The TOC-ABC Choice Debate for Product Mix Decisions: Introducing Asset Specificity as an Alternate Explanation

VG Sridharan, The University of Melbourne, Australia
Ranjani Krishnan, Michigan State University, USA
Philip Vergauwen, Universiteit Hasselt, Belgium
Tiru Arthanari, The University of Auckland, New Zealand

ABSTRACT

*Though constructed with different purposes, the theory of constraints and activity based costing systems pose a choice problem in respect of product mix decisions. We believe that the existing explanation of short versus long run criterion to explain firms' choice between these two systems is incomplete and offer an alternate explanation based on asset specificity. We argue that the extent to which specialized resources are deployed to make products in a mix determines the choice. We present a 2*2 matrix stating that when asset specificity is high, a firm is likely to choose ABC instead of TOC since ABC makes a large portion of costs visible to enable control. However, the choice is likely to be a TOC-ABC combination when the manufacture of asset specific products is also constrained by bottlenecks.*

Introduction

In the accounting literature, 'theory of constraints' (hereafter TOC) and 'activity-based costing' (hereafter ABC) are often cited as systems that exhibit contrasting features (e.g., Corbett, 2000; Holmen, 1995; Huang, 1999; Goldratt, 1992). While TOC holds that materials represent one of the very few variable costs in a firm, ABC attempts to recognize most resources as variable costs (Cooper and Slagmulder, 1999). Further, TOC argues that every firm must continually strive to improve the output of the lowest capacity or the bottleneck resource in order to maximize overall throughput. On the other hand, ABC implicitly ignores the existence of the bottleneck because ABC holds that the total acquired resources must equal their consumption and any leftover must be charged to the cost of unused or excess capacity (Campbell, 1992).

The contrasting picture arises with the differences in the main purpose of the two systems. TOC seeks to optimize production by managing the constraints and thus obtain higher throughput. ABC aims to increase the accuracy of product costs by a systematic allocation of costs to activities consumed by the products (Jones and Dugdale, 2002). Since TOC's focus is throughput driven, it aims to reduce the costs of inefficiency in constraining resources such as bottlenecks so as to enhance the throughput. However with its product cost accuracy objective, ABC aims to build the costs of most resources into the product costs, regardless of whether the resources are bottlenecks or otherwise.

Since only a few costs are deemed variable under TOC and most costs are deemed variable in ABC, the extant literature labels TOC as a short term (where most costs remain fixed) technique and ABC as a long term technique (e.g., Hilton, 2006; Horngren, Datar, Foster, Rajan and Ittner, 2008). The differences in TOC-ABC purposes imply that managers are likely to choose that system which addresses their specific needs. TOC and ABC can therefore be treated as parallel systems that do not pose a choice problem. However, an exception where managers typically confront a choice problem is in relation to a product mix decision context. We find that in real time firms face difficulty in physically making and maintaining two different product mixes, one for short and another for long term. The difficulty is especially significant if the product mixes, supported by TOC and ABC contradict with each other.

In examining the TOC-ABC choice for product mix, we introduce an established economic concept namely, 'asset specificity' as an alternate explanation to a firm's specific choice. We argue that the extent to which resources are specialized and dedicated to making one or only a few products within a product mix determines the relative ability of the firm to control the transaction costs arising with the opportunistic use of its resources. Our theoretic conclusion therefore is that if a product mix consists of one

or more asset specific products, a firm is more likely to choose ABC since it explicitly discloses the labor and most overhead (other than facility-related) costs of the resources used in different products. However since ABC ignores bottlenecks' existence, the ABC choice is relevant when bottlenecks do not exist within a firm[1]. We finally propose that the choice of integrated TOC-ABC models is explained by the complex needs of those firms that manage internal bottlenecks and simultaneously make asset specific products.

The remainder of this paper is as follows. Section 2 elaborates the contrasting features TOC and ABC and also clarifies the choice problem in a product mix context. Section 3 examines asset specificity as an alternate explanation and Section 4 concludes.

TOC-ABC Choice for Product-Mix Decisions

TOC-ABC contrasting features

TOC focuses on the resource with the lowest capacity (or the 'bottleneck') which constrains the number of units that a firm can produce at any time. TOC claims that every product that is made increases the strain on the bottleneck. To reduce (or more generally to manage) the strain, firms incur out-of-pocket costs such as extra casual labor employed at the bottleneck. Apart from the out-of-pocket costs, the only other relevant product costs in TOC are the materials required for making the product. The existing labor and other administrative costs are treated as fixed costs that do not change with the introduction of a product. TOC holds that so long as the market price of a product covers the material and other out-of-pocket costs, the product can be deemed to be profitable. Assuming that market demand will be high at such low prices, the main concern in TOC is to increase the bottleneck's productivity through efficient planning. Among others, an important way that TOC suggests is to shift the use of non-bottleneck resources to the bottleneck such that the bottleneck productivity is increased and so is throughput (Goldratt and Cox, 1989).

As regards ABC, the accounting literature suggests that the technique is relevant to those firms that make multiple products consuming diverse amounts of resources. ABC aims to first trace costs to activities and then allocate the costs of activities to the products. This is in contrast to the traditional costing where costs are traced to departments before getting allocated to the products. Traditional costing allocates all the resources traced to a department to the product regardless of whether the resource is actually consumed by the product or not. ABC charges the costs of only those activities that are demanded by the products and only to the extent demanded. Hence Cooper and Kaplan (1991) argue that ABC product costs can be considered to be more accurate than traditional costing. The contrasting characteristics of TOC-ABC are summed up in the following two points.

a) Cost variability: While TOC considers only material and related out-of-pocket costs as truly variable (the rest of the costs vary only when the managers consciously choose to spend more or make additional investments), ABC seeks to include most costs (other than facility-sustaining activity costs such as plant insurance) as variable with respect to multiple activity drivers (Cooper and Slagmulder, 1999; Kee, 1995).

b) Constraint location: While TOC considers that there is at least one constraint at any point of time which can exist either within the firm (e.g., manufacturing process) or outside of the firm (e.g., market demand), ABC does not generally recognize any constraint within the firm and holds that any constraint operating on a firm can arise from a fall in demand which could, in turn, give rise to unused capacity costs within the firm (Campbell, 1992).

In clarifying when each of these contrasting views holds, the accounting literature suggests that TOC is a short term decision tool since most costs remain fixed in short run while ABC is more of a long term tool since most costs are variable in the long run (e.g., Campbell, 1992; Cooper and Slagmulder, 1999). In general, these short and long term tools can be applied distinctively for most decision contexts. For instance, capital asset acquisition is typically assessed by a long term tool and special export order pricing by a short term tool. In these circumstances, the relevance of TOC and ABC are fairly clear and does not pose any choice problem to the decision makers.

[1] According to TOC, bottlenecks may shift from one resource to another within a firm or may even shift externally into the market, i.e., demand reduction. Note that ABC can conceptually address external bottlenecks since externality largely implies unused or excess capacity within the firm's resources.

Product mix decisions and TOC-ABC choice

However, one context that is not readily amenable for such short versus long term analyses relates to the product mix decision. Since real time operations are continuous, firms often find it difficult to segregate short and long run product mixes. Note that a product mix for short term can even conflict with the mix for long term. We label this conflict as the 'real time continuity' problem and address this later. In consequence, firms face a choice problem as to which tool is appropriate for their product mix decisions. Several studies examine the choice problem in terms of either TOC or ABC or even as a combination of the two systems (e.g., Fredendall and Lea, 1997; Gunasekaran and Sarhadi, 1998; Kee and Schmidt, 2000; Patterson, 1992; Shadan and William, 1995).

Product mix decisions using TOC are based on throughput contribution margin per time (e.g., hour or shift) of the constraint or bottleneck. As most costs are lumped as fixed, TOC seems to be a useful tool to evaluate a particular product mix only when no major changes are expected in activities (such as setting up or processing) that give rise to additional costs. On the other hand, ABC evaluates product mix decisions based on overall profitability (which is sales revenue minus unit, batch and product level activity costs) per unit of a product. Since ABC can identify costs of all activities, it seems to be a useful tool to evaluate a product mix decision that demands changes in the activities (or activity drivers), which in turn, give rise to additional costs. However, the drawback is that a sub-optimal mix may be chosen if ABC is applied in the presence of a bottleneck within a firm. This is because the mix chosen by ABC may consider the costs and benefits at an overall level without considering the offsetting costs arising from the fact that products that pass through the bottleneck are costlier than those that do not.

The extant literature suggests the short versus long run perspective to explain the choice between the two systems for product mix decisions. No major changes to the activities are expected in the short run and hence TOC is suitable for short-run product mix decisions. Similarly, Kaplan and Bruns (1987) argue that firms would seek to balance the resources acquired against resources consumed in the long run and therefore ABC does not consider any bottlenecks arising in the short run. However, these arguments do not completely explain how the real-time continuity problem is resolved through the choice. Further, these arguments do not explain why some real-world firms adopt one tool or the other regardless of the time-span.

Asset Specificity as an Alternate Explanation

We extend the analysis to situations as to when the activities relating to a product mix are less likely and when they are more likely to change. One plausible situation where activities are less likely to change is when the underlying resources are non-specific in nature[2]. A low specificity implies that all the products in a product mix can be manufactured by different types of resources without significant variations. An example is where product A can be made in Machine X, Y or Z and/or by any employee group. Regardless of how it is manufactured, one can expect that the activities for making product A are less likely to be change because it can be made in any machine. In such circumstances, TOC can be an appropriate decision tool since it considers only the relevant costs and ignores all other costs for activities that are less likely to change. Further, TOC provides useful ways to optimize the resource use such as rescheduling labor and machine use to enhance the constraint's productivity. This is generally regardless of whether the constraint is located within or outside the firm. TOC can thus be a cost-efficient decision tool in low asset specificity contexts.

In contrast, consider a high asset specific context such as some customized products in a product mix. Each product in a product mix may require a specific type of resource (e.g., a particular machine or uniquely skilled labor) and even within those resources, ascertaining the type of activities and the appropriate amount of activity drivers needed may be uncertain.

In such circumstances, scope exists for opportunistic problems if the firm continues to adopt TOC. For example, an employee can hide his/her inefficiency in resource usage since TOC treats all operating expenses as fixed and hence ignores changes in operating expenses. The opportunism problem can at least be controlled if

[2] This statement follows the accounting convention that *resources* (e.g., labor and machinery) are used to perform *activities* (e.g., setting up and processing) that give rise to *product costs*. Activity drivers are those factors that alter the costs of an activity such as 'number of setups' for setting up activity.

the firm uses ABC because it systematically identifies the activity costs at detailed levels that help capturing any resource usage inefficiencies. When any constraint exists external to the firm such as decline in market demand, ABC also enables the analysis and planning of 'unused capacity costs' in different resources within the firm (Cooper and Kaplan, 1991). Note that although ABC can be complex and hence costly to design and implement, it may be cost effective to manage the high costs of potential opportunism within the firm.

However, problem arises when the constraint exists within the firm that seeks to evaluate high asset specific product mix. ABC does not recognize the existence of constraints within the firm because the demand and supply of resources are likely to be equal. TOC offers ways to manage internal constraints but is less suitable for highly specific product mix. This is where the TOC-ABC integrated decision tool may likely provide suitable benefits. The integrated tool can identify product profitability by subtracting different activity costs from the throughput contribution per time of the constraining resource. A few alternate integrated models (for example, see Kee, 1995, Cooper and Slagmulder, 1999) are suggested in the accounting literature but we contribute to the literature by building asset specificity in the analysis and highlighting the underlying reasons for the choice of a particular decision making system against another. The theoretical structure is summarized in the following 2*2 matrix:

	Constraint Location – Internal	Constraint Location - External
If the asset specificity of all the products in the mix is *low*	Box 1: TOC	Box 2: TOC
If the asset specificity of at least some products in a mix is *high*	Box 4: TOC-ABC integrated model	Box 3: ABC

We now illustrate the matrix with a practical example. Lehigh Steel, a Harvard Business School (HBS: 5-198-112) case set in the period 1988 to 1993, offers insights on the TOC and ABC use. Lehigh initially had a very narrow range of products wherein activities did not differ significantly across different products. In line with Goldratt's (1983) argument that every firm faces at least one limiting constraint at any point of time, the case identified its continuous rolling mill (CRM) process as its limiting factor. Like most capital intensive firms, Lehigh initially followed the standard contribution analysis (also called marginal costing, this concept is similar to TOC accounting), wherein it would accept an order that offered a positive contribution (per unit of the limiting factor) over the standard variable costs[1]. Most overhead consumption was based on production volume which meant that the overhead charge increased with the increase in the product quantity. This situation is similar to box 1 in our matrix. Lehigh's accounting system was typical to firms in most capital-intense industries where additional customer orders increased largely variable costs since most fixed costs (such as depreciation) are period-based. Thus, the accounting system mostly captured the relevant costs of production and offered very little scope for opportunistic problems.

When recession hit the US economy in 1990-91, the steel industry suffered a decline in customer orders. The market prices were soft and demand volumes were scarce. The recession shifted Lehigh's constraint from its internal CRM process to an external factor namely, lack of market demand. This situation can be likened to box 2 in our matrix, where TOC could still be a relevant accounting system. Though Lehigh did not change its accounting system, it followed a different marketing and production strategy. In order to survive in an environment of falling demand, Lehigh aggressively hunted and procured all types of orders. In turn, Lehigh's product profile became very broad covering both standard and highly specialized or customized products, which is similar to box 3 in our matrix. The broader product line significantly increased the company's fixed overheads. Along with the rise in salary cost, the company faced costs of high resource usage, maintenance and insur-

[1] An important difference is that while TOC accounting considers all labor costs as fixed costs, contribution analysis includes direct labor and other incidental costs that vary with production as variable.

ance. However, the existing accounting system hardly shed any light on the changed product cost structures and the impact on final company profits. For instance, by 1993, Lehigh employed more metallurgists per pound of steel than any other steel products manufacturer. As a result, the company suffered a huge loss in 1991 even after getting a large number of orders. Though not specifically mentioned in the case, evidence suggests that the metallurgists had ample scope to hide their inefficiency in the use of company resources since the accounting system did not capture the increase in fixed overheads.

Lehigh was not totally aware of the 'lack of fit' between the TOC accounting system and the nature of production in box 3 situation until early 1993 when the managers realized the lack of control over the company's proliferating product line and continued losses. To analyze and comprehend the full cost structure for different products, Lehigh initiated ABC. This corresponds to our solution for box 3. Interestingly, around the time ABC was implemented in mid-1993, the recession ended and demand began to recover.

As the demand recovered, Lehigh could no longer make all of the high volume demanded on its entire product range given its limited capacity on the CRM process. This situation indicates that the constraint shifted back from external sources to Lehigh's internal CRM process. This moves our analysis to box 4. Among several competing products, the company had to choose only those (regardless of specialized and standard) products that held high profit potential. Though ABC was initiated with the above purpose, it could not still offer a value-maximizing solution for Lehigh. Typically, ABC can distinguish the profitable from the unprofitable products for a firm with its ability to trace all variable and most fixed (except facility-sustaining) costs of each product. However, since ABC does not typically consider the opportunity costs of the existence of an internal constraint, Lehigh could not achieve the optimal product mix that could yield high overall profits. For instance, if the machine hour rate for allocating the overheads to products were determined on the basis of historical rather than replacement value of a machine, then the rate is less likely to capture the relevant opportunity costs of the machine time. Hence, Lehigh experimented with a merged TOC-ABC structure, wherein ABC contribution per hour of the CRM process was calculated as the basis to rank the products. A comparison of the overall profits between ABC ranking and the TOC-ABC ranking revealed that Lehigh benefited more from the merged accounting system.

Conclusions

Our objective in this paper is to use the economic concept of asset specificity to offer an alternate explanation to the choice between TOC and ABC methods in a product mix decision context. We find that the short versus long run explanation in the extant literature does not adequately address the real time continuity problem and the variations that exist across firms in the real world. Our conclusions are that when one or more products in a product mix can be made only through dedicated, specialized resources, the choice is more likely to be ABC as against TOC since the firm can identify the resource costs which can help reduce potential opportunism in resource consumption. We further suggest that a choice involving a combination of the two systems is likely to result when a firm faces a major internal bottleneck along with a high degree of asset specificity. Our study has policy implications in that firms endeavoring to make product mix decisions can consider the asset specificity level in their products before committing to investment in appropriate accounting systems. Our paper can also help future accounting research to test our propositions in the 2*2 matrix using large scale survey data. In terms of limitations of our study, we submit that there could be other plausible economic explanations to this choice problem either along with or apart from asset specificity.

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Dr VG Sridharan is a senior lecturer in the faculty of economics and commerce at the University of Melbourne, Australia. He currently teaches one bachelor-level cost management course and one masters-level strategic performance management course. VG has consistently obtained recognition awards for his teaching proficiency at all the schools he has taught in India, New Zealand, Netherlands and Australia. His research interests are in the economics of costing and control systems. He has published in Journal of Management Accounting Research, Corporate Ownership and Control, ICFAI Journal of Accounting Research, and Management and Labor Studies.

Dr Ranjani Krishnan is a professor of accounting at the department of accounting and information systems at the Eli Broad School of Management, Michigan State University. She is currently working as a Visiting Professor at Harvard Business School. Ranjani has published widely in leading accounting and management journals including the Accounting Review, Contemporary Accounting Research, Journal of Accounting and Economics and Strategic Management Journal. She holds many notable awards and honors including Notable Contribution to Management Accounting Literature Award and Outstanding Faculty Research Award.

Dr Philip Vergauwen is the professor and dean of the business school at the Universiteit Hasselt in Belgium. He is currently on leave from the Universiteit Maastricht. Philip teaches managerial accounting, auditing and control systems. Philip's research interests are in intellectual property rights, and economics of cost accounting and control systems, that are published in both in English and Dutch journals. Philip regularly conducts executive management workshops in Europe and in the US. Philip is also acclaimed for his institution building abilities, particularly in infusing independence and efficient academic administrative networks, which explains his current role at Hasselt

Dr Tiru Arthanari is an associate professor of operations management at the University of Auckland Business School in New Zealand. Tiru has a B.Sc. (Statistics) with first rank from the University of Madras, a Master's degree in Statistics, M.Stat., a Diploma in O.R., and a Ph.D. all from the Indian statistical Institute (ISI, Calcutta), a premier institute of higher learning and research in the fields of quantitative methods and their applications. Tiru has served as the Head of the SQC & OR division of ISI, which provides training and consultation to industries through its 11 units spread all over India. The Quality Mission Project of the division was launched during that period with a major grant (equivalent to NZ$ 3 million) from the government of India. Tiru is a very successful quality and optimization consultant with sound theoretical basis and vast applied experience. He is a trained quality system auditor. Before migrating to New Zealand, Tiru was serving one of the three centres of ISI located at Bangalore, India as its head