



## Designing an Effective Cost System

Ramji Balakrishnan, University of Iowa  
Stephen Hansen, George Washington University  
Eva Labro, University of North Carolina



The Association of  
Accountants and  
Financial Professionals  
in Business



The Association of  
Accountants and  
Financial Professionals  
in Business

Copyright© 2011 in the United States of America by  
Institute of Management Accountants.  
All rights reserved

Virtually every firm maintains a product costing system. Over the past two decades, such systems have evolved through innovations such as activity-based costing (ABC) and Resource Consumption Accounting (RCA). Yet we have limited knowledge of how to design and implement effective systems. For instance, while ABC and RCA claim to offer “better” approaches for allocating capacity costs, they do not answer fundamental questions: Why should we allocate fixed costs in the first place? Assuming that allocated costs have a role in decision making, how many cost pools should we have? How should we form cost pools? In this report, we summarize some recent research that has begun to address these and related questions.

To begin, it's important to understand why firms allocate fixed costs to products. Survey evidence and research shows that firms design systems to allocate fixed costs (sometimes termed capacity costs) for several reasons. First, allocation is required for valuing inventories and for computing income as per the generally accepted accounting principles (i.e., the *inventory valuation* role). Second, managers use cost allocations when making decisions related to product planning and resource planning (i.e., the *product costing* role). Third, firms employ cost allocations to induce desired behavior and to dissuade or “tax” undesired behavior (the *behavior modification* role). In this report, we focus on the product costing role of cost allocations.

There is an extensive literature on the decision-making role of product costs.<sup>1</sup> Classical economists argue that fixed costs are not controllable at the product level, and, therefore, there is no theoretical basis for allocating these costs in product-related decisions.<sup>2</sup> Nevertheless, there is widespread evidence that firms do allocate fixed costs and employ the resulting “fully-loaded product costs” to make product and capacity planning decisions.<sup>3</sup>

Naturally, because product costs are inputs to important decisions, firms care a great deal about getting the costs “right” in the sense of having a cost system that precisely models the economics of the underlying production environment. Yet computational and informational complexity prevents the average firm from ever achieving a precise model. Recent research seeks to reconcile theory and practice by building on this argument. This research argues that, due to complex interactions among products and resources, it is almost impossible to formulate a conceptually complete decision problem (the “grand” problem that jointly models the capacity acquisition, capacity allocation, pricing, and product-mix decisions), let alone solve it. Thus, one rationale for the widespread use of allo-



cated product costs is that they provide a useful basis for simple, implementable decision rules that firms can use—an approach that, in effect, is tantamount to decomposing and solving the “grand problem” in small pieces.<sup>4</sup> Thoughtful allocation of the costs of shared capacity resources to products has been viewed as yielding acceptable measures of the opportunity costs of utilizing these resources in making these products, in order to price them and to calculate their demands. In turn, product demand can be translated into the demand for resources, which is useful for resource planning.<sup>5</sup>

This view of the role of product costing for decision making divides the literature on product costing systems into two broad strands. The first focuses on the economic sufficiency of allocated product costs for decision making.<sup>6</sup> The overall research objective of this strand is to evaluate the efficacy of heuristics based on product cost. That is, how much economic loss does the use of the product-cost-based heuristics entail? This literature shows that while economic sufficiency holds only under restrictive conditions, product-cost-based decision rules perform reasonably well in helping managers deal with an otherwise intractable problem.

The second strand of research focuses on issues relating to measuring product costs.<sup>7</sup> This research stream is important because many approaches to cost allocations have emerged over the last two decades both in research and in practice as management accountants continually strived to improve the decision usefulness of these systems. The overall research objective is a comparative assessment of the sources of error and how well alternate systems fare in estimating or capturing the opportunity costs of shared resources. We focus our discussion on this second strand. We summarize research that has addressed three broad questions in the context of measuring product costs:

1. What is the extent of loss from using product costs to plan capacity? Are these systems reasonable approximations of the underlying economic construct?
2. What is the nature of the errors in a cost system? How do select characteristics of the production environment affect the error in the system? In a related vein, suppose we wished to focus attention on reducing identifiable errors. Where should we focus the efforts so as to obtain the greatest benefit in accuracy?
3. Firms have no choice but to design cost systems by relying on simple rules of thumb, often based on limited information and incomplete

analyses. We often find practitioners and consultants building systems using heuristics such as “group like resources together,” “focus on the most expensive resources,” and “10-20 cost pools might be enough.” But the use of loosely worded heuristics raises many questions: How good are these rules in terms of their accuracy? How robust are they to errors in the underlying information they need? Are the rules universally valid, or do some rules work better in identifiable situations?

We now turn to research that has addressed each of these questions.

### The Role for Product Costing Systems

Are managers justified in using product costs for making decisions? Economic theory is unequivocal that we should employ measures of the opportunity costs of resources when making decisions. It is this rationale that allows us to ignore the costs of resources with excess capacity when making short-run decisions. After all, the opportunity cost of excess capacity is zero! In the long-run, however, excess capacity cannot persist. Firms will adjust capacity resources to a level that ideally balances the opportunity costs of under- and over-investing in capacity. The question then is whether product costs provide firms with sufficiently precise information to make this tradeoff.

Balachandran, Balakrishnan, and Sivaramakrishnan (1997) explore this question. It is obviously very difficult to get empirical data from the field to answer this question; each firm represents only one data point, and too many confounding factors (strategy, management style, type of cost system, and so on) make it impossible to compare practices across firms in a systematic fashion. Thus, these authors employ numerical simulations as their method of choice. This method allows them to systematically vary parameters so that they can draw precise inferences about the efficacy of product costs as decision aids.

The findings in Balachandran, et al., (1997) should give us comfort. At a broad level, their findings are that product costs do not entail an unacceptable loss relative to the optimal economic decision. Product costs deliver, on average, about 90% of the profit potential that is possible. This finding is significant because the optimal economic decision is a theoretical but impractical concept. It is simply not possible for firms to collect and process all of the information required to implement this solution. In contrast, firms routinely calculate product costs at a reasonable expense. The insight is that, while the calculated product cost is only an approximation of the underlying opportunity cost, it serves us well. The cost-



benefit tradeoff appears to favor the use of product costs for decision making! In this way, research has sought to reconcile theoretical prescriptions with what is observed in the field.

### The Nature of Errors in Cost Systems

As approximations of the underlying economic environments, cost accounting systems inevitably produce estimates that differ from a product's true marginal cost. As a first step, research sought to understand the nature of errors in the cost system. In a well-cited paper, Datar and Gupta (1994) developed the following taxonomy:

- *Aggregation error.* This error occurs when a cost system pools dissimilar resources together into the same pool. Such a choice induces errors because each pool can have only one cost driver; thus, the system design asserts similarity in consumption patterns for dissimilar resources.
- *Specification error.* This error occurs when an incorrect cost driver is chosen. For example, all labor-related overhead might be allocated using labor hours, even though some of these costs might vary with labor costs (not hours) and FTE counts.
- *Measurement error.* This error can occur both when the costs to be allocated are calculated (e.g., the costs are incorrectly accumulated into cost pools) and/or when driver quantities are measured incorrectly.

Using that taxonomy, Datar and Gupta (1994) provided several insights. Most notably, they show the following:

1. Errors often are related. For example, setup hours might be a better measure of the consumption of setup costs relative to the number of setups done. Yet measuring setup hours accurately may be more difficult than measuring the number of setups—*count drivers* are often easier to measure than are *duration drivers*. Consequently, a firm might choose to sacrifice better specification for ease of measurement and choose the number of setups as the allocation basis.
2. The offsetting nature of errors might mean that “local” improvements in cost systems might actually increase rather than decrease overall error. For example, reducing specification error in one cost pool might decrease the error in the allocation from that cost pool to products; however, it is possible that overall error increases because the

(now corrected) error was off-setting the error in allocations from another cost pool. Datar and Gupta (1994) implicitly argue for an overall systems design approach when firms seek to improve the accuracy of their cost systems.

Labro and Vanhoucke (2007) tested how well the findings in Datar and Gupta (1994) could be generalized. In particular, they argued that while such offsetting of errors is possible, it might not occur frequently enough for it to be a concern. They constructed an elaborate simulation experiment that allowed them to control the presence and magnitude of different kinds of errors at different parts in the system. By relating these effects to the overall error in the system, Labro and Vanhoucke (2007) establish the following:

1. Unlike the implications in Datar and Gupta (1994), partial improvement in the costing system usually increases the overall accuracy of reported product costs. The exceptions occurred in specific cases where there is aggregation error in the activity cost pools and measurement error in the resource drivers. In other words, the “local” or incremental efforts aimed at improving cost system accuracy usually do so. This is good news for firms seeking to improve their cost systems.
2. Cost systems can usually be thought of as comprising two distinct stages. In Stage 1, the firm allocates resource costs to form cost pools. In Stage 2, the costs are allocated from the cost pools to products. The results in Labro and Vanhoucke (2007) show that the impact of Stage 2 costing errors on overall accuracy is stronger than Stage 1 errors. In other words, given a choice, firms should focus efforts to refine systems in Stage 2 of the allocation process.
3. The presence of aggregation and measurement errors usually result in relatively more products being under-costed rather than over-costed, with large amounts of over-costing for a few “big-ticket” (in dollar terms) products, and small amounts of under-costing for a larger number of cheaper products. The practical implication is that firms that rely on a few high-value product lines for the bulk of their profit should be particularly careful to refine their cost systems, as there is a strong possibility that the accounting system over-estimates the real cost of these products. In other words, there is more room for a price-quantity tradeoff than is suggested by the accounting data on product costs.



Labro and Vanhoucke (2008) followed up on this exercise with a companion experiment. The goal was to provide insight into assessing costing system quality, improving costing system robustness to unwanted errors, and identifying situations where costing system refinement efforts (such as introducing an ABC system intended to better reflect causal relationships) are likely to pay off most in terms of increased accuracy.

It is intuitive that costing systems are likely to be more sensitive to errors in firms that wrestle with diversity. With limited resources, firms should focus their efforts on refining cost systems in such cases where they are likely to be most effective. Indeed, Labro and Vanhoucke (2008) report that decreasing diversity in the dollar amount of the resource cost pools and in the proportional resource consumption by cost drivers at each cost pool increases the robustness of cost systems to errors. That is, if a firm has many resources of roughly equal values and/or if the production methods for various products is roughly similar, then there is little to be gained by refining product costing systems. In contrast, decreasing diversity in the sharing of resources across the whole of the costing system (which is arguably the most important aspect of diversity) generally does not lead to increased costing system robustness to errors.

### Designing Effective Systems

In this section, we summarize the research and findings in Balakrishnan, Hansen, and Labro (2011).<sup>8</sup> Their research argues that firms employ a number of heuristics when designing cost systems. For example, common sense suggests that grouping similar resources into the same cost pool is one avenue to limit the error created in a system. Yet common sense also suggests that firms go after the “big potatoes,” i.e., keep large-value resources in distinct pools, with the thinking being that getting the big items right will reduce the amount of error in the system. The issue then is to evaluate the efficacy of these rules and gain insight into the conditions where a given rule excels.

These authors conducted an extensive simulation experiment to investigate these rules. They focused on two types of heuristics: (1) grouping resources to form cost pools and (2) picking drivers to allocate the costs from the pools to products. Their major findings and the evidence that underlies the conclusions are as follows:

**Finding 1:** Size-based rules (“focus on most expensive resources”) perform better than correlation-based rules (“combine like resources”) in situations where



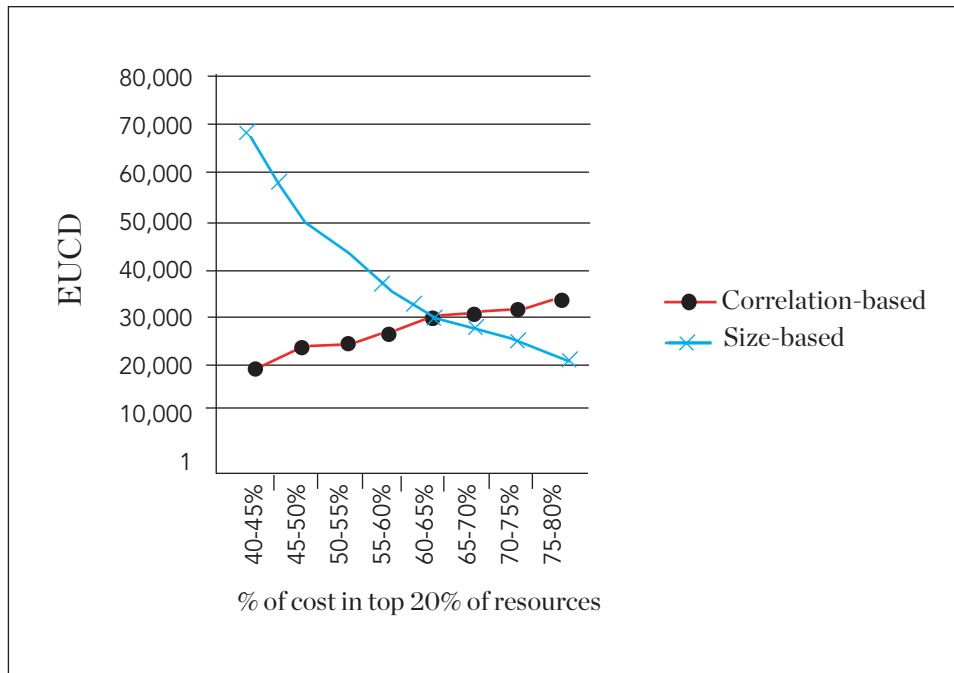
a few resources account for a majority of the costs. In particular, firms may be well-advised to look to size-based rules for forming cost pools if 20% of the resources account for more than 70% of costs. When resources are less varied in size (less dispersed), however, correlation-based rules dominate.

**Figure 1** provides the evidence that supports the claim. The X-axis plots the percent of costs accounted for by the top 20% of resources, and the Y-axis is the value of overall costing system error metric (EUCD). Higher levels of EUCD indicate a less-accurate costing system.<sup>9</sup> The figure plots two rules: (1) organize the largest resources in separate pools and group left-over resources into a “miscellaneous” pool and (2) use correlations in resource-consumption patterns to group resources into the required number of pools.

Notice that the error in size-based rules is large when resource dispersion is low (20% of resources account for 40%-50% of costs). But the relative performance improves steadily, and size-based is the preferred choice in environments where a few resource categories account for the lion’s share of costs. One way to interpret this finding is that simple systems might work when resource costs are concentrated and that ABC-like systems are likely to have the greatest benefit when resource costs are diffused across categories. Management accountants likely have quite a good idea of whether or not their firm operates in a production environment where resources are dispersed or not and can hence decide which method of forming pools will work best for their firm.

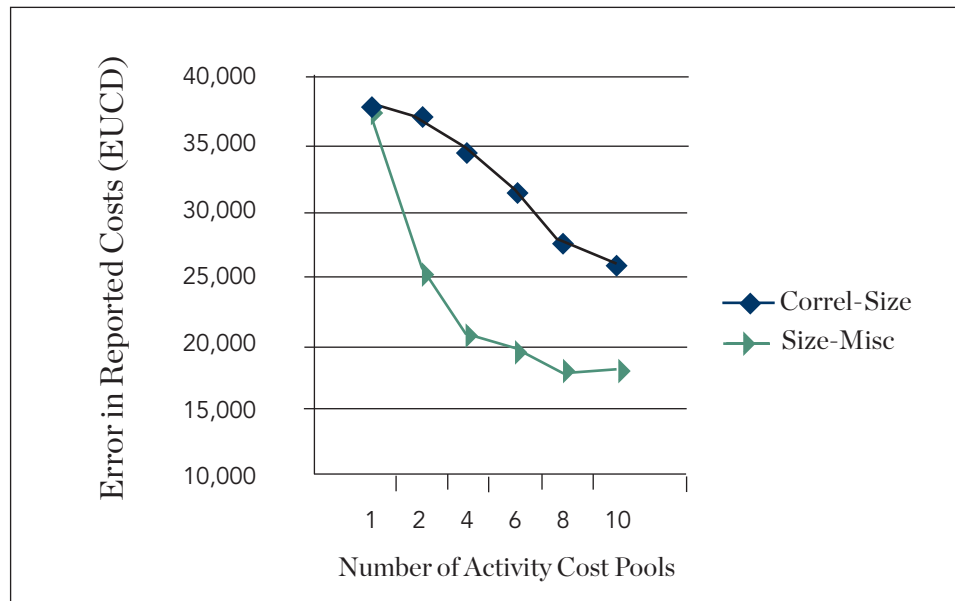


**Figure 1. The Performance of Heuristics as the Resource Costs Become More Concentrated**



**Finding 2:** Consistent with intuitive prescriptions by Turney (1991), who writes that “10-20 cost pools might be enough,” as well as by Cooper and Kaplan (1998), who report that “ABC systems settle down to between 35-50 activity cost drivers,” a fairly low number of cost pools formed using gross information about consumption patterns seems to be an acceptable tradeoff between the costs of adding more pools and benefits of system accuracy, even for firms with a large number of resources.<sup>10</sup> In particular, Figure 2 shows that the rate of increase in system accuracy drops off dramatically after 10-15 pools. While the difference from adding more pools continues to be statistically significant, the economic significance is low. This suggests that the cost-benefit ratio might not be favorable: The cost of developing and maintaining larger costing systems may not be worth the accuracy gained.

**Figure 2. The Performance of Heuristics as the Number of Activity Pools Increases**



**In the above chart – Correlation-based and Size-based to used**

**Finding 3:** It is preferable to group small-value resources into one miscellaneous overhead cost pool rather than to distribute them into the other, larger pools. In practice, this means that it is reasonable to add various small-value resources together in a cost pool rather than add them to the larger cost pools that contain somewhat-related costs. Surprisingly, this result holds true even when the set of small resources accounts for up to 50% of total costs.

Table 1 provides the evidence. The further down a column we go, more and more resources are pooled into a miscellaneous cost pool. All other features of a cost system design are held constant. Now, consider how the measure of error (the first entry in each cell) changes as we go down a column. Surprisingly, while the error increases, this change is marginal. Yet the firm reaps considerable advantages from not having to analyze the consumptions of a significantly greater number of resources.

**Finding 4:** Correlation-based rules perform well even when the precision of available correlation information is low. Crude estimates of correlations in consumption patterns (e.g., merely knowing whether the correlation is greater than

0.4) appear to be sufficient to implement correlation-based rules effectively. The practical implication is that firms can design systems with rough estimates of consumption patterns; the gain from investing resources to garner more accurate data on correlation in resource consumption patterns does not seem worth the cost.

For evidence, compare the error values across the columns in Table 1. The third data column represents a setting in which the firm uses very coarse information to identify like resource (here the definition groups resources together if the correlation in their consumption exceeds 20%). As we move right, the criteria become more stringent; the right-most column considers a cutoff value of 80% to identify “like” resources. Naturally, as we become more stringent in identifying like resources, the 50 resources form more groups (i.e., cost pools) even though each pool contains fewer resources, on average. For example, when the last 10 resources are grouped together into the “miscellaneous” cost pool, the average number of cost pools increases from 5.4 to 26.9 as the cutoff value moves from 0.2 to 0.6.



**Table 1. Grouping Resources into a Miscellaneous Pool and Precision of Correlation Information**

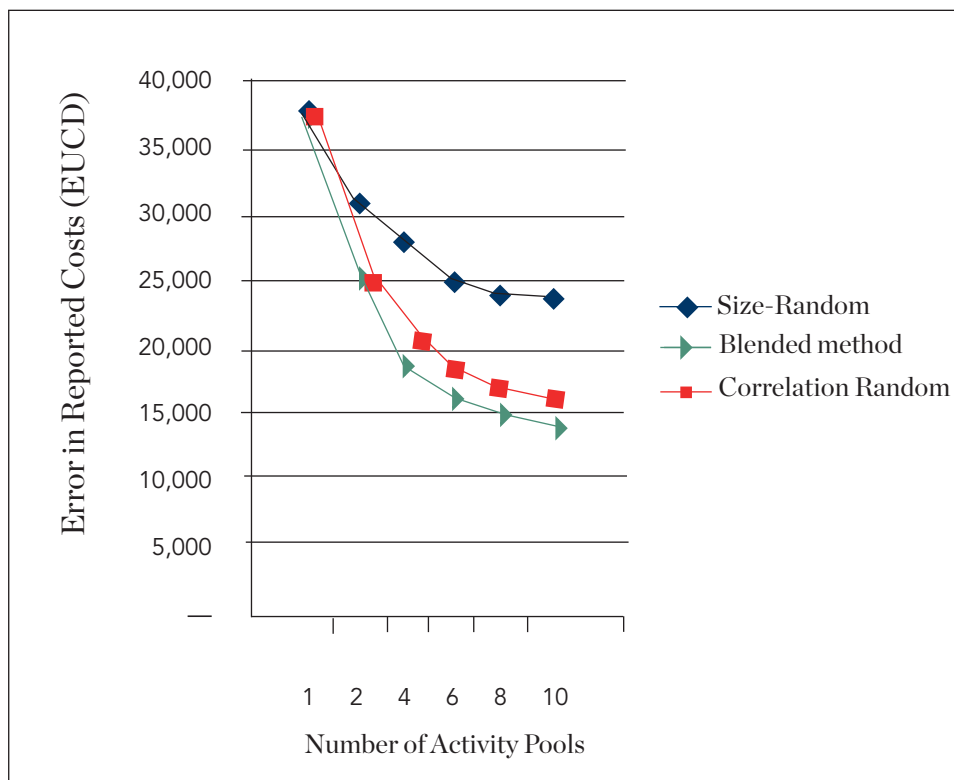
		Cutoff correlation value for grouping resources into the same activity pool			
Number of resources in Misc cost pool (% of resources)	Average of cost in the miscellaneous cost pool (in %)	0.2	0.4	0.6	0.8
5 (10%)	5.24%	22,823 [7.13]	17,018 [19.17]	12,173 [29.11]	Max # Pools Reached
10 (20%)	9.53%	22,742 [5.47]	17,408 [15.79]	12,263 [26.93]	
15 (30%)	15.81%	22,842 [4.39]	17,761 [12.25]	12,620 [22.96]	
20 (40%)	23.04%	23,216 [3.58]	18,176 [9.33]	13,647 [18.33]	10,508 [25.65]
25 (50%)	31.08%	Min # of pools reached	19,610 [6.35]	15,041 [13.89]	12,089 [20.68]

The first entry in each data cell is the error value; the second is the average number of cost pools formed.

**Finding 5:** A blended method that groups resources into “tiers” (using coarse estimates of correlations in consumption patterns) and then uses a size-based rule within tiers performs very well in terms of the accuracy of reported product costs.

This blended method resembles the structure of an ABC system, which classifies costs into a hierarchy but does not demand as much information. Thus, the findings in Figure 3 provide support for the intuitive prescriptions for designing an ABC system.

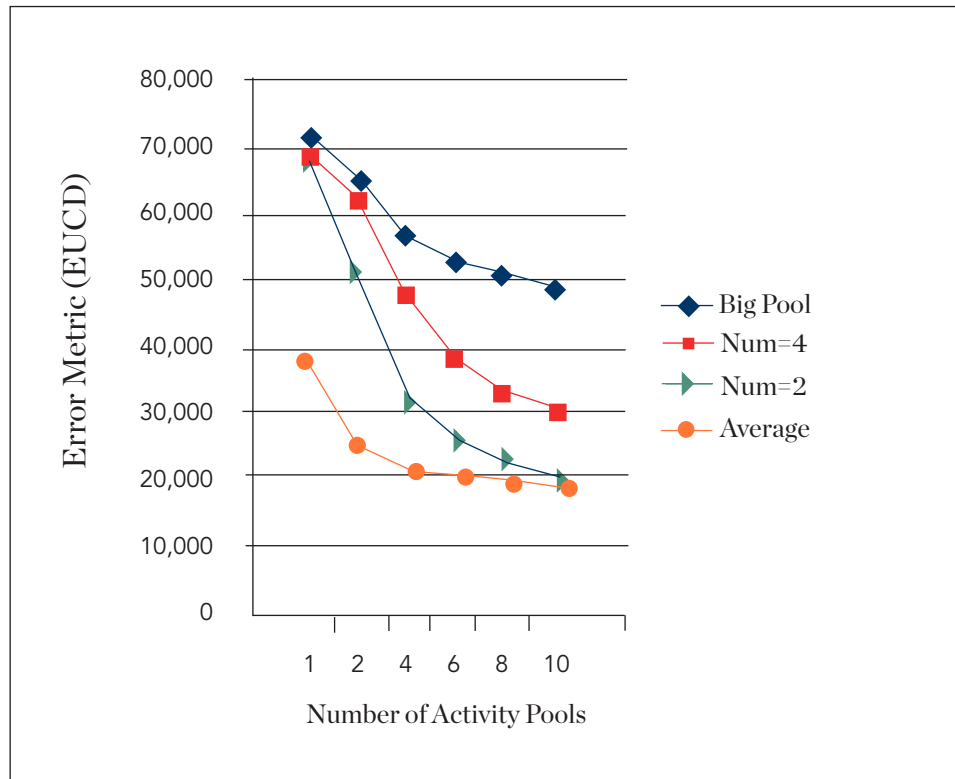
**Figure 3. The Performance of the Blended Method**



**Finding 6:** Figure 4 illustrates that even marginal improvements in specification have the potential to considerably reduce error in a wide-range of environments. In other words, there is value to considering indexed drivers that incorporate the consumption patterns of several resources. When allocating labor-related costs, it might be worth considering both head count and supervisory hours when constructing a cost driver.

This finding is particularly salient in settings where pooling resources of similar magnitudes, but there is a steep drop off in the value of constructing ever more complex drivers. It seems enough to consider only the two or three most expensive resources in a pool (NUM = 2 and 3, respectively, in Figure 4) to get most of the gains. Indeed, such a parsimonious driver might even deliver better results than a driver that considers *all* of the resources in a pool, regardless of size (the "Average" line in Figure 4.)

**Figure 4. The Effect of Increasing Number of Resources in the Index**



### Summary

Research in product costing has attracted considerable attention over the last decade, spurred in part by practice-driven innovations such as activity-based costing and resource consumption accounting. This body of work has made significant progress in reconciling the apparent contradictions between theoretical

prescriptions and observed practice.

While there has been some progress, considerable work remains and provides an opportunity for researchers. Casual empiricism shows that firms implementing advanced cost systems also are likely to engage in cost management. The link is intuitive because superior cost systems provide management with insight on the cost structure and opportunities for improvement--yet altering the production process will invalidate the cost system! Thus, an interesting question is the frequency with which a cost system needs to be updated, recognizing that the decision is endogenous as it depends on the quality of the cost system. A related question is the robustness of a cost system to measurement and other errors. Are some forms of product costing systems more robust to errors than others? Does the fit of the cost system with its environment affect this property? We simply do not know. These questions are ripe for additional research, and we look forward to more work in this area.

### References

- Rajiv D. Banker and John S. Hughes, "Product Costing and Pricing," *The Accounting Review*, vol. 69, iss. 3, July 1994, pp. 479-494.
- Bala V. Balachandran, Ramji Balakrishnan, K Sivaramakrishnan, "On The Efficiency of Cost-Based Decision Rules for Capacity Planning," *The Accounting Review*, vol. 72, iss. 4, October 1997, pp. 599-619.
- Ramji Balakrishnan, Scott Hansen, and Eva Labro, "Evaluating Heuristics Used When Designing Product Costing Systems," *Management Science*, 2011 (forthcoming).
- Ramji Balakrishnan, and K. Sivaramakrishnan, "A Critical Overview of the Use of Full-Cost Data for Planning and Pricing," *Journal of Management Accounting Research*, vol. 14, 2002, pp. 2-31.
- Robin Cooper and Robert Kaplan, *Cost and Effect: Using Integrated Cost Systems to Drive Profitability and Performance*, HBS Press: Cambridge, Mass., 1998.
- Srikant Datar and Mahendra Gupta, "Aggregation, Specification and Measurement Errors in Product Costing," *The Accounting Review*, vol. 69, iss. 4, October 1994, pp. 567-591.
- V. Govindarajan and Robert N. Anthony, "How Firms Use Cost Data in Price Decisions," *Management Accounting*, vol. 65, no. 1, July 1983, pp. 30-36.
- J.S. Jordan, "The Economics of Accounting Information Systems," *The American Economic Review*, vol. 79, no. 2, May 1989, pp. 140-145.



- Eva Labro and Mario Vanhoucke, "A Simulation Analysis of Interactions Among Errors in Costing Systems," *The Accounting Review*, vol. 82, iss. 4, July 2007, pp. 939-962.
- Eva Labro and Mario Vanhoucke, "Diversity in Resource Consumption Patterns and Robustness of Costing System to Errors," *Management Science*, vol. 54, no. 10, October 2008, pp. 1715-1730.
- Eunsup Shim and Ephraim F. Sudit, "How Manufacturers Price Products," *Management Accounting*, vol. 76, iss. 8, February 1995, pp. 37-39.
- Peter B.B. Turney, *Common Cents: The ABC Performance Breakthrough*, Cost Technology: Portland, Ore., 1991.

### Works Cited

- <sup>1</sup> See Balakrishnan and Sivaramakrishnan, 2002, for a review.
- <sup>2</sup> A *controllable* cost for a decision alternative is a cost whose value will change, relative to the status quo, if the decision maker chooses to implement the alternative. The controllable cost for a decision is the union of the controllable costs of the decision alternatives. Some prefer the term *avoidable* cost, defining it as the cost that will be avoided if this alternative is not chosen.
- <sup>3</sup> Govindarajan and Anthony 1983; Shim and Sudit 1995; Cooper and Kaplan 1998
- <sup>4</sup> Balachandran, et al., 1997.
- <sup>5</sup> As Balachandran, et al., 1997, note, there are alternate avenues (e.g., resource-based planning) for decomposing the grand problem. In this paper, we focus on the most commonly observed avenue: product-costing systems.
- <sup>6</sup> For example, Jordan, 1989; Banker and Hughes, 1994; Balakrishnan and Sivaramakrishnan, 2002.
- <sup>7</sup> For example, Cooper and Kaplan, 1988; Datar and Gupta, 1994; Labro and Vanhoucke, 2007; Balakrishnan, et al., 2011.
- <sup>8</sup> This research was supported, in part, by the Foundation for Applied Research, IMA. Figures and tables are adopted from the original article published in *Management Science*, with permission.
- <sup>9</sup> The findings are robust to alternate error metrics; see Balakrishnan, et al., 2011, for details.
- <sup>10</sup> Turney, 1991, p. 51; Cooper and Kaplan, 1998, p. 99.



### About IMA

With a worldwide network of more than 60,000 professionals, IMA is the world's leading organization dedicated to empowering accounting and finance professionals to drive business performance. IMA provides a dynamic forum for professionals to advance their careers through Certified Management Accountant (CMA®) certification, research, professional education, networking and advocacy of the highest ethical and professional standards. For more information about IMA, please visit [www.imanet.org](http://www.imanet.org).

