relationship between the related input and any one (but only one) of the three types of output (administrative, selling, or factory)?

*Yes*: The cost is traceable to that particular kind of output during that particular year.

*No*: The cost isn't traceable to this level.

*Level 4* Responsibility center. If *Yes*, is there a productive relationship between the related input and one (and only one) department's (or other cost, profit, or investment center's) production of that particular kind of output during that particular year?

*Yes*: The cost is traceable to that responsibility center's total output during that year.

*No*: The cost isn't traceable to this level.

*Level 5* Specific product or other output. If *Yes*, does the center produce only one output of the kind in question? Or, if not, is there a productive relationship between the related input and one (but only one) output of the kind in question?

*Yes*: The cost is traceable to that specific output of that center during the particular year.

*No*: The cost isn't traceable to this level.

*Level 6* Unit of output. If *Yes*, is there a productive relationship between the related input and some one (and only one) unit of that specific output?

*Yes*: The cost is traceable to that particular unit.

*No*: The cost isn't traceable to this level.
Please note that an input's cost often will be traceable to two or more levels of activity aggregation -- for these levels tend to assume a hierarchy.

**Waste and Side Effects**

In practice, of course, accountants allocate to output various costs that they should have assigned to waste, and misclassify as waste other costs whose inputs do enter productive relationships. But such misclassifications, the fruits of error, management's reluctance to admit inefficiencies, and practical needs to minimize accounting costs, don't affect the basic theoretical issues to be considered, and will be disregarded henceforth.

Similarly, one can argue on theoretical grounds that some waste is an inevitable concomitant of production and that, therefore, some waste should be allocated to any output. Here, there's a bona fide allocation problem (that accountants try to solve intuitively). Again, I'll disregard it in subsequent discussion because it only rarely has substantial impact on accountants' calculations. (5)

Finally, when asking whether an input affects one and only one year, type of output, responsibility center, specific output, or unit of output, I'll respect accountants' customary materiality rule and ignore minor, byproduct productive relationships. For example, if a firm conducts a process that requires a minimum ambient temperature, its labor input may slightly reduce its power consumption, since the workers supply bodily heat. But we'll disregard such side effects.

**The Corrigibility of Allocations of Traceable Costs**

Whenever the cost of one or more units of a particular input is traceable to output at one of the levels of activity aggregation just described, at that level the allocation of that cost to output is corrigible. The simplest reason why this is so is that the allocation can be verified by simple, unequivocal counting: the units were devoted to the particular activity, and their cost is known.

We may distinguish two kinds of allocations: physical distributions of resources (with which, for instance, economists are concerned) and notional assignments of costs and revenues (with which financial accounts are concerned). In allocation traceable costs to output, managerial accountants simply assign them in ways consistent with the physical distributions of the related inputs. Doing so seems to offer scarcely any more theoretical difficulties than does preparing net-quick-assets funds statements -- which, similarly, merely require counting physical distributions of cash and near-cash. In both cases the association of dollar values with what's physically distributed seems automatic.

To be sure noncash traceable costs can provide a few allocation ambiguities. For example, there are situations where labor costs of a particular batch of product are influenced by other output (or lack of it) and consequent availability (or lack of availability) of different grades of labor, necessity (or lack of necessity) to use high-seniority (high-pay and/or high-efficiency) employees, etc. But, once again, these ambiguities will rarely be so material that they need concern us.

Nonetheless, physical distributions of inputs and notional assignments of their costs are different things. With traceable costs, the physical distribution is unambiguous. But why don't financial accounting's incorrigibility problems arise for the cost allocations? Here are two reasons: (6)

1. Any allocation of the input's cost to an output to which it isn't traceable can be refuted on the simple grounds that there's no productive relationship between the input and that output -- refuted in exactly the same way that, if I give my son a slice of bread, I can immediately confute any suggestion that the bread's cost forms part of the costs of feeding the Prime Minister of New Zealand. By multiple eliminations, allocation of the input's cost to the one output with which it does have a productive relationship is the only disposition to make of that cost that can't be refuted.
2. Financial accounting's incorrigibility problems arise from its attempts to allocate single figures for total lifetime-to-date revenues (or cashflows) first to individual years then to multiple inputs within each year. Such allocations are just as irremediably arbitrary as managerial accounting's joint-cost allocations (which attempt to attribute single cost figures individually to multiple outputs). With traceable costs, we reverse things and allocate from many to one instead of from one to many. This reversal automatically eliminates the factor that makes financial-accounting and joint-cost allocations incorrigible. Indeed, one ordinarily would describe what's done with traceable costs as cost *aggregation*, not allocation. Illustration 1 diagrams the difference between these two situations.

**Illustration 1**

<table>
<thead>
<tr>
<th>Incorrigible and Corrigible Allocations Contrasted</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-to-Many Allocations (Incorrigible)</td>
</tr>
<tr>
<td>Joint-cost Allocations</td>
</tr>
<tr>
<td><img src="image1" alt="Diagram" /></td>
</tr>
<tr>
<td>Financial-Allocation Allocations</td>
</tr>
<tr>
<td><img src="image2" alt="Diagram" /></td>
</tr>
</tbody>
</table>

| Many-to-One Allocations (Corrigible)          |
| Traceable-Cost Allocations                   |
| ![Diagram](image3)                           |

**Allocations of Untraceable Costs**

Incorrigibility becomes a potential problem in managerial accounting whenever an input *isn't* traceable to one and only one output, yet management or institutional considerations force allocation of its cost. There are two main ways in which an input may not be traceable:

1. For convenience, and to minimize accounting expense, managerial accountants don't bother to trace certain overhead costs that, in theory, they could trace to individual outputs. For example, often they can calculate with high precision the cost of electricity used in manufacturing a particular batch of product. Under process costing, managerial accountants often will allocate this cost to the product; under job-order costing, they're apt instead to lump electricity costs with other overheads -- that's to say, not try to trace them. In the latter instance we once again see accountants invoking a form of materiality rule.

   We may perceive applications of such overheads proportionate to direct labor hours worked
(or some other index of activity) as a *surrogate* for corrigible, traceable allocations: as attempts to trace in an aggregated, statistical way costs whose tracing would otherwise be impractical. Following this logic, overhead allocations are illegitimate when accountants use the same index to apply other costs that theory indicates are *untraceable* -- for instance, to apply fixed overheads to individual units of product.(8)

2. The input is joint on two or more outputs at a particular level of activity aggregation. Here, All the familiar dilemmas of joint-cost allocation arise. We accountants tend to picture joint-cost problems as occurring at Level 5 (Specific product or other output): as problems of allocating costs of a single manufacturing process to its multiple products. Yet, identical problems arise whenever we try to:

*Level 2 Year:* Allocate costs common to two or more years (such as the depreciable base of a depreciable asset) to individual years,

*Level 3 Administrative, selling, or factory:* Allocate costs common to administration, selling, and manufacturing (such as certain head-office expenses) to these individual activities.

*Level 4 Responsibility center:* Allocate costs common to several responsibility centers (such as those of building occupancy) to individual responsibility centers, or

*Level 6 Unit of output:* Allocate costs common to a batch of product (such as set-up costs) to individual units of that product.

Horngren suggests that accountants make such allocations for three main reasons: pricing, income determination, and inventory valuation.(9) The latter two are really financial accounting issues, and I've dealt with them elsewhere. To pricing, I shall add one related concern: whether or not to produce the product at all.

**Decisions That Don't Require Allocations of Untraceable Costs**

Let's begin by examining a situation in which allocations of untraceable costs are clearly unnecessary and illegitimate. A group of investors is considering organizing a firm to manufacture and sell a particular product, x, for t years, then either liquidate this firm or sell it to others. For simplicity, at first I'll disregard taxes and waste, and assume stable input prices and that the investors are profit maximizers. Also, I'll disregard uncertainty -- *not* because uncertainty is unimportant, but because I wish to explore other, even more fundamental, issues.

The project requires an initial investment of I. The investors expect variable costs per unit of output to be v, and each year's fixed outlays (exclusive of any amortization of I) to be fn (n = 1, ..., t). The investors also envision some profit maximizing strategy for marketing product x. This might involve selling all units at the same price, p, or it might happen that profit maximization requires selling different units, i, at different prices, Pi.(10)

Under either assumption the investors expect to sell some total number of units of product, un, during each year of the project's life. Of course, the u's and p's are ultimately functions of the estimated demand characteristics of the product and would be calculated without reference to any accounting allocations.

The investors won't undertake this project unless they expect to obtain some minimum rate of return, r, on their investment. Assuming a constant price for the product and that they anticipate a scrap value of S from liquidating or selling the firm at the end of year, t, the investors will undertake this project if and only if its net present value, \( NPV_x \), is nonnegative:
If the product's price isn't to be constant, we must substitute the expression \( \sum_{i=1}^{n} u_n (p - v) \) for \( u_n (p - v) \) in Inequality (I).

Since there's only one product, most of the firm's costs -- even administrative and selling costs -- are traceable to its annual outputs of product \( x \), and allocating them to this output would be corrigible. The only exceptions are:

1. Any components of the annual fixed outlays that interact with other years' fixed-outlay components. (For brevity, I'll disregard this possibility hereafter.)

2. The cost of the investment or, more precisely, its depreciable base \( (I - S) \).

There's no theoretically legitimate way to calculate the full cost (including allocated investment) of any individual year's output -- for doing so requires joint-cost allocation. But decision-makers have no need to calculate such full costs. For you may verify that whichever price assumption we make, neither the decision to undertake the project nor the decision of what price(s) to charge for it require any allocation of the initial investment's depreciable base (nor any allocation of annual fixed outlays to individual product units, either). You should also be able to satisfy yourself that there will be no need to allocate untraceable costs even if Inequality (I) is recast to provide for taxes, waste, price instability, uncertainty, continuous compounding, or investors who seek satisfactory (or equitable) returns rather than maximum profits.

**Untraceable Costs Allocated Anyway; Sterilization (11)**

However, it may be that the investors, like many managers, are habituated to basing their decisions on the kinds of full-cost data used in financial accounting and, therefore, require allocation of the investment's depreciable base. The article cited at the outset claimed that any such financial accounting allocations would be incorrigible: no allocation method can be verified because infinitely many other methods are just as plausible as it is, yet no method can be refuted, since each is just as plausible as any alternative. Here, matters become slightly more complicated. Some possible allocations can be refuted; the remainder will be incorrigible, unless unique.

Demonstrating this requires a concept introduced by my 1974 AAA study: sterilization of an allocation method. In practice it's fairly common for decision makers inappropriately to base their decisions on allocated untraceable costs. The AAA study gave the example of decisions whether or not to process joint products past their splitoff points. Under circumstances specified there, management's decision should depend upon whether product revenues, less costs to complete, are positive. Yet, some managements may instead be concerned whether revenues less full costs (including allocated joint costs) are positive.

The latter decision approach is inappropriate. However, one way of allocating joint costs -- the familiar net realizable value (NRV), or approximated relative sales value, approach recommended by textbooks -- has an amiable characteristic. If management does make the mistake of basing its decisions on full costs, but calculates these costs by the NRV approach, its decisions will be identical with those that it would have made had it used a correct approach that avoided untraceable-cost allocations. That's to say, use of the NRV approach ensures, under these particular circumstances, that inappropriately allocating untraceable costs won't affect the decision one way or another. Such a no-effect allocation is sterilized.
with respect to the particular decision and circumstances.

Please note that sterilization is a rather odd concept. It doesn't mean "right" or "good surrogate" or "possesses high decision-utility." Indeed, it doesn't refer so much to the allocation itself as to the relationship between an allocation and a decision and set of circumstances. And even there, to say that an allocation is sterilized merely means that, although it shouldn't have been made, it does no harm because decision-makers who use it will make the same decision that they would had they used appropriate allocation-free data instead. (One really shouldn't consult fortune tellers. But if their advice doesn't affect one's decisions, doing so may be harmless.)

Similarly, it can be demonstrated that implicit-rate (economic) depreciation of divisional assets is sterilized with respect to division managers' decisions whether or not to invest in new capital projects when these managers are evaluated according to divisional ROIs.

In general this notion of sterilization attempts to isolate what research in progress indicates is a goal common to a great variety of managerial-accounting behavior -- despite management's not being conscious of following this goal. Thus, potentially, it offers a simple, unified explanation of much that otherwise seems complex and disparate. Earlier research made two more points about sterilized allocations that are important for our purposes, and which I'll illustrate presently:

1. There's no reason to expect that an allocation method that's sterilized with respect to a particular decision and set of circumstances will continue to be sterilized for other decisions or in other circumstances.

2. Often many allocation methods will be sterilized with respect to any one decision and set of circumstances.

**Sterilization and Corrigibility**

Now, whenever a decision should be based on data free of untraceable-cost allocations but decision-makers insist on an approach that uses them, sterilized allocations are preferable to unsterilized ones. For an unsterilized allocation could lead the decision-makers to make an incorrect decision whereas, by definition, a sterilized allocation couldn't. Accordingly, in such situations unsterilized allocations aren't incorrigible -- for they can be refuted.

However, we should try to be very clear about what's going on here, even at the price of repetition. Something has made management believe that decisions should be based on allocated data. Yet decisions should instead be based on data free of allocations. The only ground for choosing sterilized untraceable-cost allocations is that they don't affect decisions one way or another and are, therefore, harmless errors. In no sense of the word does this "verify" sterilized allocations. Moreover, whenever more than one untraceable-cost allocation method is sterilized with respect to a particular decision and set of circumstances, each individual sterilized method is incorrigible -- for each is inappropriate, yet each avoids affecting the decision.

I'll illustrate all this by the two decisions made by our investors, assuming, for brevity, that the price charged for the product must be constant. It should be emphasized that in both of the following examples the investors are using foolish decision rules. For the purpose of these illustrations is to show that even under a patently bad rule requiring untraceable-cost allocations it may be possible to select sterilized allocations that leave decision makers in the position that they would have occupied had they been sensible.

1. Perhaps the investors will decide whether or not to engage in the project by first calculating the product's optimal price and annual outputs (by the allocation-free analysis of potential demand mentioned earlier), then, for each year, comparing that price with the full
unit cost of the product plus a small markup for an equitable profit. If price always exceeds marked-up full cost, the investors will undertake the project; if it fails to do so in one or more years, they won't.

Calculations of annual full costs plus markup require allocating the initial investment's depreciable base to individual years. If $NPV_x \geq 0$, any method of doing this that results in each year's marked-up full cost being less than the optimal price will be sterilized. If $NPV_x < 0$, any method that results in at least one year's marked-up full cost exceeding the price will be sterilized. For, in either event, any such allocation method will ensure that the investors make the same decision that they would have had they followed the correct decision approach reflected in Inequality (I). On the other hand, any way of allocating the depreciable base that isn't sterilized could tempt investors to make a wrong decision and, therefore, can be refuted in this particular context of decision to be made and surrounding circumstances. (14)

As you may readily verify, whether $NPV_x \geq 0$ or $< 0$, infinitely many allocation methods will satisfy the rather modest requirements for sterilization here. Some might be more familiar than others. But, with respect to this decision and its particular circumstances (considered in isolation), each will be as good as the other, and each incorrigible. Any rule to choose among them must either be arbitrary or, as we'll soon see, be based on some other decision to be made from the allocated data.

2. For our second bad decision rule, perhaps instead, the project is so obviously profitable that the investors decide to undertake it without first determining exactly what they'll charge for the product. They plan to set this price by applying a percentage markup (one regarded as equitable in the industry) to the product's full, fast-year unit cost.

Any allocation method that generates the particular first-year, full-cost figure that, in turn, yields a marked-up selling price equal to the allocation-free, profit-maximizing price, $p$, will allow the investors to follow their inappropriate decision rule yet simultaneously maximize profits. Here, one allocation of the depreciable base to Year 1 is preferable to all others, and any allocation method that doesn't yield this Year-1 allocation can be refuted. But there will be infinitely many ways of allocating the depreciable base over the firm's entire life that satisfy this Year-1 constraint yet differ in what's assigned to Years 2 through $t$; each of these will be as good as any other with respect to this particular decision and circumstances.

An Objection

By now, some listeners should have begun to feel uneasy. As Anthony argued at the outset, in both examples surely some sterilized allocations won't be as good as others; some, in fact, will be quite weird. For instance, in the second illustration sterilization could be attained by allocating the "appropriate" portion of the depreciable base to Year 1, the remainder to Year 2, and nothing whatever to any other year. Clearly (it could be argued) such an allocation approach is inferior to other, less whimsical, ones. Thus, choice among sterilized allocation methods isn't incorrigible.

The answer is simple. As emphasized earlier, a sterilized allocation method is sterilized with respect to a particular decision and set of circumstances. It may also be sterilized with respect to other decisions and circumstances, but there's no reason to expect this to be so. If the allocation method in question is inferior to others, this must be because we perceive it interfering with sonic other decision(s) -- perhaps by generating unsatisfactory Year-2 profits and thereby tempting decision makers to raise the product's price (or to make some other inappropriate decision). But this merely signifies that the subject allocation method isn't sterilized with respect to other decisions.
Similar comments apply to rejecting otherwise-sterilized methods of allocating untraceable costs for violating GAAP rules -- or, as in Anthony's objections, for violating some concept of equity. Notions of what's equitable vary so much from individual to individual and situation to situation, and are so subject to unintentional bias from self-interest, that one despairs of giving them analytical significance. But any attempt to make them operational must specify that certain kinds of decisions based on certain allocations are erroneous. For instance, to use Anthony's example, one shouldn't allocate all equipment costs to one loaf of bread, and none to the others, then decide to base prices charged for loaves on the resulting book costs.

Of course, decision makers who set prices by an approach free of untraceable cost allocations should never be tempted to make such an inequitable pricing decision in the first place. Anthony's rule against allocating all equipment costs to one loaf merely places decision makers who inappropriately base their pricing decisions upon such allocations in the same position as they'd have occupied had they not allocated (though only, to be sure, with respect to this particular decision).

This conclusion is equally applicable to any standards of equity (for fairness) that someone might use to reject allocations of untraceable costs that are otherwise sterilized. Either such standards refute all of these allocations (in which case sterilization with respect to all relevant decisions and circumstances is impossible) or one ends up with a smaller set of allocations that now are also sterilized with respect to the decision and circumstances implicit in the standards of equity. Thus, all that such standards do here is to impose additional sterilization criteria upon allocations that shouldn't have been made in the first place; and nothing in Anthony's observations or his article conflicts with the following conclusions:

1. Managerial allocations of untraceable costs (and other one-to--many allocations) are either refutable or sterilized with respect to one or more decisions and sets of circumstances. That's to say, they're either demonstratably wrong or without effect.(15)

2. There's no guarantee that any allocation method will simultaneously be sterilized for all the decisions that decision-makers with to make and all circumstances in which they wish to make them.

3. When an allocation method is sterilized with respect to one or more decisions and sets of circumstances, there's no guarantee that it will be uniquely so.

4. When it's not unique, all sterilized methods will be incorrigible though, of course, some or all of these could be refuted if one invoked additional decisions or circumstances.

5. If more than one method is sterilized, the accountants' final choice among them will depend upon such considerations as ease of calculation, freedom from data problems or excessive sensitivity to errors in parameter estimates, or familiarity.(16)

6. Finally, when one concludes that one-to-many managerial allocations must be either refutable or sterilized, one is saying something damning about them: at best, all that can be claimed in their favor is that they're harmless excrescences.

Two or More Products

For simplicity, we've assumed that our imaginary firm makes only one product. Let's relax this assumption now, first by supposing that the investors contemplate the firm's making two products, x and y, throughout its t-year life, and that sales of these products will be independent. Each product will have its own traceable initial investment, variable cost, annual fixed outlays, and (perhaps) scrap value. In addition, there will be joint (untraceable) initial investment costs, \( I_j \), joint annual fixed outlays, \( f_{jn} \) and a joint component to the scrap value at the end of the year t, \( S_j \). (17) For brevity, I'll assume that all variable costs are traceable to individual products and that it's appropriate to apply the same rate of return, r, to all calculations.
The significance of the net present value of an investment in either product changes slightly; since the amounts of such net present values may differ from what would be calculated in a single-product case, I'll use the following notation for them:

$$\overline{\text{NPV}}_x = \sum_{n=1}^{t} \left( \frac{(u_{nx}[p_x-v_x] - f_{nx})}{(1+r)^n} \right) - I_x + \frac{S_x}{(1+r)^t}.$$

As before, it may be necessary to substitute the expression $\sum_{p_x=1}^{u_{nx}} (p_x-v_x)$ for $u_{nx}(p_x-v_x)$ in the foregoing.

Once again, the investors will envision some profit-maximizing strategy for marketing both products, and will undertake both only if:

$$(\text{II})$$

The investors must now decide what prices to charge for each product, and whether to produce either $x$, $y$ or both. Inequality (II) describes the criteria that these product decisions should satisfy; none of its expressions are allocated magnitudes (nor are any of the components of its NPV's). Accordingly, despite this situation's being more complex than the one reflected in Inequality (I), it's evident that our earlier conclusions remain true: None of the decisions that investors must make require allocation of untraceable costs, and any such allocations that investors do make will be either refutable or sterilized (with all sterilized allocation methods being incorrigible if more than one is available). Listeners are invited to satisfy themselves that as long as we continue to assume a limited-life firm (and make our earlier assumptions), these conclusions hold no matter how many products the firm manufactures. Moreover, we can relax the assumption that all such products are manufactured throughout the firm's entire $t$-year life by substituting zero values for appropriate $u_n$'s and $f_n$'s, and discounting any initial investments that are to occur after the firm begins.

Indeed, it should be apparent that in theory none of the investor's decisions require allocation of untraceable costs even were we to go much further in relaxing assumptions and allow uncertainty, unstable input prices, joint variable costs, multiple rates of return, interaction of products, and an indefinite-life firm. However we should consider two possible objections to this conclusion. At least one author has implied that such allocations are a necessary response to a complex decision environment. Also, the question inevitably arises: if such allocations are unnecessary, why do so many managers make them?

**Objection: Allocation as a Response to Complexity**

It might be argued that once we relax Inequality (II)'s assumptions and admit more complications, appropriate untraceable-cost-allocation free calculations rapidly evolve beyond the capacities of most or all decision makers (perhaps because of limited channel capacity and difficulties in making the necessary estimates) -- and that, as a practical matter, they must instead allocate costs that are joint to various years, responsibility centers, and products. Wells seems to imply this in his description of the origins of managerial accounting's untraceable-cost allocations. (19)
Specifically, it could be urged that firms must often calculate full costs for products when bidding for new business or when deciding whether or not to undertake new products whose selling prices are given. For instance, a parts manufacturer preparing a bid may need to estimate a minimum amount below which this bid shouldn't fall, in the sense that if it bases all of its bids on parallel calculations it will earn just enough to keep profits at a satisfactory level. Calculation of any such floor price requires allocating untraceable costs to individual jobs. I shall call this the UCA (for untraceable-cost allocation) approach to such decisions.

Someone taking Wells' general view would go on to emphasize that these are merely hypothetical allocations, made solely for specific decisions, that they have no significance for other purposes, and that nothing is served by booking them. Yet, if they are necessary for practical purposes, doesn't this make them a legitimate part of managerial accounting?

There are at least two answers to this question:

1. The UCA approach entails that firms will make product decisions in series, as a way of simplifying complex decision environments -- that's to say, make them one product or group of products) at a time. But, if so, firms can legitimately simplify even further by using a familiar variant of capital-budgeting analysis. Instead of calculating individual NPV's for a multiplicity of products, they need merely regard all products that they're currently producing as though they were a single product, x, and the candidate product as Inequality (II)'s product y. The candidate product should improve the profitability of the firm as a whole; therefore, the criterion for product decisions becomes:

$$\text{NPV}_{xy} > \text{NPV}_x.$$

For brevity, I'll call this the *capital-budgeting* approach to deciding whether or not to produce a product and what price(s) to charge for it. Under the capital-budgeting approach, these product decisions are sensitive only to differential considerations. Any complicating factors common to both NPV's drop out of the calculations.

2. The UCA approach doesn't escape any of the capital-budgeting approach's remaining complications. For the UCA approach still requires firms to estimate investment costs, scrap values, and variable costs -- and to develop pricing strategies. Both approaches require making the estimates of total output to be produced and sold that Inequality (II) demands. (In particular, whatever way the UCA approach charges untraceable costs to units of output necessarily implies a total output over which all such costs are to be recovered.)

Similarly, the UCA approach's provisions for a minimum profit require calculations that parallel Inequality (II)'s and (III)'s need to specify a minimum rate of return. Other considerations such as uncertainty, equity, unstable input prices, joint variable costs, and interactions of products affect both approaches equally. To be sure, the UCA approach might often disregard these. But whenever doing so is legitimate, the capital-budgeting approach can just as properly ignore them, too.

Thus, any supposed practical advantages of the UCA approach in complex decision environments seem illusory. Instead, it minglestheoretically illegitimate data (untraceable-cost allocations) with legitimate data, thereby rendering an already complicated decision situation even *more* confusing.
Objection: The Widespread Use of Allocations in Practice

Accordingly, we may conclude on both theoretical and practical grounds that managerial accountants should eschew allocations of untraceable costs. Why, then, do we encounter such allocations in practice?

1. One reason often offered is that financial accounting's GAAP require full-cost inventory figures. The UCA approach provides these; the capital-budgeting approach doesn't. But this would be a satisfactory reply only if GAAP arose independently of the managerial accounting practices, which doesn't seem to be the case. (The same point applies to any claim that we allocate untraceable costs because we've been trained to do so.)

2. Many-to-one allocations are legitimate. It's a natural error to suppose that one-to-many (joint-cost) allocations, though admittedly "somewhat arbitrary," are legitimate, too.

Similarly, in our private lives we often feel confident of being able to make meaningful profit and loss calculations on such things as sales of securities or decisions to change employment. We feel equally confident calculating profits for very simple business ventures of the kinds that characterized capitalism until relatively recent times. Such calculations require few significant allocations of untraceable costs.

It's only natural that we should wish to make similar calculations for today's complex business enterprises: why shouldn't it be just as meaningful to calculate General Motors' profits, or the profits of a responsibility center, as it is to speak of one's personal profits? Of course, such calculations do require important untraceable-cost allocations. But we go ahead and make them anyway, soothing any uneasiness by reasoning that such profits must exist, and that there's no way to avoid allocations if we are to calculate them: charging zero amounts for relevant untraceable-cost factors seems clearly refutable, therefore any systematic, consistent, plausible-sounding allocation method seems preferable to no allocation at all.

I've argued elsewhere that this train of reasoning is defective at its root: that profit, as commonly understood, cannot be corrigibly calculated for large enterprises, and that the analogy from personal profits is as misleading as the classic false analogy between prudent personal savings behavior and surplus/deficit policies appropriate to national governments. Nonetheless, as long as Society continues to encourage this natural error, we may expect managers to continue to request profit data for responsibility centers (rather than data about their contributions), and thus accountants to continue to allocate untraceable costs. (22)

3. Allocations of untraceable costs are required by both the cost theory of pricing and the medieval notion of just price in which, presumably, it originates. Neither of these will stand up to modern analysis, but both seem deeply embedded in management thinking and in the terms of many contracts (notably government contracts). This, and the previous discussion, suggests that some reasons for allocating untraceable costs reflect survivals from simpler eras of business organization that have persisted long enough to become part of our habitual ways of thought -- examples of what Schumpeter called the ancient truth that the dead always rule the living. (23)

Unfortunately, by now any change to untraceable-cost-allocation free accounting will require extensive reeducation and some dislocation. This, of course, perpetuates our allocation fallacies. So does the seeming absence of potential alternatives that stems from our inurement to present practices and resulting failure to experiment with untraceable-cost-allocation free ones.

4. Many believe that the kinds of marginal or incremental calculations involved in the capital-budgeting approach can lead a firm to financial ruin. Here's an example. Let's suppose for simplicity that a firm manufactures a single product and rents all of its plant and equipment. Variable costs are $3 per unit and fixed costs $100,000 per year. The firm, which has excess capacity, produces and sells 20,000 units per year. It must, therefore, charge $8 per unit just to break even.
Incremental analysis assures us that if the firm could legally sell additional units in a separate market without affecting its existing sales, its total profits would increase at any selling price exceeding $3. Yet, of course, if the firm applied this approach across the board it would go bankrupt. Moreover, there's the additional danger that sales in the $3+ market eventually could spoil sales in the $8+ market. Therefore, many conclude that one should allocate untraceable costs (the $100,000 of fixed costs, here) to individual units -- at least as part of the firm's routine cost accounting.

But this conclusion simply doesn't follow. All that's really occurring here is that the firm has an opportunity to substitute two different $p_i$'s for $p$ in the detailed expressions that lie behind Inequality (III). In doing so, there's no chance that choice of a low $p_i$ for the secondary market will affect the primary market's $8 + p_i$ one way or another. And any dangers of leakage between the two markets can be incorporated quite as well into Inequality (III)'s untraceable-cost-allocation free, capital-budgeting approach as they can into the UCA approach.

What these fears really seem to boil down to is a concern that if one gets used to thinking in marginal or incremental terms one may end up disregarding fixed costs. Since the capital-budgeting approach explicitly incorporates all fixed costs, this fear is groundless and the reason for allocating untraceable costs collapses.

5. To many, the capital-budgeting approach may appear to be overly complex and to require estimates of parameters that, as a practical matter, are impossible to estimate reliably. Decision makers may therefore believe that some rule-of-thumb approach to pricing, based on traceable costs but charging an additional percentage markup to allow for imponderables and profit, may be the best that they can do. Indeed, if reliable estimates are impossible, such a rule-of-thumb approach may be best from a cost-benefit standpoint. But please note that:

   a. Although such a rule-of-thumb approach superficially resembles the UCA approach, it's a retreat from it, too. For, as we've seen, the UCA approach requires making the same kinds of estimates as the capital-budgeting approach does and, thus, is equally complex.

   b. There's no need for the rule-of-thumb approach to involve any allocation of untraceable costs: all it requires is a percentage mark-up over direct costs. To be sure, decision makers may speak as though such markups were intended to cover both fixed costs and profits, but that's merely symptomatic of the pervasive ideology of profit calculation and untraceable-cost allocation, discussed earlier.

6. Relatedly, managers sometimes also believe that estimates of traceable costs tend to be understated (or that dangers from understating them exceed those of overstatement), and that therefore some "boot," or safety factor, should be allowed in marginal or incremental calculations. But even if this is true, there's no need to allocate untraceable costs in order to provide such a safety factor. Nor is there any need to do so in order to make managers more aware of the costs incurred and benefits offered by other parts of the organization --another rationale sometimes given for allocating untraceable costs.\(^{(24)}\)

7. Capital-budgeting approaches are generally less attractive to decision makers than theorists might desire. This is partly for the reasons just discussed, but partly also because of something identified by Ijiri: a firm's divisions compete for investment funds from headquarters, and tend to make overly optimistic estimates for long-lived projects.\(^{(25)}\)

Although this affords an additional explanation for firms' preferring rule-of-thumb approaches, it provides no reason for allocating untraceable costs. For, once again, the UCA approach requires essentially the same estimates as does the capital-budgeting approach.

8. As inspection of Inequality (II) should suggest, the untraceable-cost-allocation free capital-budgeting approach...
The relevant question here is how much real lower-echelon independence is possible under the UCA approach when joint input factors are significant. The gloomy literature of transfer pricing suggests that allocation of untraceable costs doesn't really help matters here.

9. Finally, it could be argued that accountants, as practical men, really aren't trained to be terribly sensitive to logical issues, to worry much about theory, or to be distressed by mere cognitive dissonance. Thus, once in the habit of allocating the unallocable, we may be content to continue to do so indefinitely, theory be hanged, as long as the practical consequences of doing so seem bearable. If this paper has been correct, the trouble with such attitudes is that major potentials for reducing managerial accounting costs and confusions exist that won't be realized until practical accountants come to worry more about the intellectual foundations of their craft.

SUMMARY

We've reached the following overall conclusions. Managerial accounting's numerous many-to-one allocations often can be verified. Our allocation problems are, instead, with one-to-many allocations. These are theoretically illegitimate; in particular, Anthony's rationale for them and the rationale that could be developed from Wells' work don't hold up under scrutiny.

One-to-many allocations fall into two types, depending on the nature of the allocatee -- that's to say, upon what the cost is allocated to:

1. *Allocations of total output to two or more inputs that generate it*. Conceivably, the inputs might have entirely independent (linear) effects on the production process (as when an individual's income equals the dividends that he or she receives from two unrelated firms). In such cases, it's theoretically legitimate to allocate the output to the individual inputs in proportion to their separate effects -- the amounts of output that each allocatee would generate in the absence of any other inputs.

   Usually, though, inputs interact to produce output, and total output differs from the sum of such separate effects. Here, earlier research on financial accounting's allocations (together with this paper's analysis) indicates that all allocations must be either refutable or incorrigible. (26)

2. *Allocations of total inputs to two or more outputs generated by them*. Conceivably, these outputs might be entirely independent effects of the production process, freely substitutable for each other and occurring in entirely variable proportions (as when one cuts either 3x5 or 4x6 filing cards out of 48x60 blank sheets). In such cases, it's theoretically legitimate to allocate the total cost of the inputs to the outputs in ratio to the actual quantities of each output produced.

   Often, though, outputs are *joint* -- *not* independent; they occur in proportions that are partly or wholly fixed. Here, we've seen that all allocations must be either refutable or sterilized. And if more than one is sterilized, each will be incorrigible. In any event, it's widely recognized by writers on managerial accounting that all such allocations are arbitrary.

Thus, accounting's basic allocation problem results from lack of independence of allocatees. We call this lack of independence *interaction* when the allocatees are inputs and *jointness* when they're outputs. The extreme case of input interdependence occurs when all inputs are essential (fixed input
proportions); the extreme case of output interdependence occurs when all outputs are unavoidable (fixed output proportions). Most often, inputs and outputs are partly substitutable. But anything materially short of full allocatee independence results in irremediable theoretical difficulties.

The upshot for untraceable-cost allocations is that all will be either refutable or sterilized -- and, if the latter, incorrigible unless unique. Sterilization here signifies that these allocations won't affect certain decisions made under certain circumstances. This is the very best that can be said of them: they can be designed to be ineffectual, to lack any decision impact whatever, to be tripe.

Since such allocations complicate analyses, waste time, and cause misunderstandings, we accountants should stop making them -- especially since research in progress indicates that untraceable-cost allocations often can't be sterilized for all relevant decisions and circumstances simultaneously. For if, at best, such allocations have no effect, we can obtain this no effect easier and more safely by not allocating at all. It's just that simple.

* Professor of Accounting, McMaster University. I wish to thank Robert N. Anthony, Maurice Moonitz, Paul Rosenfield, Robert R. Sterling, and, especially, Joseph G. Louderback, III, for comments on an earlier draft. Be warned that not all of these individuals agree with what follows. Also, much of this paper originated in reactions to a close rereading of the first twelve chapters of Charles T. Horngren, Cost Accounting, A Managerial Emphasis. Third Edition (Prentice-Hall, Inc., 1972).


(2) Finally, I've made no attempt at this point to provide a scholarly bibliography.


(5) The extractive industries offer an exception: decisions whether costs of unsuccessful exploration should be charged to, successful projects can have major significance.

(6) It should be repeated that this discussion disregards waste -- assumes, if you prefer, that the firm's wastes have already been identified and that all costs under consideration are waste-free.

(7) More precisely, many-to-one allocations encounter such difficulties only when conflicting ways to perform aggregations are available, only one of which can be correct, and there's no conclusively defensible way to narrow down the possibilities. The discussion under point 1, above, indicates that this problem doesn't arise here. To be sure, as noted earlier, costs that can defensibly be allocated at a particular level of activity aggregation often can also defensibly be allocated at other levels. But this poses no dilemma. For, unlike the aggregation of current-exit values in the Appendix to SAR9's Chapter 7, hem we're not required to choose one and only one figure. All are correct.

(8) Similarly, variance accounting may often be a practical surrogate for elaborate investigations whereby, at Level 1, costs could be allocated to productive output or waste depending upon whether output would have been physically different had the cost not been incurred.

(2) See Horngren, op. cit., p. 88.
(10) Perhaps following a strategy similar to that by which ball point pens were introduced in the late 1940s: initially charging very high prices, then, once demand at these prices has been tapped, successively lowering prices to reach additional layers of demand.

(11) For background to the following discussion, see SAR9, pp. 40-46 and 163-74.

(12) This point can be subtle. Imagine, if you will, a situation where marginal or incremental data are appropriate to a decision, and an allocation method generates exactly these data. Their merit resides in their being what allocation-free analysis would have provided; therefore, the allocation itself isn't verified.

(13) For more familiar (and plausible-seeming) bad decision rules, you may wish to refer to SAR9's examples.

(14) Context is important here. Ideally, an allocation method would have both features -- be sterilized whether NPV_x was >= or < 0. However, it may be impossible to devise such a method. In that ewe, one would be forced to conclude that although it was easy to sterilize the allocation with respect to the decision and the specific circumstances NPV_x >= 0 or NPV_x < 0, more general sterilization happens to be unattainable.

(15) As a practical matter, a general understanding that allocated data will be ignored for certain decisions may be a satisfactory alternative to their sterilization. This depends in part on style of leadership. Sterilization will be of maximum value (such as that value is) where decision makers take book figures very seriously, and less important where they temper them with "non-quantifiable" considerations.

(16) Other criteria may dominate particular cases. For example, in allocating direct materials variances between price and quantity, desires for timely data encourage calculating the price variance at actual quantities purchased or ordered, thereby attributing price-quantity interactions solely to price. Accountants then allocate the corresponding direct-labor price-quantity interactions exclusively to price, too, apparently for consistency. (See SAR3, pp.14-15, for the allocation issue here.)

(17) If the firm is sold as a whole at the end of Year t, there may be no separate scrap values for the investments in the two products.

(18) Please note that even if NPV_x or NPV_y < 0, it still might be more profitable for the firm to manufacture both products than just one if they share facilities.


(20) For example, if untraceable costs are to be allocated equally to each unit of output and total $120,000, a charge of 40C per unit implies a total output of 300,000 units, a 240,000-unit output, and so forth.

(21) This conclusion corrects my earlier tentative agreement with the claim that hypothetical allocations are a legitimate feature of managerial accounting -- see SAR9, p. 27n.

(22) For an extended discussion of why the financial accounting allocations that underlie our notions of profit seem plausible, see the section headed "Why Isn't This Obvious?" of my chapter in the Third Edition of Baxter and Davidson's Studies in Accounting Theory, forthcoming. The related question of why such allocations are, appropriate in economic theory but not in accounting is discussed there and in
SELECTED QUESTIONS AND ANSWERS

Question?
Could you for my benefit and perhaps for other as well give us a simple illustration of how an allocation becomes sterilized.

Answer:
I wish I had some figures, because this is where figures becomes handy. As an example, let's use the divisional depreciation calculation. You have division managers with enough autonomy that they are allowed to propose new capital projects. A division manager starts looking around at possible projects, and he sees one that has a very high internal rate of return. Let us say it's 30% per year; but in the early years it has a rotten pay-out. The division manager hopes to be promoted within three or four years. If he proposes this particular project and it is approved by top management, he will have low cash flows and revenues in the early years. His successor will receive all the credit for the high ones. At the same time if the firm is using straight line depreciation, he will be showing a very low rate of return for this project. Again, his successor will be showing a splendid rate of return. If the firm is using accelerated depreciation for book and tax purposes, he may show a disastrous rate of return on the project. In a situation like this, the division manager is apt to make the incorrect decision of suppressing the proposal for capital expenditure, even though the firm would benefit from it. Well now if you use economic depreciation, the one that gives the same book rate of return in each year, the division manager will never be tempted into doing this type of censorship of an otherwise attractive proposal. In that sense, the use of this particular allocation method for depreciation makes him use the same criteria for selecting projects and come to the same decision as if allocation, depreciation, and divisional net income calculated on depreciation wasn't a factor at all. In that sense, it's sterilized.

Again you can show with joint cost allocation that as long as products don't have any positive or negative values at split-off and you use the net realizable values approach, any product that should receive further processing will have a positive book profit associated with it and any product that shouldn't receive the processing will have either zero or negative book profit associated with it. If management is so unwise as to be made uneasy by carrying products that have negative or zero book profits, then the best thing to be done is to use the NRV approach. Whenever they do have negative or zero profits, these are ones that management should discontinue anyway. Again you have a case where management shouldn't be allocating at all, but should figure whether to retain or get rid of products in terms of the contributions they make. But if they use book profits for the products, you can work out an allocation method for the joint costs that keeps management from making mistakes.

Question:
You have given us a maximization rule for the firm. What notion do you offer for performance evaluation and interim reporting?
Answer:
The simplest answer is that you have a cash flows notion, or rather a net quick asset flows notion. One can evaluate individual managers or individual employees using a cash flows criteria rather than a profit criteria. Again, I'm saying this in the abstract. In the world in which we live since everyone is geared to think in terms of profit, this is impossible. You know even the Russians in the last 15 years have started to reintroduce the notions of profit. At the moment we live in a society where profit is one of the central concepts in accounting. How long it will take to get away from this I don't know. All I'm saying in the long run, we will get away from it.

Question:
Don't you think you should emphasize the fact there really isn't any problem in accounting if there is certainty? Shouldn't one view all these responses as an attempt to deal with uncertainty?

Answer:
It is always permissable to isolate in any scientific inquiry one problem from other problems. I agree with you about uncertainty, it is a very important problem. On the other hand if you're examining meat for lead contamination, you don't have to simultaneously be examining it for coliform bacteria contamination. They are two separate problems. The uncertainty problem is being very adequately handled by people such as Brief and Owen. I'm interested in a different problem. The only way I can get into trouble is if the kinds of interaction problems and incorrigibility problems that I'm worried about interact themselves with uncertainty. I've tried to set things up tonight and in my other research so that uncertainty isn't a problem. Even in a world of certainty, the problems I'm talking about exist.