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A management control system to support corporate sustainability strategies

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ABSTRACT

This paper outlines a management accounting system, based upon cost variance analysis, which supports the pursuit of environmental and traditional financial goals within a decentralized organization. The framework decomposes inefficiencies into two parts. The first consists of what might be considered a natural outcome of pursuing the traditional economic goal of efficiency through cost-minimization, a "waste" variance. The second part consists of sustainability gains that produce societal benefit but may be incongruent with short-term economic goals, a "sustainability" variance. While elimination of waste variances can be encouraged using a traditional performance evaluation and reward structure, elimination of sustainability variances requires re-design of performance evaluation tools and reward structures. We demonstrate that differing production functions across operational units within organizations can impact the relative magnitude of the two variances. The failure to recognize and incorporate these differences can lead to inefficient allocation of resources and/or only partial fulfillment of the strategic environmental goals of the organization.

1. Introduction

As noted by Hartmann, Perego, and Young (2013), there has been insufficient work in the management accounting control literature focused on the development of corporate policy tools that address the misallocation of environmental resources within the firm. The delegation of tasks within a decentralized firm can make it difficult for top management to achieve its sustainability goals.

Recent experience at Diageo North America illustrates the difficulty in coming to grips with such organizational challenges. Diageo, one of the world's largest producers of spirits, wine, and beer, has become recognized as a global leader in environmental sustainability. Since 2007, Diageo North America, the company's largest division by volume, has reduced its greenhouse gas emissions by more than 75%, well ahead of its 50% reduction target for 2015, despite a significant increase in production volumes (Winston, 2013). The area of interest in the present paper is how a firm like Diageo communicates its environmental strategy internally, and what management accounting control tools are used to assure compliance throughout a complex decentralized organization.

An anecdote from the company's recent experience illustrates the involvement of various levels of management. By 2012, the company's North American division had already made substantial progress against its reduction target. At this point the division's sustainability manager proposed that the company's Canadian distillery enter into contracts to purchase natural gas harvested from a landfill, thereby reducing the carbon footprint for Diageo North America by another 30%. This would increase energy costs by more than $1 million per year, an incremental expense larger than the single plant could justify. A senior manager, the president of Global Supply and Procurement, realized that even though the landfill gas solution would increase operating costs for this one plant, it was actually a relatively cheap way to deliver a large reduction in emissions. He gave the go-ahead and some financial leeway to the plant manager who had to take an annual million-dollar-plus charge to his bottom line.

This anecdote has two interesting aspects. First, the management control system adapted to "allow the financial leeway" to the plant manager who was forced to internalize the million dollar cost. The system was required to identify the appropriate amount of leeway to be provided to the plant manager and communicate this information to him/her. Second, the decision process leading to the outcome involved at least three responsibility centers. If such decisions to internalize external costs are to become more widespread and routine, it is important to consider the design of responsibility accounting systems capable of achieving environmental goals at minimum costs.

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As with Diageo, when decisions affecting environmental performance are made at different levels within an organization, a management accounting information system that transmits information and organizational policy across various levels of management is required (Yakhou & Dorweiler, 2004). Epstein (1996) notes: "The success of an environmental strategy implementation depends on providing information related to corporate environmental impacts to various managers within the corporation. Thus, the development and improvement of these systems is critical." Dutta, Lawson and Marcinko (2013) develop a variance-based responsibility accounting system to facilitate such internal communication. In this paper we extend that framework to firms where operating divisions are subject to varying technological constraints. We demonstrate that the optimal response to the firm's strategic environmental goals can differ across divisions within a firm, and the information system and the incentive structure must take such differences into account. In doing so, we address the need to develop a single integrated accounting system to support traditional firm goals and environmental management goals (Hartmann et al., 2013).

Prior research has considered how the conflict between environmental and business goals has affected the design of management accounting system. Gabel and Gabel and Sinclair-Desgagné (1993) investigate the design of optimal wage contracts to alleviate the kind of environmental moral hazard problems encountered by Diageo. Lothe, Myrtveit, and Trapani (1999) envision a compensation system that features an earnings constraint with bonuses awarded for progress against environmental targets. Based on survey evidence, Lothe and Myrtveit (2003) recommend a compensation system that includes performance measures related to both environmental and earnings goals. Figge, Hahn, Schaltegger, and Wagner (2002) attempt an extension of Kaplan and Norton's (2006) balanced scorecard to assess and reward progress against both environmental and social goals.

This paper takes a different approach. We provide a management accounting control mechanism based on traditional responsibility accounting systems to direct attention at appropriate levels of the organization. Using a standard cost system, we demonstrate that variances capable of distinguishing between departures from optimality along both financial and environmental dimensions are sensitive to the technology employed by an operating unit. This approach is beneficial to firms with multiple operating units, each characterized by its own production technology. The cost system also has the capability of assigning responsibility for inefficiencies across various management levels within an organization. Perego and Hartmann (2009) found that the relationship between environmental strategy and the use of environmental performance measures for decision-influencing purposes operated indirectly through systems focused on environmental information quantified in financial terms, which this model provides.

The remainder of this paper is organized as follows. In the next section we develop a management control system that can be used to achieve alignment between environmental strategy and performance measurement. Next, the model is illustrated with numerical examples. We then discuss its implications. Finally, we conclude with observations regarding its implementation and significance.

2. Input choice model

The model of the firm assumes three levels of management: top management, upper level management and the cost center. In traditional management accounting literature these are referred to as the investment center, profit center and the cost center. The objective of the firm is to minimize the cost of producing a budgeted level of a single output Y sold in a competitive market at price p_Y. The budgeted level of output is determined by top management and communicated through the organization. Production requires a number of inputs subject to the technological constraint of a production function, known with certainty throughout the organization. The inputs are substitutable at rates specified by the production function. That is,

$$Y = f(x_1, x_2, \ldots, x_n) \tag{1}$$

Where:

Y = output of the cost center
x_i = quantity of the i^{th} input

The function f is assumed to be single valued. The first partial derivatives with respect to the inputs x_i, are assumed to be positive, i.e., additional amounts of each input would result in higher output:

$$f'_i > 0 \text{ for all i}$$

The profit center manager is aware of the prices of the inputs and uses these prices to determine the optimal input mix that will be used to produce the budgeted level of output. The profit center manager's decision process can be represented by the following constrained optimization problem:

$$\begin{aligned} &\text{Minimize} \sum_{i=1}^{n} p_i x_i \\ &\text{Subject to}: \quad Y_0 = f(x_1, x_2, \ldots, x_n) \end{aligned} \tag{2}$$

where Y_0 equals the budgeted level of output. The problem is solved by introducing a Lagrange multiplier λ and constructing the function:

$$\sum_{i=1}^{n} p_i x_i - \lambda[f(x_1, x_2, \ldots, x_n) - Y_0] \tag{3}$$

The familiar first order minimization conditions require the manager to choose the vector $\boldsymbol{X}$, $(x_1, x_2, \ldots x_i, \ldots x_n)$ as the solution to:

$$\frac{p_i}{p_j} = \frac{f_j}{f_i} \text{ for all i, j} = 1, \ldots, n \tag{4}$$

The first-order conditions [4] imply that a reduction in the price of x_i will require a substitution of x_i for one or more other inputs in order to minimize cost.

This familiar neoclassical model of the firm can be generalized to include the costs of negative externalities resulting from input consumption. Managers are usually unaware and therefore indifferent to the costs borne by society and consequently do not include these in their decision-making process. Private production activities consume resources, the costs of which are not all internalized and paid for by the producer. The costs not borne by the firm are instead borne by society. Shadow prices communicate the social cost of emission, as measured by the decrease in social welfare caused by the emission of one more unit of pollutant. Theoretical development of estimated shadow prices has generally occurred in a mathematical programming context for a variety of pollutants.[1]

The incorporation of shadow prices in the model is accomplished by partitioning the vector of inputs into two subsets: x_1 through x_j, are inputs whose use either cause zero environmental discharges or discharges whose cost is completely captured in the market prices of those inputs; and the remaining inputs, x_{j+1} through x_n, whose use causes negative externalities through environmental discharges, the costs of which are not fully captured in the market prices of those inputs. Thus, p_i for i = 1,…, j measures the full social opportunity cost of consuming one unit of that input, while p_i for i = j + 1,…, n understate the full

[1] Shadow prices for sulfur oxide(s) and nitrogen oxide(s) emissions have been computed for the Korean electrical power industry (Lee, Park, & Kim, 2002). Similarly, a linear programming approach was used to determine shadow prices for sulfur dioxide emissions in thirty regions of China (Ke, Hu, Li, & Chiu, 2008). Underscoring the versatility of a programming approach, shadow prices of runoff and leaching of pesticides was calculated in U.S. agriculture industry (Fare, Grosskopf, & Weber, 2006).

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