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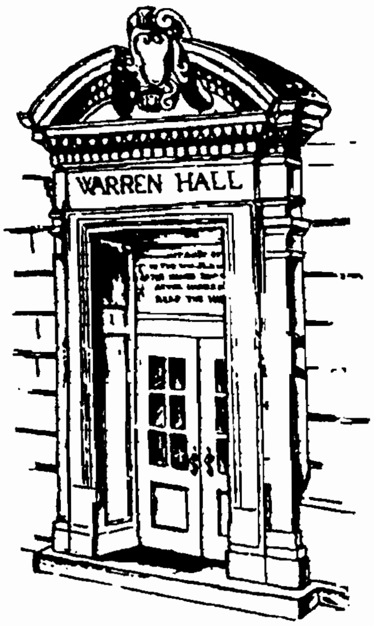

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ESTIMATING THE ORGANIZATIONAL COSTS OF MANAGING THE FARM

by

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Abstract

The organization cost of managing the firm, which Williamson has referred to as the governance costs of internal firm organization, is measured using nonparametric production efficiency concepts. An application to 395 New York dairy farms resulted in an estimate that organization costs, on average, amount to 9 percent of output.

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ESTIMATING THE ORGANIZATIONAL COSTS OF MANAGING THE FARM

Introduction

Demetz has stated that the real tasks of firm management are to devise or discover markets, products and production techniques, and to manage the actions of employees. A neoclassical production function definition of the firm has little to contribute to understanding these management tasks because it assumes that all markets, products, production techniques, and prices are fully known at zero cost. The only management task left is the selection of profit-maximizing quantities of inputs and outputs, but those decisions are effortless and costless to make since the necessary price information required is assumed readily available to all. So although the neoclassical definition of the firm may have assisted us in price analysis in how the firm may digest and pass on an input tax, for example, it has done very little in helping us understand the management process of the firm itself (Demetz).

Färe et al. have further stated that it is inappropriate in economic analysis to assume that all firms operate on the frontier of a production set, and a vast literature has developed in measuring the efficiencies of firms. Little effort has been expended on a theory of waste that Stigler stated is necessary in order for efficiency measurement to have much usefulness. Work instead has concentrated on prescription efforts by determining what characteristics of a firm may be associated with a low efficiency index.

It would be useful to develop a theory that relates a firm's inability to operate on the production frontier and choose the least-cost combination of inputs on that frontier to managerial ability.

In this paper I develop a conceptual framework where a firm is not on the frontier of a production set partially because the organizational costs of moving to that frontier are greater than the benefits from increased efficiency. Williamson has referred to these organizational costs as the governance costs of internal organization, which are simply the costs of organizing within a firm. Production inefficiency may also exist because some firms are ignorant of production possibilities. The distinction between production and organizational inefficiency is made by measuring the efficiency of a firm dominated by another single firm, and then dominated by linear combinations of firms. Measuring inefficiency by single firm dominance only was introduced by Deprins, Simar, and Tulkens. The procedure is discussed thoroughly in Tulkens, where it is referred to as the "FDH" (free disposal hull) production set.

I argue that any inefficiency relative to any other single firm is due to production ignorance because another firm has demonstrated it is possible to produce more efficiently. In contrast, inefficiency relative to any linear combination of firms reflects production plans that are organizationally inefficient since a firm could reorganize as a linear combination of firms and produce more efficiently. If we assume that the firm has complete information to the extent of this organizational inefficiency, then that firm has not replicated the linear combination of firms because the cost must be at least as great as the gain in efficiency. Otherwise, that firm would have organized its production accordingly. Alternatively, a firm could expend resources on reorganization up to the amount of the inefficiency and still accrue a net gain in efficiency. In contrast, single firm dominant inefficiency is assumed due to production ignorance since it is illogical to believe that a firm would have knowledge of increasing its outputs using the same inputs (or decreasing inputs producing the same outputs) and not act on that knowledge.[1] These inefficiencies are measured using nonparametric methods, also referred to as Data Envelopment Analysis in management science.

The Theory

The underlying concept of the nonparametric approach to measuring technical inefficiency is the existence of a bounding technology characterized by an input requirement set L(Y), which can be constructed from observed input/output data from K firms. This set is specified as

$$L(y_1,\ldots,y_m) \equiv \left\{ \begin{array}{l} (x_1,\ldots,x_n):\ y_i \le \sum_{k=1}^{K} \mu_k\, y_{ik}, i = 1,\ldots,m; \\ x_j \ge \sum_{k=1}^{K} \mu_k x_{jk}, j = 1,\ldots,n;\ \mu_k \ge 0, k = 1,\ldots K \end{array} \right\}, \qquad (1)$$

where $\mu = (\mu_1,\ldots,\mu_k)$ is an intensity vector that forms linear combinations of the observed input vectors x_j and output vectors y_i.

Note that this specification allows for linear combinations of the input/output data of the K firms on the set exterior without any loss of efficiency. In the new economic theory of the firm beginning with Coase, allowing linear combinations to represent

[1] A contradictory argument, however, is that a firm can observe any single firm and emulate it. It is much more difficult to determine how a linear combination of firms could be constructed to increase firm efficiency.

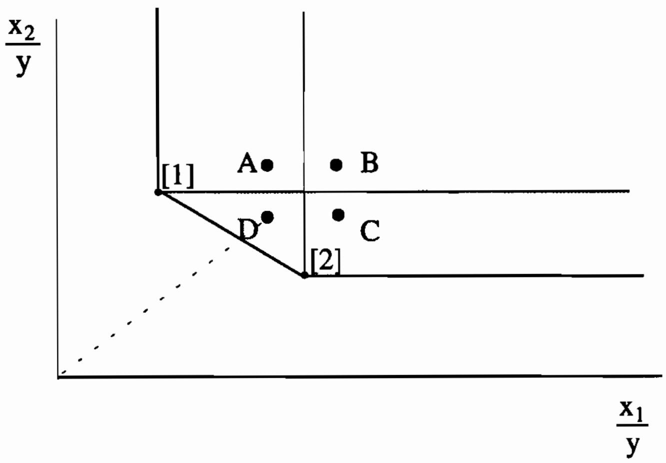
production possibilities would imply that the management inefficiency (cost) of organizing resources between existing firms would be zero. In the terminology of Williamson, the governance costs of internal reorganization, using the current organizational structure of existing firms as a guide, would be zero. That reorganization costs are assumed to be zero in measuring efficiency would appear to be at odds to the fact that inefficiency of any firm may be due to that firm's cost of organizing its current production process.

A more reasonable approach might be to eliminate the assumption of linear firm combination and measure efficiency by strict dominance by any other firm. This allows for positive organizational costs, which would be reflected in the observed input/output data of any firm. This restriction can be imposed on the technology set specified by (1) with the additional condition that $\mu_k \bullet \mu_p = 0$ for $k \neq p$. Models that relax convexity were introduced by Afriat, with extensions by Deprins, Simar, and Tulkens, and by Petersen.

The impact of single firm dominance versus combination dominance is illustrated in Figure 1. In that figure, firms 1, 2, A, B, C, and D input/output ratios for two inputs and a single output are plotted. Firms 1 and 2 are technically efficient. Permitting costless combinations of firms 1 and 2 would measure all the other firms of A, B, C, and D as inefficient. Not allowing combinations of firms 1 and 2 would measure firms A, B, and C as still inefficient, but firm D would be efficient. (Firm A would be dominated by firm 1; firm C, by firm 2; and firm B, by either firm 1 or firm 2.)

The fact that a firm such as D is not dominated by any single firm but can be made dominated by a linear combination of firms, allows the opportunity to use that knowledge to measure the cost of combining firms, in essence, the ability to compute the

Figure 1. Firm Efficiency and the Management Cost of Internal Firm Organization



management cost of organizing production. Firm D can be viewed as efficient; the reason it does not reorganize as a linear combination of the input/output ratios of firms 1 and 2 is because the cost of that reorganization must be greater than the benefit.

In contrast, the structures of either firm A, B, or C cannot be used to determine organization costs. Those firm are clearly inefficient compared to another firm, and they would be better off emulating either firm 1 or firm 2. However, the gains in efficiency that those firms would incur cannot be used to measure the management cost of a gain in efficiency, only the potential benefit of that gain is measurable. The cost of accomplishing that gain must be in an amount greater than the benefit or those firms would have made the necessary changes.

Measurement

The programming model to measure the input distance function technical efficiency of a firm, k, allowing for linear combinations of firms, is

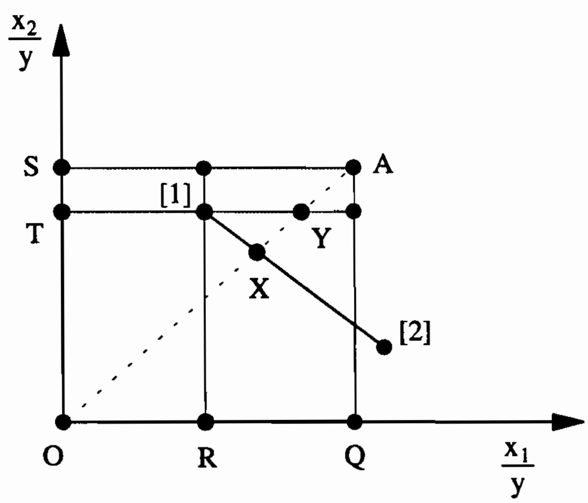
$$\begin{aligned} &\underset{\mu_k}{\text{Min}}\ \lambda_k \\ &\text{s.t.} \sum_{k=1}^{K} \mu_k y_k \geq y_k, \\ &\quad \sum_{k=1}^{K} \mu_k X_{jk} \leq \lambda_k x_{jk}, j = 1,\ldots,n \\ &\quad \mu_k \geq 0, k = 1,\ldots K \end{aligned} \tag{2}$$

where y_k is the output produced by firm k, x_{jk} is the input j used by firm k, μ_k is the intensity vector, and λ_k is the computed efficiency for firm k (Seiford and Thrall). This specification assumes radial technical inefficiency, strong disposability of inputs and outputs, plus constant returns to scale since the summation of the intensity vector μ is not constrained to be equal to one (variable returns to scale) or less than one (increasing returns to scale).

To restrict only single firm dominance rather than linear firm dominance, the additional condition $\mu_k \bullet \mu_p = 0$, $k \neq p$ is added. Unfortunately, the addition of this constraint to the data discussed later produced the local optimal result that $\mu_k = 1$ for all k. An alternative that is computationally efficient and was eventually used is to derive the input/output vector of each firm and divide that matrix of vectors iteratively by each firm's vector. A divisor firm is dominated if any vector of the divided matrix contains all elements less than one. The extent of inefficiency is the element value that is the minimum of each vector's maximum element. Since each firm's vector was divided by itself, the upper bound on this selected element is one. A limitation to this procedure is that it requires constant returns to size in efficiency measurement (the intensity vector μ_k is not constrained).

This procedure is illustrated in Figure 2, which is a subset of Figure 1. Firm A is inefficient to a linear combination of firms 1 and 2. The extent of that radial inefficiency is measured by the ratio of the distance OX to OA. Firm A is also single firm inefficient to firm 1 but not firm 2. The inefficiency of A relative to 1 is measured by the maximum of OT/OS or OR/OQ, which is OT/OS. The ratio OT/OS is equal to the ratio OY/OA, which is a radial measure of efficiency using single firm dominance. No other single firm dominates A, but if any did, then the value of OT/OS, the maximum ratio with comparison to firm 1, would be compared to the maximum ratio with comparison to another firm, with the minimum of the two ratios determining the extent of inefficiency.

Figure 2. Measuring Radial Efficiency by Single Firm Dominance



<u>An Application</u>

A data set comprised of 395 dairy farms from the production year 1990 is used to compute organizational costs (Smith, Knoblauch, Putnam). An application with farms is appropriate because farms are constantly consolidating by purchasing other farms, either partially or completely. This consolidation process incurs organization costs. A large number of firms for a reference set also allows a greater potential for dominance by single firms.

These farms primarily produce milk, and any other sales, such as cull cows or excess grown feed, are by-products incidental to the operation. These and other miscellaneous receipts were converted into a milk equivalent basis by dividing by each farm's price received for milk and then adding to milk output. Seven inputs were defined and include hired labor, unpaid labor (family), purchased feed, grown feed, energy expenditures, miscellaneous expenses, and total assets. The data are measured on an accrual basis, reflecting actual production and input use during the year rather than simply sales or purchases.

Hired labor includes family paid labor and is measured in expenditure dollars. Months of hired labor are available, but the wage rate per month, which averaged $1,269, had a standard deviation of $522, implying that labor quality varies significantly across farms, since local supply and demand conditions across New York cannot explain this large variation in wage rates. Any effort to measure inefficiency should entail homogeneous inputs. Some degree of heterogeneity apparently exists, and one method to partially correct for that is to use the market value of the input, which reflects quality, and is done here. Unpaid labor is measured in months and includes unpaid family as well as operator labor. Many farms had more than one operator or fraction thereof.

Purchased feed consisted of expenditures for feed, and grown feed consisted of total expenditures on various crop-growing inputs. The dry matter of crops produced is available but only reflects one of many important attributes of grown feed and, so, is not used as the input quantity. Using costs of growing feed as a measure of its quality-adjusted quantity may be viewed as assuming that the market value is equal to production cost, but that is not so. If a farmer is expending too much relative to another farmer in relationship to the resultant milk produced, then that farmer will be measured as inefficient.

Energy expenditures primarily include fuel and electricity. Miscellaneous expenses consist of remaining expenses, including items as diverse as veterinarian and farm magazine expenses. Finally, the total value of assets was defined as an input. This is a stock rather than a flow measure, but the information to convert this to a differentiated flow per farm was not sufficiently concise.

The technical efficiency of each of the 395 farms was measured, allowing for both single firm dominance and then linear firm dominance. Of the 395 farms, 200 are dominated by another firm, implying those 200 experienced production inefficiency; in each case another firm has demonstrated that it can produce the same output using less of at least one input and the same quantity of the other inputs (constant returns assumed). Of the 395 firms, 314 are linear firm dominated. (Of course, single firm dominance is a subset of linear firm dominance since a linear combination of one firm is the same as single firm dominance.) Of the 195 farms not dominated by any other single firm, 114 are still dominated by some linear combination of the 395 farms, implying that although those 114 firms did not experience production inefficiency, they nonetheless suffered from organizational inefficiency.

Allowing for linear combinations of firms, which measures both production and organization inefficiency, the average efficiency of the 395 firms is .84, with a standard deviation of .12 (minimum of .50). With the single firm dominance programming specification which only measures production inefficiency, the average efficiency of the 395 farms is .93, with a standard deviation of .09 (minimum of .60). Thus, it would appear that overall technical inefficiency (as measured by a standard DEA model) reduces output by 16 percent on average, but more than half of that (9 basis points) are due to the governance costs of internal organization. The remaining 7 basis points are due to production inefficiency.

Conclusions

The governance costs of internal firm organization, or what Demetz has simply called management costs, is measured using nonparametric production efficiency concepts. It is argued that any technical inefficiency relative to any other single firm is due to production inefficiency, but that technical inefficiency relative to any linear combination of firms reflects the costs of internal firm organization as well as production inefficiency.

An application of these concepts to 395 New York dairy farms, using 1990 data, resulted in an estimate that the governance costs of organization, on average, amount to 9 percent of output, and inefficiency due to production ignorance, on average, amounts to 7 percent of output.

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