DATA ENVELOPMENT ANALYSIS AS A NEW MANAGERIAL AUDIT METHODOLOGY-TEST AND EVALUATION, W. P. 1442-83, OCTOBER 1982

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by

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Abstract

Data Envelopment Analysis (DEA) is a linear programming based technique that was developed to evaluate relative efficiency of nonprofit and public sector Decision Making Units (DMU's) that use multiple inputs to produce multiple outputs. In this study, DEA is evaluated and tested for use as a managerial audit tool to identify and measure inefficiencies among a set of DMU's. Based on three applications of DEA, this technique is found to be a useful technique for allocation of audit resources and for analytic review of operating efficiency when applied to a specific set of audit situations and when interpreted with recognition of DEA's particular strengths and limitations. The value of DEA is further found to extend to a class of for profit managerial audits in addition to the nonprofit and public sector types of audits.

Managerial audits designed to evaluate the effectiveness and efficiency of the operations of an organization have gained increased acceptance and have been increasingly used by managers in government and business. These managerial audits, also referred to as "comprehensive audits" [7], operational audits", "operation reviews" [9], were first actively used by the U.S. General Accounting Office [11] and have since been utilized by other governments, e.g., Canada, Australia, and Israel as well as by various state audit agencies. Corporate internal auditors have increasingly been required to complete managerial audits [9] and regulatory agencies have hired management consulting firms to conduct such audits for utilities (see for example [12]). It has been suggested by J. Burton [1] that managerial audits should be included as an integral part of a financial audit by CPA's to increase the value of their service and to better justify the increasing cost of such audits to management. Trends toward increased use of managerial audits suggest that any methodologies which help to achieve the objectives of these audits will be of value.

In this paper the use of Data Envelopment Analysis is evaluated as a managerial audit technique. Data Envelopment Analysis (DEA) is a linear programming based technique developed by A. Charnes, W. W. Cooper, and E. Rhodes (CCR) [5] [6] to evaluate the relative efficiency of public sector Decision Making Units (DMU's) that use multiple inputs to produce multiple outputs. The mathematical integrity of DEA and its consistency with microeconomic theory have been documented by CCR [5] [6]. Relying on the soundness of this theoretical foundation, DEA has been used to evaluate various public sector DMU's such as educational institution [2] [3] and armed forces recruiting office [8]. The purposes is to investigate how DEA results can be interpreted and used in a managerial audit context to evaluate the efficiency of DMU's and to define the application where DEA is most

appropriate compared with more traditional audit technique to assess organization efficiency. In addition, this investigation serves to clarify and illustrate the strengths and weaknesses of DEA and suggests that DEA can be effectively applied in many for profit business settings for managerial audit purposes in addition to its original intended use for public sector and other nonprofit organization evaluations.

Efficiency versus Effectiveness - Defined

Before proceeding, I should clarify the types of audit objectives for which we consider use of DEA in this paper. The managerial audit may attempt to evaluate effectiveness, the ability of a DMU to set and meet goals, and efficiency, the use of inputs to produce the desired outputs. I do not consider the effectiveness objective in this paper but rather assume that the ouptputs selected by the DMU are consistent with their effectiveness criteria, i.e., that they are producing goods or services that are consistent with the goals. Rather, the emphasise is on the assessment of DMU's technical efficiency. A DMU is defined here to be technically inefficient if a) the DMU could produce the same level of the outputs it produced with fewer inputs than it used or b) the DMU could have produced more outputs than it produced with the same level of inputs used.

Efficiency Evaluation of multiple output-multiple input organizations

The characteristics of DEA that prompt interest in evaluating public sector and nonprofit organizations are as follows

1. Ability to simultaneously consider multiple outputs and inputs in evaluating efficiency.
2. The production function, i.e., efficient input-output relationship need not be known.

These characteristics are particularly useful for nonprofit/public sector evaluation because such organization produce multiple outputs which cannot be

adequately evaluated with more traditional measures such as profit and return or investment, as profit maximization or cost minimization is but one of a broader set of goals. For example, a nonprofit hospital may produce multiple ouptputs including treatment of a variety of patient types, research, training nurses and medical students, and community education. Most of these outputs do not have competitive market prices and the amount of inputs needed to efficiently produce these outputs is generally not known in any detail. An evaluation of hospital efficiency needs to consider the amount of resources used to provide all these outputs when the efficient output input relationships are not known. Hence, DEA appears to be well suited to evaluate the efficiency of such organizations and consequently it is evaluated as a managerial audit tool for such applications. The applicability of DEA in a for profit audit application is also considered at a latter point in the paper.

Outline of the paper

The following section 2 briefly describes the DEA technique and ways it can be applied using standard linear programming computer codes. Section 3 describes an application of DEA to an artificial data set where the efficient and inefficient DMU's are known a priori. We use this artificial data set to investigate DEA's ability to identify inefficient DMU's compared to the known inefficient DMU's. This approach is adopted because in field application of DEA as in [3] and [8] the truly inefficient DMU's are not known and hence, the accuracy of the DEA results cannot strictly be evaluated as I attempt to do here. When DEA locates inefficient DMU's, these DMU's are strictly inefficient compared to other DMU's in the observation set. However, I also find that even in this somewhat simple example, all the inefficient DMU's are not identified as such. In addition, comparing the detailed DEA results to the known inefficiencies indicates alternative paths to improving efficiency