

# DECISION CONTROL OF PRODUCTS DEVELOPED USING TARGET COSTING

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## ABSTRACT

*For firms using target costing, separating decision management from decision control helps to minimize the agency costs incurred throughout a product's economic life. Prior literature focuses on decision-management issues related to target costing, such as new product development (i.e., initiation) and production (i.e., implementation). In contrast, this article highlights the decision control aspects of target costing, which consist of ratifying product proposals and monitoring the product's implementation. While products initiated with target costing are chosen because they meet their allowable cost, product ratification requires assessing how well products contribute toward strategic goals, such as improving the firm's market value. To facilitate the ratification decision, this article develops an equation for determining a product's net present value (NPV) based on the same accounting data used during the initiation process. The article also describes monitoring a product's implementation through periodic comparisons to flexible budgets and a post-audit review at the end of the product's economic life.*

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Target costing is a process of managing the development and production of products to ensure that they earn a satisfactory level of profitability. Consequently, target costing acts as both a cost management and profit management system. The technique was initially developed at Toyota Motor Corporation and is widely used among Japanese manufacturing firms (Bayou & Reinstein, 1997). Several large international U.S. and European manufacturing firms, such as, Boeing, Caterpillar, Texas Instrument, and DaimlerChrysler, have also adopted target costing (Ansari & Bell, 1997). The philosophy underlying target costing is that 80–85% of a product's life cycle cost is determined during the development stage. As a result, the greatest potential for influencing or managing a product's cost occurs during its development. The target costing process begins with market analysis to decide upon a product's price and sales quantity. A product's target cost is computed by subtracting the firm's desired profit margin from the product's market price. Designers and engineers then create the product to meet its allowable cost.

A critical aspect of any process, such as target costing, is the separation of decision management and decision control (Fama & Jensen, 1983). Decision management involves the initiation of a proposal and its implementation, while decision control consists of ratifying the proposal and monitoring its execution. The separation of decision management and control encourages individuals who initiate and implement a decision to act in the firm's best interest, rather than their self-interest. For instance, without adequate separation of decision management and control, a manager could pursue projects that maximize short-run earnings to influence his/her near term performance and reward. Conversely, a manager may be averse to accepting risky projects whose unsystematic risk the firm can diversify away, which the manager cannot. Consequently, separating decision management from decision control minimizes agency costs by reducing opportunistic and sub-optimal decisions for the firm.

The academic and practice literature provide an extensive coverage of the decision-management issues associated with target costing. Field studies and surveys describe in detail target costing initiation and implementation. However, little appears to be known about the decision control aspects of target costing. Consequently, managers have limited theoretical and/or practical guidance for the ratification and monitoring aspects of target costing. The purpose of this paper is to discuss the target costing issues relevant to decision control and to demonstrate how decision ratification and monitoring can be performed consistently with the goal of maximizing firm value.

The remainder of the paper is organized as follows. The next section outlines the different approaches to product development, and reviews studies of target costing. The following section describes target costing decision management and control. The subsequent sections discuss economic value added (EVA<sup>1</sup>) and develop mathematical equations to aid managers in determining a product's impact on the firm's market value. A numerical example then illustrates how to use the mathematical equations for product ratification and how to monitor the product throughout its life cycle. The final section presents the paper's summary and conclusions.

## **PRODUCT DEVELOPMENT**

Many U.S. and European firms follow a cost-based approach to product development. Under this methodology, firms design a proposed product, estimate its cost, and then add the desired profit margin to arrive at the product's selling price.<sup>2</sup> However, the market, rather than the firm, establishes the relationship between a product's price and sales volume. If the product's price exceeds the market price, the firm may not sell a sufficient quantity of the product to earn its desired profit margin. Consequently, the firm must consider lowering its price to increase sales volume as well as reducing the product's cost to increase its profit margin. However, 80–85% of a product's life cycle costs are committed during the development stage. Therefore, limited potential exists for reducing a product's cost after production begins. A firm in this situation faces abandoning the product, redesigning the product, or selling the product and earning a minimal or negative return.<sup>3</sup>

Target costing overcomes this deficiency of the cost-based approach to product development by recognizing the primacy of a product's market and structuring the development process to incorporate market demands and constraints. Target costing takes a product's expected market price less its expected profit margin to obtain the product's allowable cost. A product's market price is frequently determined using market research and analysis. The results of this analysis facilitate understanding the functionality and quality that customers desire in a product, and the price they are willing to pay for these features. When evaluating the market price, the firm must also consider additional information, such as forecasted demand for the product and the impact of competing products.

The next step in target costing is to estimate the profit margin necessary for the firm to manufacture the proposed product. Firms use a variety of techniques to compute a product's profit margin. [Cooper and Slagmulder](#)

(1997) report that a sample of Japanese firms assigned profit margins to new products based on the margin earned by similar products in the past. Conversely, Gagne and Discenza (1995) note that firms selected a profit margin consistent with the profitability goals in the firm's strategic plan, while Kato, Böer, and Chow (1995) indicate that firms established profit margins based on medium-term plans consistent with the corporate strategic plan. Once selected, the desired profit margin is subtracted from a product's market determined price to estimate its allowable cost. The allowable cost represents the maximum product cost which the firm can incur and achieve its profit objectives.<sup>4</sup>

Under target costing, a multidisciplinary team works within the constraint of the product's allowable cost to design the product and its production processes to meet the functionality and quality demands of customers.<sup>5</sup> In effect, the market attributes of a product become inputs into its development process. Using functional cost analysis, the team decomposes the product's target cost into functions, and then into the components that provide these functions (Yoshikawa, Innes, & Mitchell, 1994, 1995). The team then endeavors to design the product and its components to meet the desired functionality, quality, and cost.

As the design evolves, the product's cost is estimated and compared to its target cost. Typically, the estimated cost will exceed the product's allowable cost. The difference between estimated and target cost represents the cost reduction facing the product development team. When a product's estimated cost exceeds its target cost, value engineering is used to analyze the functions of a product to find ways to achieve these functions more efficiently. For example, value engineering may be used to simplify how components are produced and to determine how they may be manufactured with fewer inputs and/or lower-cost inputs. After redesign, the product's revised cost is compared to its target cost. The redesign process continues until either a product's expected cost is equal to or less than its target cost or the potential for further cost reductions are minimal.

At the beginning of the product life cycle, the target costing process explicitly considers the level of profitability necessary to justify a new product's production. The process ensures that products are produced at a cost sufficient to generate their desired profit. In fact, the cardinal principle of target costing is that firms should only manufacture a product with an expected cost less than or equal to its target cost (Cooper & Slagmulder, 2002).<sup>6</sup> This principle preserves the discipline of target costing during product development. Once a product enters production, Japanese firms use Kaizen costing to increase the efficiency of a product's production processes.

Kaizen costing is important to maintain a product's profitability when the firm confronts increased competition and/or future unanticipated price reductions (Cooper & Slagmulder, 1997).

### *Target Costing Research*

Studies of target costing have examined the characteristics of adopting firms, factors that affect target costing performance, and problems and limitations of its use. Much of the target costing literature describes either case-study observations (e.g., Shank & Fisher, 1999; Bhimani & Neike, 1999; Schmelze, Geier, & Buttross, 1996) or in-depth field studies (e.g., Lin & Yu, 2002; Nicolini, Tomkins, Holti, Oldman, & Smalley, 2000; Lee & Monden, 1996) of firms adopting target costing. These descriptive studies focus on the product development and implementation aspects of target costing. In addition, several surveys of management accounting practices identify how prevalent target costing use has become (e.g., Chen, Romocki, & Zuckerman, 1997). For instance, separate surveys of Indian and Malaysian companies report target cost adoption rates of 35% and 41%, respectively (Sulaiman, Ahmad, & Alwi, 2004).

The characteristics of firms that use target costing have been explored with both small samples (e.g., Swenson, Ansari, Bell, & Kim, 2003; Hibbets, Albright, & Funk, 2003; Ellram, 2000) and surveys (e.g., Tani, 1995; Dekker & Smidt, 2003). These studies reveal that, while cost reduction is the primary reason, most firms have multiple reasons for adopting target costing (Ellram, 2000; Dekker & Smidt, 2003).<sup>7</sup> Other motives for target-cost adoption include cost disclosure and understanding, continuous improvement and competitiveness, improved supplier communications and early supplier involvement, and improved design and accountability (Ellram, 2000). Target-cost users also operate in intensely competitive environments (Swenson et al., 2003; Hibbets et al., 2003; Dekker & Smidt, 2003). According to Hibbets et al. (2003), rivalry among competitors may be the strongest competitive force faced by target-cost users. Additional characteristics of firms that use target costing include extensive supply chains and relatively long product development cycles (Swenson et al., 2003).

Experimental settings have been used to examine how organizational characteristics influence target-costing decisions. For instance, Monden, Akter, and Kubo (1997) investigated how participation in the target-setting process and controllability of the performance-evaluation information affect cost-reduction performance. Their results suggest that a target-cost environment, which allows individuals to participate in the target-setting process and

evaluates them strictly on controllable information leads to better performance. In a similar experiment, Akter, Lee, and Monden (1999) examined how the specificity and difficulty of the target cost influence cost-reduction performance. After splitting their sample based on the degree of goal acceptance, Akter et al. (1999) found that, regardless of goal specificity, high-goal acceptance accompanied by tight goals led to better performance. Finally, Everaert and Bruggeman (2002) explored the influence of time pressure on new product development with and without target costs. The low-pressure group achieved lower product costs when provided with target cost data than without the data. However, supplying the high-pressure group with target costs had little impact on their product cost. Instead, the combination of high time pressure along with target cost data resulted in longer development times compared to the high-pressure group without target costs.

Nicolini et al. (2000), Kato et al. (1995), and Davila and Wouters (2004) have discussed problems and limitations of target costing. For instance, Nicolini et al. (2000) describe the difficulties they encountered when trying to establish a target-costing process in the UK construction industry. Kato et al. (1995), after studying two Japanese firms that use target costing, assert that it can produce “longer development times, employee burnout, market confusion, and organizational conflict.” (p. 49) Finally, Davila and Wouters (2004) suggest that target costing is inappropriate for firms in high-technology industries because it (1) focuses attention away from revenue drivers, and is (2) too time-consuming, (3) too linear and bureaucratic, and (4) too detailed.

## **TARGET COSTING DECISION MANAGEMENT AND CONTROL**

Fama and Jensen (1983) describe the four different aspects of the decision process as initiation, ratification, implementation, and monitoring. Decision initiation, the first step in the decision process, involves analyzing alternatives and proposing a course of action for management to ratify. During the decision-ratification process, managers review the proposals and recommendations from various groups. The ratification process leads to accept or reject decisions regarding which proposals the firm will pursue. Ratified proposals are then implemented. Throughout the implementation phase, monitoring activities are used to review and reward performance. Fama and Jensen (1983) refer to the combination of decision initiation and implementation as decision management, and decision ratification and monitoring as decision control. According to agency theory, separating decision management from

decision control limits the ability of managers to pursue goals that conflict with those of the firm (Weir, 1996).

With target costing, individuals at different levels within the firm, with different skills and perspectives, are responsible for decision management and control. Decision management is a product-oriented process. The personnel involved in decision management specialize in engineering, production, purchasing and other areas with expertise in the design, development, and manufacturing of the firm's products. As part of product initiation, these operational employees use their unique skills and knowledge to design a product and its production processes within the constraints of customer expectations of the product, and at a cost sufficient to justify its production. For firms in highly competitive markets, satisfying both these constraints may require intensive analysis and redesign of a product. During product implementation, operational employees engage in an ongoing process of product and production process improvement. Development teams initiating a target-costing proposal have a strong commitment to their recommendation and a significant investment of time and effort in preparing the proposal for ratification. Similarly, managers implementing a product also have considerable interest in its success. Consequently, personnel involved in decision management risk a loss of reputation and lower performance evaluations, if a product proposal is rejected and/or poorly implemented.

In a target-costing environment, the firm's personnel responsible for decision control ratify proposals prepared during product initiation, and monitor product implementation. Unlike the target costing development team, managers ratifying product proposals do not have an emotional attachment to the product or the personal investment of time and effort. Consequently, managers who ratify product proposals are less biased in their analysis and in their decision of whether to produce the product. Likewise, the individuals monitoring a product's implementation are expected to provide an impartial review of its performance over time and an objective analysis of the need for taking corrective action.

Managers make the decision to ratify a target costing product proposal from a strategic, rather than an operational, perspective. Financial theory suggests that one of management's primary goals is to maximize the firm's share price (Stewart, 1991). As a result, the managers who ratify proposals should integrate the potential effect a product will have on the firm's stock market value into their analysis. Furthermore, since managers review competing proposals for the firm's resources, they must also incorporate into their analyses the capital asset investment needed to support a prospective product's production. Financial theory advocates evaluating investments using

discounted cash-flow techniques. Thus, decision control involves assessing a product's impact on the firm's stock market value, while taking into account the product's investment in capital assets based on its discounted cash flows. Recent advances in financial theory suggest that EVA can deal with these issues simultaneously.

## EVA AND DECISION CONTROL

In the 1990s, [Stewart \(1991\)](#) proposed using EVA to enhance a firm's market performance. Operationally, a firm's EVA reflects the difference between its net operating profit after taxes less a charge for the cost of capital used to earn the profit. [Stewart \(1991\)](#) asserts that a firm's stock market performance is more closely associated with EVA than with accounting measures of income.<sup>8</sup> By letting EVA guide resource allocation decisions, managers can make economic choices congruent with the firm's goal of increasing its stock market performance.

Firms commonly use EVA at the corporate, divisional, and strategic business unit level of their organizations. However, EVA supporters advocate using it at successively lower levels of a firm's operations. For example, [Kaplan and Cooper \(1998\)](#) propose driving EVA down to the firm's activities, products, and customers by integrating it with activity-based costing (ABC).<sup>9</sup> As noted by [Kaplan and Cooper \(1998\)](#), ABC overcomes the distortions of traditional cost systems associated with assigning overhead to cost objects, while EVA corrects the failure of financial accounting to include the cost of capital as an economic expense. Integrating EVA and ABC allows managers to identify which products offer a return greater than the firm's cost of capital. Equally important, managers can assess the efficient and inefficient use of capital in the firm's operations. Finally, managers can determine where cost improvement efforts are needed and where divestiture decisions may be required.

Firms can integrate EVA and ABC by tracing assets, along with other resources, to the activities where they are involved in providing an activity's service ([Kee, 1999](#)). The book value of the assets used by an activity times the firm's cost of capital represents the activity's capital cost. An activity's capital driver rate is computed by dividing its capital cost by the practical capacity of the activity's service or cost driver. Then, capital cost is charged to a product based on the quantity of the capital driver consumed by the activity during its production. Finally, the sum of the product's cost of capital for each activity is subtracted from its after-tax income to compute its EVA. In effect,

integrating EVA and ABC means treating the cost of capital similar to other resources that are traced to activities and then to the products that consume an activity's output. By incorporating EVA, ABC no longer measures a product's accounting profitability but rather its economic income.

EVA represents the value added or destroyed during some period of time. Stewart (1991) notes that the present value of a firm's future EVAs is the firm's market value added, which is the premium or discount between the firm's market value and its capital. Hartman (2000) and Shrieves and Wachowicz (2001) provide mathematical proofs that discounting an investment's EVA over successive periods of its expected life to an investment's acquisition date is equivalent to its net present value (NPV). Similarly, the present value of a product's EVA over its life equals its NPV.<sup>10</sup> Employing Stewart's (1991) concept of market value added, the discounted value of a product's EVA over its life, which is its NPV, reflects the incremental effect the product is expected to have on the firm's market value.

The mathematical proofs by Hartman (2000) and Shrieves and Wachowicz (2001) demonstrate that a product's EVA based on accounting income, rather than its cash flows, can be used to measure its NPV. Their work has several important implications for decision control. First, by discounting a product's EVAs to when production begins, managers assess the product's expected impact on the firm's market value by relying on the same data used for product development (i.e., initiation). Second, managers who base their assessment on the product's discounted EVAs also simultaneously consider the economic feasibility of the capital asset investment used to manufacture the product. Finally, comparing a product's planned and actual discounted EVAs reflects the economic value created or destroyed from product implementation.

## A MODEL FOR DECISION RATIFICATION OF TARGET COSTING PRODUCTS

Before ratifying recommendations made by the target costing development team, managers need to consider the product's expected impact on the firm's market value. As part of the ratification decision, managers can assess whether the proposed product will create or destroy market value by discounting the product's EVA over its expected life, which is equivalent to computing its NPV. A product's NPV will be derived using the following notations:

- $i$  = period index,  $i = 1, 2, \dots, N$ ,
- $j$  = activity index,  $j = 1, 2, \dots, M$ ,

- $P_i$  = unit price in period  $i$ ,  
 $C_{i,j}$  = operating cost of activity  $j$  in period  $i$ ,  
 $Q_i$  = quantity produced and sold of a product in period  $i$ ,  
 $I_{i,j}$  = book value of long-term assets used by activity  $j$  in period  $i$ ,  
 $I_{WC}$  = investment in net working capital for a product,  
 $r_i$  = cost of capital rate in period  $i$ , and,  
 $t_i$  = effective tax rate in period  $i$ .

When a subscript or index is omitted, the variable has been summed over the missing subscript. For example,  $C_i$ , or the unit cost of the product in period  $i$ , represents the sum of the operating cost of  $C_{i,j}$  for each activity  $j$ . Similarly,  $C$  is the unit cost of a product over each period of its life when  $C_i$  is the same for each  $i$ . The subscripts for the other variables can be interpreted in a similar manner.

Using Hartman (2000) and Shrieves and Wachowicz (2001) mathematical proofs, a product's NPV over its economic life may be expressed as

$$NPV = \sum_{i=1}^N \sum_{j=1}^M \frac{(P_i - C_{ij})Q_i(1 - t_i)}{(1 + r_i)^i} - \sum_{i=1}^N \sum_{j=1}^M \frac{r_i I_{i,j}(N + 1 - i)}{N(1 + r_i)^i} - \sum_{i=1}^N \frac{r_i I_{WC}}{(1 + r)^i} \quad (1)$$

On the right-hand side of Eq. (1), each term is discounted to when production of the product will start, i.e., the beginning of period one. The first term measures a product's operating income after taxes,<sup>11,12</sup> while the second and third terms measure the cost of capital for the investment in production assets and working capital, respectively. In the second term, the expression  $(N + 1 - i)/N$  adjusts the assets' book value as successive period's depreciation expense is taken. By summing across each activity used to manufacture a product, Eq. (1) may be restated as

$$NPV = \sum_{i=1}^N \frac{(P_i - C_i)Q_i(1 - t_i)}{(1 + r_i)^i} - \sum_{i=1}^N \frac{r_i I(N + 1 - i)}{N(1 + r_i)^i} - \sum_{i=1}^N \frac{r_i I_{WC}}{(1 + r)^i} \quad (2)$$

If a product's price, unit operating cost, annual product demand, effective tax rate, and cost of capital rate are constant over a product's life, Eq. (2) simplifies to

$$NPV = \frac{(P - C)Q(1 - t)[1 - (1 + r)^{-N}]}{r} - \frac{I}{1} \left[ \frac{1}{1} - \frac{1 - (1 + r)^{-N}}{Nr} \right] I_{WC}(1 - (1 + r)^{-N}) \quad (3)$$

Similar to Eq. (1), the first term on the right-hand side of Eq. (3) is the present value of a product's operating income after taxes, while the second and third terms measure the cost of capital on the investment in operating assets and working capital, respectively. Throughout the remainder of the paper, Eq. (3) will be referred to as the NPV model. As indicated in this model, the present value of the cost of capital on the investment in operating assets equals the difference between the value of the funds initially invested, or  $I$ , and the present value of the depreciation expense taken over the product's life. Conversely, the investment in working capital, or  $I_{WC}$ , is the difference between the initial outlay for working capital and the present value of the funds recovered at the end of the product's life.

Basing the final decision to accept or reject a product on the NPV model has several advantages.<sup>13</sup> First, managers relying on this model will make a product's ratification decision with the same accounting data used by the target costing development team. Therefore, this model minimizes potential confusion between the team initiating the decision and managers ratifying it. Second and more importantly, the NPV model incorporates into the ratification decision the economics of the capital asset and working capital investments needed to manufacture the product. Thus, through a product's NPV, managers gain insight into the expected impact of the product upon the firm's market value.

## **ILLUSTRATION OF THE TARGET-COSTING DECISION PROCESS**

This section provides a numerical example illustrating how a firm can use a product's NPV to separate decision management and decision control in a target-costing environment.

### *Decision Initiation*

Consider a firm evaluating whether to manufacture Product X and/or Product Y. Market research indicates that customers are willing to pay \$48.50 and \$19.00 for Products X and Y, respectively. The research further suggests that at these prices, annual product demand will be 500,000 and 2,000,000 units, respectively, over each product's three-year economic life. The firm requires a profit margin of 10% on products similar to X and Y. Each product's target cost is computed by taking the product's market price less its unit profit, or desired profit margin, times the product's price. As

indicated in Panel I of Table 1, the allowable costs of Products X and Y are \$43.65 and \$17.10, respectively.

To achieve the products' allowable cost, a multidisciplinary team was commissioned to design each product and its production processes. After the initial design, the team compared the estimated cost of Products X and Y to their target cost. Like most firms using target costing, the estimated cost of each product's initial design exceeded its allowable cost. The product development team worked to reduce each product's estimated cost using value engineering to identify different product and process design alternatives. This iterative process of product development continued until each product's estimated cost was less than or equal to its allowable cost or further cost reductions were no longer feasible. Table 1 lists the resulting resource requirements, required investment, cost driver rates, and projected unit costs in Panels II–V, respectively.

Panel II identifies each product's resource requirements. For example, each unit of Product X needs a half pound of material, one labor hour, and two machine hours in the assembly activity. The firm plans to manufacture Product X in batches of 1,000 units. Each production run requires two set-up hours and 20 purchase orders from the set-up and purchasing activities, respectively. Finally, to incorporate new features and technology, Product X calls for 600 engineering drawings from the engineering activity during each year of its economic life. The resource requirements for Product Y can be interpreted in a similar fashion.

Panel III identifies the investment in operating assets and working capital required to produce and sell Products X and Y. The first column of Panel III lists each production-related activity, along with its cost driver. The capital investment and the capacity these funds provide are given in the second and third columns for Product X and fourth and fifth columns for Product Y. For each production-related activity, the investment reflects the capacity needed to manufacture the product's expected demand. Product X requires \$30,000,000 of capital investment to acquire the machinery and other long-term assets needed for production-related activities, compared to \$32,280,000 for Product Y. The last item in Panel III is the net working capital required to support each product.

The cost driver rate computations for the overhead-related activities used to manufacture each product appear in Panel IV. The second column lists the cash expenditures needed to manufacture Product X. The third column contains the annual depreciation cost associated with each activity. The depreciation is computed using each activity's asset cost (Panel III) and assuming straight-line depreciation over a three-year economic life.<sup>14,15</sup>

**Table 1.** Investment, Cost, and Operating Data.

<b>Panel I: Target Cost</b>		Product X		Product Y	
Desired Profit Margin		10%		10%	
Market Based Price		\$	48.50	\$	19.00
Desired Profit Margin			<u>4.85</u>		<u>1.90</u>
Target Cost per Unit		\$	<u>43.65</u>	\$	<u>17.10</u>
<b>Panel II: Product Resource Requirements</b>					
Direct Material (Lbs @ \$5/Lb)		0.5 Lbs /Unit		0.5 Lbs /Unit	
Direct Labor (DLH @ \$15/DLH)		1 DLH/Unit		0.5 DLH/Unit	
Assembly (MH)		2 MH /Unit		0.5 MH /Unit	
Set-up (Hours)		2 Hours/Batch		1 Hours/Batch	
Purchasing (Orders)		20 Orders/Batch		12 Orders/Batch	
Engineering (Drawings)		600 Drawings		500 Drawings	
Batch Size		1,000		1,000	
Expected Annual Demand (units)		500,000		2,000,000	
Useful Life		3 years		3 years	
<b>Panel III: Required Investment</b>					
Activity (Cost Driver):	Product X		Product Y		
	Invested Funds	Practical Capacity	Invested Funds	Practical Capacity	
Assembly (MH)	\$ 24,000,000	1,000,000	\$ 24,000,000	1,000,000	
Set-up (Hours)	1,200,000	1,000	2,400,000	2,000	
Purchasing (Orders)	1,200,000	10,000	2,880,000	24,000	
Engineering (Drawings)	3,600,000	600	3,000,000	500	
	<u>\$ 30,000,000</u>		<u>\$ 32,280,000</u>		
Working Capital (net)	\$ 1,200,000		\$ 1,900,000		
<b>Panel IV: OH-Related Cost Driver Rates</b>					
	Cash Expenditures	Depreciation Expense*	Operating Cost	Practical Capacity	Cost Driver Rates
Assembly (MH)	\$ 2,000,000	\$ 8,000,000	\$ 10,000,000	1,000,000	\$ 10.00
Set-up (Hours)	200,000	400,000	600,000	1,000	\$ 600.00
Purchasing (Orders)	600,000	400,000	1,000,000	10,000	\$ 100.00
Engineering (Drawings)	240,000	1,200,000	1,440,000	600	\$ 2,400.00
	<u>\$ 3,040,000</u>	<u>\$ 10,000,000</u>	<u>\$ 13,040,000</u>		
<b>Panel V: Projected Unit Cost</b>					
	Cost Driver Rate	Input Quantity Product X	Input Quantity Product Y	Unit Cost** Product X	Unit Cost** Product Y
Direct Material (Lbs)	\$ 5.00	250,000	1,000,000	\$ 2.50	\$ 2.50
Direct Labor (DLH)	\$ 15.00	500,000	1,000,000	15.00	7.50
Assembly (MH)	\$ 10.00	1,000,000	1,000,000	20.00	5.00
Set-up (Hours)	\$ 600.00	1,000	2,000	1.20	0.60
Purchasing (Orders)	\$ 100.00	10,000	24,000	2.00	1.20
Engineering (Drawings)	\$ 2,400.00	600	500	2.88	0.60
				<u>\$ 43.58</u>	<u>\$ 17.40</u>

\*Straight-line depreciation is used.

\*\*Unit cost is the product of the cost driver rate and the input quantity needed to manufacture a product divided by the product's annual demand.

Each activity's operating cost, found in the fourth column, is the sum of its cash expenditures and depreciation expense. In the final column, each activity's operating cost is divided by its practical capacity to estimate its cost driver rate. For example, the assembly activity's cash expenditures are \$2,000,000 and its annual depreciation expense is \$8,000,000. Therefore, the

assembly activity's annual operating cost equals \$10,000,000. This amount is divided by the assembly activity's capacity of 1,000,000 machine hours to arrive at a cost driver rate of \$10 per machine hour. The cost driver rates for the other activities listed in Panel IV are computed in a similar manner.

Products X and Y use the same activities and assets in their production. The operating cost of Product Y's activities and their capacities are assumed to be proportional to that of Product X. Consequently, the cost driver rates for the activities required to manufacture Product Y are the same as those for Product X.

Panel V shows the projected unit cost calculation of Products X and Y, which is based on the data from Panels II, III, and IV. The first column of Panel V lists the resource inputs and overhead-related activities, along with their related cost driver, needed to manufacture each product. The second column contains the cost driver rates originally presented in Panels II and IV. The third and fourth columns identify the quantity of inputs needed to manufacture Products X and Y, respectively. These amounts are estimated from the data provided in Panel II. The final two columns detail each product's projected unit cost, \$43.58 for Product X and \$17.40 for Product Y. The projected unit cost is computed by multiplying each activity's cost driver rate times the quantity of its cost driver needed, and then dividing by the product's annual demand. Comparing the data in Panels I and V reveals that Product X's projected cost is less than its allowable cost (\$43.58 versus \$43.65, respectively), while Product Y's expected cost is greater than its target cost (\$17.40 versus \$17.10, respectively). Based on their analyses, the multidisciplinary team recommended that management accept Product X and reject Product Y.

#### *Decision Ratification*

The managers ratifying Products X and Y should begin by reviewing the reliability of the product demand, cost, and investment data presented by the target costing development team (see Table 1). Next, to evaluate the products using the NPV model, the managers must determine an appropriate cost of capital rate and tax rate.<sup>16</sup> The managers ratifying Products X and Y estimated that a cost of capital rate of 10% appropriately reflected each product's risk, and that the firm's effective tax rate of 20% captured their tax effects upon the firm. Substituting these amounts into the NPV model, along with the relevant data for each product found in Table 1, yields an NPV for Products X and Y of -\$535,778 and \$372,367, respectively.<sup>17</sup> Despite exceeding its target profit margin of 10%, Product X's

negative NPV indicates that this product destroys rather than creates economic value for the firm. Conversely, Product Y's profit margin falls below its target profit margin of 10%, but is projected to add economic value to the firm.

The NPV model enables managers ratifying the product development decision to identify cases where the product's target profit margin is insufficient to justify its production (e.g., Product X), and to discover products that increase firm value even though they fail to achieve their target profit margin (e.g., Product Y). During the ratification process, products with a negative NPV may be sent back to the target costing development team to search for further cost reductions. Ultimately, products that do not earn a positive NPV will be rejected. If managers making the ratification decision reject a product, they can use the NPV model to help the development team understand their decision by showing that the product destroys economic value. Conversely, the NPV model can also be used to explain the acceptance of a product with a positive NPV, despite its failure to earn its target profit margin. In this case, this model reveals that the product adds economic value to the firm. Since the NPV model relies on the data provided by the target costing development team, using it to explain the decision to accept or reject a product should help minimize confusion between the operational personnel initiating the proposal and the managers ratifying it.

The target costing development team, with its operational focus, developed the proposals for Products X and Y by benchmarking profit margins from similar products. However, managers who made the ratification decision, evaluated the products based on strategic objectives, such as their potential for increasing stock performance. By relying on the NPV model, managers will only ratify products that are expected to earn a positive NPV, which is consistent with the strategic objective of increasing the firm's market value. As a result, contrary to the development team's expectations, management decided to produce Product Y.

### *Decision Monitoring*

Decision monitoring, which is the second aspect of decision control, involves two types of reviews. Throughout a product's life, managers evaluate the product's performance as well as the individuals in charge of its implementation by periodically comparing actual to planned results. In contrast, the second type of review, a post audit of the product, occurs only at the termination of the product's economic life.

During a product's implementation, operational personnel adjust a firm's manufacturing processes by focusing on a product's short-term (i.e., daily, weekly, and monthly) performance measurements (e.g., defective units, rework, scrap, and yield rates). Conversely, managers responsible for decision control develop an overview of a product's performance by comparing its planned and actual results at periodic intervals (i.e., quarterly and/or annually). This monitoring function enables the decision control managers to review the actions of operational personnel and to evaluate how well they have maintained operational efficiency. By highlighting deviations between planned and actual performance over a period of months, managers monitoring the product's implementation can discover trends and repetitive problems, and separate causes of operational inefficiencies from their symptoms. This information helps identify problematic aspects of the firm's operations and directs management resources toward eliminating inefficiencies in the firm's production processes. At times, the deviations between planned and actual performance result from overly optimistic estimates of the quantity and cost of resources used to manufacture a product. In such cases, periodic monitoring allows the firm's management to revise its plan for subsequent operations using more accurate data.

Table 2 presents data used to monitor the implementation of Product Y. Panels I and II of Table 2 provide the actual and budgeted cost data for the first quarter's production. In Panel I, the second column lists the actual units of Product Y manufactured and the quantity of direct material, labor, and overhead-related resources consumed. The total cost of the inputs used in production, actual cost driver rates, and actual unit cost appear in the remaining three columns, respectively. The actual cost driver rates in the fourth column are computed by dividing the total cost of an input by the quantity of the input consumed. For example, the actual direct material cost driver rate of \$5.00 equals the \$1,249,500 total cost of direct materials divided by the 250,000 lb. of direct materials used to manufacture Product Y. Similarly, the actual unit cost for each input in the fifth column equals the total cost of each input divided by the actual number of units of Product Y manufactured in the first quarter. Except for engineering, the cost of the firm's inputs is closely tied to Product Y's production. However, the firm incurs the entire year's engineering cost at the beginning of each year. Since manufacturing and sales of Product Y are uniform over time, the first quarter's results include one fourth of the annual engineering cost.

Managers who decided to manufacture Product Y relied on the target costing development team's projected sales of 2,000,000 units of Product Y each year. These annual sales figures translate into expected sales of 500,000

units each quarter. However, as seen in Panel I of [Table 2](#), only 490,000 units were actually sold during the first quarter of production. Furthermore, a comparison of planned to actual unit cost (see Panel V of [Table 1](#) and Panel I of [Table 2](#), respectively) indicates that actual cost exceeded planned cost by \$0.322245 per unit ( $= \$17.40 - \$17.722245$ ). While these deviations from planned performance may seem small, the significance of the first quarter's operations can be understood by forecasting future results based on its sales and cost data. For instance, substituting annual sales of 1,960,000 units, or four times first quarter's sales, and actual unit cost data into the NPV model yields a projected NPV of  $-\$1,011,517$ . When managers ratified Product Y, they expected an NPV of  $\$372,367$ . However, if the first quarter's results continue, the realized value of Product Y will decline by  $\$1,383,884$  relative to the amount originally expected. By periodically monitoring a product's performance, managers can determine when deviations from expectations occur and ensure that operational personnel involved with the product's implementation take appropriate corrective action.

The original budget for Product Y and the actual operating results for the first quarter appear in Panel II of [Table 2](#). The first quarter's actual operating income after taxes was  $\$139,120$  less than originally budgeted. This difference arose from the lost contribution margin associated with the 10,000 fewer units sold than expected, and inefficiencies in the first quarter's production. The projected contribution margin per unit for Product Y of  $\$2.20$  equals its price of  $\$19.00$  less combined unit- and batch-level costs of  $\$16.80$  (see Panel V of [Table 1](#)). Therefore, the 10,000 fewer units sold resulted in lost contribution margin of  $\$22,000$  and a reduction of operating income after taxes of  $\$17,600$ . In addition, the cost of the engineering activity, a product-level cost, was originally based on projected output of 500,000 units. Since the firm only manufactured 490,000 units in the first quarter, the actual cost per unit for engineering exceeded expectations by  $\$0.012245$ .

To evaluate manufacturing efficiencies and inefficiencies, Panel II of [Table 2](#) includes a flexible budget based on Product Y's actual sales. The flexible budget reflects the revenue and costs that should have been incurred for Product Y's first quarter actual sales of 490,000 units. The difference between the actual revenue and cost and those in the flexible budget measures the deviation of each activity from efficient operations. As shown in the final column, except for revenue and engineering, all of the variances are negative, indicating operating inefficiencies. The assembly activity has the largest variance of  $-\$107,800$ , increasing the expected cost of assembly from  $\$5.00$  per unit (see Panel V of [Table 1](#)) to  $\$5.22$  per unit (see Panel I of [Table 2](#)). While the other activities' variances are substantially smaller than

**Table 2.** Monitoring of Product Y.

<b>Panel I: First Quarter Results</b>				
	Quantity	Total Cost	Actual Cost Driver Rate	Actual Unit Cost
Production and Sales (Units)	490,000			
Direct materials (Lbs)	250,000	\$ 1,249,500	5.00	\$ 2.550000
Direct labor (DLH)	244,000	3,679,900	15.08	7.510000
Assembly (MH)	250,000	2,557,800	10.23	5.220000
Set-up (Hours)	495	303,800	613.74	0.620000
Purchasing (Orders)	5,950	592,900	99.65	1.210000
Engineering (Drawings)*	500	300,000	600.00	0.612245
		<u>\$ 8,683,900</u>		<u>\$ 17.722245</u>

  

<b>Panel II: Comparison to Budget</b>				
	Original Budget	Actual Results	Flexible Budget	Variance
Quarterly Demand (Units)	500,000	490,000	490,000	
Revenue	\$ 9,500,000	\$ 9,310,000	\$ 9,310,000	\$ -
Direct Materials	\$ 1,250,000	\$ 1,249,500	\$ 1,225,000	\$ (24,500)
Direct Labor	3,750,000	3,679,900	3,675,000	(4,900)
Assembly	2,500,000	2,557,800	2,450,000	(107,800)
Set-up	300,000	303,800	294,000	(9,800)
Purchasing	600,000	592,900	588,000	(4,900)
Engineering*	300,000	300,000	300,000	-
Operating Expenses	\$ 8,700,000	\$ 8,683,900	\$ 8,532,000	\$ (151,900)
Operating Income Before Taxes	\$ 800,000	\$ 626,100	\$ 778,000	\$ 151,900
Tax Expense (20%)	160,000	125,220	155,600	30,380
Operating Income After Taxes	<u>\$ 640,000</u>	<u>\$ 500,880</u>	<u>\$ 622,400</u>	<u>\$ 121,520</u>

  

<b>Panel III: Budgeted and Actual NPV</b>				
	Annual Budget		Actual Results	
	Years 1-3	Year 1	Year 2	Year 3
Annual Demand (Units)	2,000,000	1,985,000	1,998,500	2,000,000
Revenue	\$ 38,000,000	\$ 37,715,000	\$ 37,971,500	\$ 38,000,000
Operating Expenses	34,800,000	34,806,050	34,864,733	34,831,000
Operating Income Before Taxes	3,200,000	2,908,950	3,106,767	3,169,000
Tax Expense (20%)	640,000	581,790	621,353	633,800
Operating Income After Taxes	<u>\$ 2,560,000</u>	<u>\$ 2,327,160</u>	<u>\$ 2,485,414</u>	<u>\$ 2,535,200</u>
Capital Cost (10%)				
Operating Assets		3,228,000	2,152,000	1,076,000
Working Capital		190,000	190,000	190,000
Annual EVA		<u>\$ (1,090,840)</u>	<u>\$ 143,414</u>	<u>\$ 1,269,200</u>
NPV	<u>\$ 372,367</u>	<u>\$ 80,420</u>		

\*The first quarter includes one fourth of the entire year's product-level cost (i.e., engineering) of \$1,200,000, which was incurred at the beginning of the year.

assembly's, collectively they increased Product Y's operating cost, which led to a \$44,100 decrease in its operating income.

As part of the monitoring activity, managers analyzing Product Y's performance should review the results from Panels I and II of [Table 2](#) with operational personnel who implement the product's marketing and production activities. Questions asked might include why Product Y's sales fell 10,000 units below projections and why costs were \$151,900 more than expected. The insights gained from operational personnel about their knowledge of these issues and the corrective actions taken will help managers monitoring Product Y determine whether the situation warrants further attention. As part of the monitoring process, the performance of Product Y will be reviewed at the end of each successive quarter, and annually, using actual and budgeted data similar to that presented in Panels I and II of [Table 2](#). By comparing the current period's results to those of prior periods, the managers monitoring Product Y's operations can assess whether identified problems were addressed. They can also evaluate whether new problems have emerged and how effectively they are being managed.

A final review, or post audit, of Product Y should be performed at the end of its economic life. A post audit involves evaluating a product's performance over its entire economic life to promote organizational learning. Conducting a post audit helps managers identify problems incurred, assess how well they were managed, and better understand the strengths and weaknesses of the firm's operations. A comprehensive review of all aspects of a product from its conception to its termination provides a wealth of insight into the firm's marketing and manufacturing capabilities as well as its limitations. Equally important, a post audit generates information for improving the development and production of future products.

The post audit begins by comparing a product's planned and actual operating performance over its economic life. The second column in Panel III of [Table 2](#) lists the annual budgeted operating income after taxes computed when Product Y was originally ratified. Product Y's actual operating income after taxes for each year appears in the remaining three columns. As seen in Panel III, Product Y never achieved its planned operating income after-tax of \$2,560,000, although the firm made progress toward attaining this goal in years two and three.

Another aspect of the post audit process relates to evaluating the ratification decision, which includes comparing a product's projected NPV to its actual NPV. The actual data in Panel III also lists the cost of capital below each year's actual operating income after taxes. In year one, the cost of capital equals Product Y's investment (see Panel III of [Table 1](#)) times the cost of

capital rate of 10%. Since operating assets are depreciated, the capital cost associated with these assets declines each year. Consequently, the cost of capital in years two and three reflects the book value of assets used to manufacture Product Y at the beginning of the period times the 10% cost of capital rate. However, the cost of capital associated with working capital remains the same each year since this investment relates to a non-depreciable asset.<sup>18</sup> For each year, Product Y's EVA equals the actual operating income after taxes less its total cost of capital. Discounting the EVA for each year to the beginning of period one yields Product Y's actual NPV of \$80,420. Each year, the budgeted EVA can be computed by subtracting the total cost of capital for the year listed in Panel III from the annual budgeted operating income after taxes of \$2,560,000. This calculation results in a budgeted EVA of -\$858,000, \$218,000, and \$1,294,000 in years one, two, and three, respectively. Discounting each budgeted EVA to the beginning of period one derives the original projected NPV for Product Y computed using the NPV model of \$372,367. Even though Product Y did not achieve its entire expected NPV, the post audit reveals that the decision to ratify the product was appropriate.

During the post audit, managers also reexamine a product's quarterly and annual reviews, since they present a comprehensive history of the product's economic life. The marketing and production problems described in these reviews provide managers with information they can use to improve future products. For instance, by analyzing a product's history, managers can assess the reliability of the original sales and cost estimates, which may lead to more accurate forecasts during the product development stage of future products. Besides improved forecasts, such an analysis can also help managers anticipate problems with future products and develop strategies to prevent them from occurring. Moreover, analyzing management's response to the problems documented in a product's reviews can identify areas where additional training of the firm's personnel may be beneficial.

## SUMMARY AND CONCLUSIONS

Decision management includes initiation and implementation decisions, while decision control consists of ratification and monitoring. Fama and Jensen (1983) propose that separating decision management from decision control helps to minimize agency cost. They argue that because of this separation, individuals are more likely to act in the best interest of the firm, rather than their self-interest. However, little has been written concerning the application of Fama and Jensen's proposal to managerial accounting.

This article examines the separation of decision management from decision control in the context of target costing. Operational personnel involved in the product initiation stage of target costing invest a significant amount of their time, energy, and creativity in the iterative process of designing a product to achieve its allowable cost. Similarly, the firm's personnel implementing a product designed with target costing have a substantial commitment to meeting the product's expected functionality, quality, and cost parameters. Therefore, operational personnel developing a product have a vested interest in its acceptance, while those implementing the product have a personal interest in its perceived success. The separation of decision control from decision management promotes an independent evaluation of a product with respect to its ratification. Similarly, the monitoring aspect of decision control provides an impartial evaluation of a product's implementation, and helps identify problems and ways to correct them.

The product initiation phase of target costing involves designing a product to meet a profit goal, frequently, based on the profit margin of similar products. However, product ratification includes assessing a product's impact on strategic objectives, such as increasing the firm's market value. Product ratification also requires evaluating the economics of the capital asset investment necessary to manufacture a product. Managers can combine these two aspects of the ratification decision by using the NPV model developed in this article. This model relies on the work of [Hartman \(2000\)](#) and [Shrieves and Wachowicz \(2001\)](#) who demonstrate through mathematical proofs that discounting an investment's EVAs is equivalent to its NPV. Consequently, the NPV model computes a product's economic income based on the accounting data used during the product's development. Incorporating the same data during product ratification and initiation aids in minimizing confusion between managers responsible for the different types of target cost decisions.

This article also describes monitoring a product's performance through two different types of review. First, monitoring that occurs at periodic intervals throughout a product's implementation involves evaluating deviations between a product's planned and actual performance. This analysis highlights issues encountered during the product's production to direct resources toward correcting operational inefficiencies. The second type of monitoring, a post audit, reviews a product's performance at the end of its economic life. A post audit compares a product's expected and realized NPV, and identifies factors that account for the difference. Monitoring a product at periodic intervals during its life and at the termination of its production helps identify patterns, trends, and problematic issues in the

firm's initiation, ratification, and implementation processes. More importantly, these two types of review stimulate learning and lead to improvements in the development and implementation of future products.

## NOTES

1. EVA is a registered trademark of Stern Stewart and Company.
2. See, for example, [Barfield, Raiborn, and Kinney \(2003\)](#).
3. Once a product's research and development expenditures have been incurred, they become a sunk cost. Consequently, even though the product generates a minimal or negative return, the firm may decide to produce the product based on its expected future revenue and expenses.
4. Technically, external conditions and the market for the firm's product establish its allowable cost, while a product's target cost is determined internally by the firm's design and production capabilities. Sometimes the firm's design and production capabilities are unable to achieve a product's allowable cost. In this situation, the firm must identify the cost reduction that can be attained. The unachievable part of the cost reduction is called the strategic cost-reduction challenge. A product's target cost equals its market price less both the desired profit margin and the strategic cost-reduction challenge. A strategic cost-reduction challenge of zero means a product's allowable and target cost are the same. According to [Cooper and Slagmulder \(2002\)](#), many firms blur the distinction between allowable and target cost. Therefore, throughout the paper, allowable and target cost are used synonymously, similar to their treatment in the target cost literature and their treatment by many firms.
5. As a strategic management accounting practice, target costing requires a cross-functional team effort. In their survey of target cost adopters, [Dekker and Smidt \(2003\)](#) report that while product development and product design are the two departments most involved in the target-costing process, other participants include product planning and finance/accounting.
6. According to [Cooper and Slagmulder \(2002\)](#), firms occasionally break the cardinal rule. For example, "products that create high visibility for the firm, products that introduce the next generation of technology, or products that fill a critical gap in the product line" may be produced even though their expected cost exceeds their target cost ([Cooper & Slagmulder, 2002, p. 11](#)).
7. Interestingly, [Dekker and Smidt \(2003\)](#) report that Dutch firms use cost management practices with characteristics similar to target costing, although they rarely call it target costing.
8. Empirical studies of the relationship between EVA and stock market performance relative to accounting income measures are somewhat mixed. [Chen and Dodd \(1997\)](#) reported a higher association between EVA and stock price returns than with accounting and residual income variables. Conversely, [Biddle, Bowen, and Wallace \(1997\)](#) found that earnings were more highly associated with stock price returns than was EVA. The data in both studies used Stern Stewart's publicly available database that includes a small number of standard adjustments to earnings. However, Stern Stewart makes additional adjustments to its clients' incomes to determine their EVA.

Thus, the data used by [Chen and Dodd \(1997\)](#) and [Biddle et al. \(1997\)](#) may not fully reflect the EVA of the firms in their studies.

9. See [Lee \(2003\)](#) for an extended discussion of the cost and benefits of ABC relative to other cost systems.

10. Financial theory suggests that a firm's stock price already captures current and future anticipated positive NPV projects ([McConnell & Muscarella, 1985](#); [Brown, Lonie, & Power, 1999](#)). Even so, additional unexpected investments in positive NPV projects will increase a firm's stock market performance when sufficient information about the new investment reaches the market ([McConnell & Muscarella, 1985](#)). When a firm's management has lost the market's confidence, announcement of positive NPV projects may not increase the firm's stock market performance ([Brown et al., 1999](#)). However, as the market receives information verifying management expectations, the firm's stock market performance should respond accordingly.

11. A product does not create value for the firm until all of its costs, including those imposed externally on the firm, are recovered. Consequently, both EVA and NPV are computed on an after-tax basis.

12. If a firm sells a product in countries with different tax rates, the economics of target costing become more difficult to evaluate. The higher tax rate in one country may reduce a product's target cost to the point that it cannot be manufactured at this cost. Conversely, the lower tax rate in another country can make a product's target cost relatively easy to achieve. Consequently, a product's target cost in each country must be evaluated from a global, rather than individual country, perspective. That is, target cost for the product in each country should be established from a joint analysis of the product's prospective price, sales quantity, and tax rate in each country. For further discussion of multinational tax planning see [Scholes, Wolfson, Erickson, Maydew, and Shevlin \(2002\)](#).

13. In cases where a product's price, unit operating cost, annual demand, effective tax rate, and/or cost of capital rate are not uniform over a product's life, then Eq. (1) or Eq. (2) should be used in lieu of Eq. (3).

14. Frequently, the assets used to manufacture a product are not product specific and have an economic life longer than the product's life. In such cases, the depreciation and cost of capital for these assets should be limited to the periods when the assets are used to manufacture the product. Conversely, if the assets are product specific, their useful life should reflect the life of the product they will produce.

15. Other depreciation methods, such as sum of the year's digits, could also be used to compute a product's target cost. Straight-line depreciation was chosen for its simplicity of exposition in the paper.

16. Corporate finance has a well-developed body of research for estimating a firm's weighted average cost of capital (WACC). To evaluate the cost of capital for individual projects, many firms classify projects into risk categories. The WACC is subjectively increased (decreased) for categories with more (less) risk than that of the firm. A project is assigned to a category based on its risk relative to that of the firm; then, its cash flows are discounted using the category's risk-adjusted cost of capital. Conversely, the capital asset pricing model can be used to determine a project's risk-adjusted cost of capital. For an extended discussion of the WACC, its measurement and related issues, see [Brigham and Houston \(2001\)](#).

17. The annual projected cash inflows for Product Y total \$13,320,000 in year one and two and \$15,220,000 in year three. Years one and two cash inflow is the sum of Product Y's operating income after taxes, of \$2,560,000, plus depreciation expense of \$10,760,000. Year three cash flow is the sum of operating income after taxes, depreciation expense of \$10,760,000, and the recovery of net working capital of \$1,900,000. The initial cash outlay was \$32,280,000 for operating assets and \$1,900,000 for working capital. The NPV for an initial investment of \$34,180,000 and cash inflows of \$13,320,000 in years one and two, and cash inflow of \$15,220,000 in year three at a cost of capital of 10% equals \$372,367. Similar analysis of Product X's operating cash flows leads to an NPV of  $-\$535,778$ .

18. The difference between the initial investment in working capital and the present value of the funds recovered at the end of the product's life is mathematically equivalent to the present value of an annual capital charge for working capital as computed in Panel III of Table 2. For instance, Product Y requires an initial investment in working capital of \$1,900,000, which will be recovered at the end of year three. The economic cost of working capital equals  $-\$472,502$  ( $= -\$1,900,000 + \$1,427,498$ ). Alternatively, a capital charge of 10% times the working capital investment each year results in an annual cost of \$190,000, which when discounted also yields an economic cost for working capital of  $-\$472,502$ .

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