BENCHMARKING MANAGED HEALTH CARE ORGANIZATIONS USING DATA ENVELOPMENT ANALYSIS

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ABSTRACT

The objective of this paper is to benchmark the performance of twelve publicly owned managed care organizations against one another for the period 2009 to 2011. In this paper, we use data envelopment analysis, an operations research technique, to benchmark the performance of twelve publicly managed care organizations. Data envelopment analysis clearly brings out the organizations that are operating more efficiently in comparison to other firms in the industry. Data envelopment analysis also points out the areas in which poorly performing firms need to improve.

Keywords: Health Care, Data Envelopment Analysis

INTRODUCTION

Healthcare represents the largest sector of the US economy. According to the Centers for Medicare & Medicaid Services (CMS), a division of the US Department of Health and Human Services, total healthcare spending reached $2.59 trillion in 2010—$8,402.00 per capita—and 17.9% of the gross domestic product (GDP). The US government estimated that figure rose by 4.4% to $2.71 trillion, or 17.7% of GDP, in 2011.

Until late 2007, a confluence of trends helped the managed care industry thrive: a strong economy, pricing discipline, moderating medical cost trends, enrollment gains (including an influx of Medicare and Medicaid beneficiaries into private managed care programs), geographic expansion, and ongoing consolidation. Disciplined control of administrative functions—including above-average cost cuts and information system upgrades—was another positive driver. With the onset of economic crisis that began in December 2007, unemployment rates rose until October 2009 before trending down, albeit slowly. This rise in unemployment created obstacles to growth for managed care organizations, as commercial membership rolls dropped meaningfully. The rise in the number of uninsured people (16.3% of the US population for the year ended 2010, according to the US Census Bureau) has been an increasing burden on US society. Medicare funding for physicians and hospitals was poised to run out by 2017 (healthcare reform has extended its solvency to 2029), and national health expenditures continue to account for a growing share of US gross domestic product (GDP).

The objective of this paper is to benchmark the performance of twelve publicly owned managed care organizations against one another for the period 2009 to 2011. In this paper, we use data envelopment analysis, an operations research technique, to benchmark the performance of twelve publicly managed
care organizations. Data envelopment analysis clearly brings out the organizations that are operating more efficiently in comparison to other firms in the industry. Data envelopment analysis also points out the areas in which poorly performing firms need to improve.

This study is important for several reasons. Firstly, due to new health care reform legislation being introduced in the economy, the economic and operating environment for the large managed care organizations (MCOs) is less favorable than in recent years. Secondly, due to new legislation several drivers of cost and revenue in the health care industry will change and will impact the profitability of managed care organizations. Healthcare cost expansion in aggregate appears to have ceased moderating, the unemployment rate is up significantly (though it has recently started a gradual uneven decline), and government funding has been rising at a slower pace. With healthcare reform, the government radically changes the way MCOs operate. Although it provides funding to help subsidize the purchase of insurance by those in need (a positive for health insurers), it also imposes prohibitions on certain long-standing insurance industry practices designed to improve profitability and will exact fees from the insurers to help pay for the reforms. Furthermore, the growth in commercial market (i.e., employer-sponsored health insurance) has been stagnant. Therefore, it is important to benchmark the performance of these large managed care organizations to evaluate their performance against one another during the post-recession period.

The rest of the paper is organized along the following lines. In section II, we provide a review of previous studies. Section III discusses the model that we use in this study. Section IV discusses the data and methodology used in this study. In section V, we provide an empirical analysis of our results. Section VI summarizes and concludes our study.

**LITERATURE REVIEW**

Use of data envelopment analysis to analyze financial statements has been illustrated in some previous academic studies. Feroz, Kim, and Raad (2003) illustrate the use of data envelopment analysis to evaluate the financial performance of oil and gas industry. Edirisinghe and Zhang (2007) develop a data envelopment analysis model to evaluate a firm’s financial statements over time in order to determine a relative financial strength indicator that can predict firm’s stock price returns. Zhu (2000) uses data envelopment analysis to develop a multi-factor financial performance model that recognizes tradeoffs among various financial measures. Kao and Liu (2004) compute efficiency scores based on the data contained in the financial statements of Taiwanese banks. They use this data to make advanced predictions of the performances of 24 commercial banks in Taiwan. Pille and Paradi (2002) analyze the financial performance of Ontario credit unions. They develop models to detect weaknesses in Credit Unions in Ontario, Canada. Yasar and McCure (1996) use data envelopment analysis for measuring and assessing the financial performance for hospitals. They compute a financial performance index (FPI) as a measure of aggregate financial performance. They show that financial performance index across many financial ratios eases the comparison of an individual hospital with its peers. Halkos and Salamouis (2004) explore the efficiency of Greek banks with the use of a number of suggested financial efficiency ratios for the time period 1997-1999. They show that data envelopment analysis can be used as either an alternative or complement to ratio analysis for the evaluation of an organization's performance. The study finds that the higher the size of total assets the higher the efficiency. Neal (2004) investigates X-efficiency and productivity change in Australian banking between 1995 and 1999 using data envelopment analysis and Malmquist productivity indexes. It differs from earlier studies by examining
efficiency by bank type, and finds that regional banks are less efficient than other bank types. The study concludes that diseconomies of scale set in very early, and hence are not a sufficient basis on which to allow mergers between large banks to proceed. Paradi and Schaffnit (2004) evaluate the performance of the commercial branches of a large Canadian bank using data envelopment analysis. Chen, Sun, and Peng (2005) study the efficiency and productivity growth of commercial banks in Taiwan before and after financial holding corporations' establishment. They employ a data envelopment analysis approach to generate efficiency indices as well as Malmquist productivity growth indices for each bank. Howland and Rowse (2006) assess the efficiency of branches of a major Canadian bank by benchmarking them against the DEA model of American bank branch efficiency. Sufian (2007) uses DEA approach to evaluate trends in the efficiency of the Singapore banking sector. The paper uses DEA approach to distinguish between technical, pure technical and scale efficiencies.

Sanjeev (2007) evaluates the efficiency of the public sector banks operating in India for a period of five years (1997-2001) using DEA. The study also investigates if there is any relationship between the efficiency and size of the banks. The results of the study suggest that no conclusive relationship can be established between the efficiency and size of the banks. Lin, Shu, and Hsiao (2007) study the relative efficiency of management in the Taiwanese banking system through DEA. The goal is to estimate the competitiveness of each bank and managerial efficiency is to show the efficiency variation of each bank through Malmquist index. Bergendahl and Lindblom (2008) develop principles for an evaluation of the efficiency of a savings bank using data envelopment analysis as a method to consider the service orientation of savings banks. They determine the number of Swedish savings banks being "service efficient" as well as the average degree of service efficiency in this industry.

As illustrated above, there is no study that specifically deals with the managed health care industry. This study extends previous literature by analyzing the performance of the managed health industry at a point in time when the industry is the focus in the United States.

MODEL

The Data Envelopment Analysis Model:
The Data Envelopment Analysis (DEA) (Charnes et al., 1978) is a widely used optimization-based technique that measures the relative performance of decision making units that are characterized by a multiple objectives and/or multiple inputs structure. Data envelopment analysis is a technique used to assess the comparative efficiency of homogenous operating units such as schools, hospitals, utility companies, sales outlets, prisons, and military operations. More recently, it has been applied to banks (Haslem, Scheraga, & Bedingfield, 1999) and mutual funds (Haslem & Scheraga, 2003; Galagedera & Silvapulle, 2002; McMullen & Strong, 1998; Murthi, Choi, & Desai, 1997). It is a powerful technique for measuring performance because of its objectivity and ability to handle multiple inputs and outputs that can be measured in different units. The DEA approach does not require specification of any functional relationship between inputs and outputs, or a priori specification of weights of inputs and outputs. DEA provides gross efficiency scores based on the effect of controllable and uncontrollable factors.

The DEA methodology measures the performance efficiency of organization units called Decision-Making Units (DMUs). This technique aims to measure how efficiently a DMU uses the resources available to generate a set of outputs. The performance of DMUs is assessed in DEA using the concept
of efficiency or productivity defined as a ratio of total outputs to total inputs. Efficiencies estimated using DEA are relative, that is, relative to the best performing DMU or DMUs (if multiple DMUs are the most efficient). The most efficient DMU is assigned an efficiency score of unity or 100 percent, and the performance of other DMUs vary between 0 and 100 percent relative to the best performance.

DATA AND METHODOLOGY

We used the data available from Standard & Poor’s Netadvantage for this study. We used three operational efficiency variables (years 2009-11) to evaluate twelve managed care organizations. Twelve organizations that we include in our study are: Aetna, AGP, Centene, Cigna, Coventry, Health Net, Humana, Magellan, Molina, United Health Care, Well Care, and Well Point. We benchmark the operational performance of these organizations on the basis of the following functional variables:

- **Return on equity** - Return on Equity equals the LTM Net Income from Total Operations divided by Common Stock Equity from the most recent balance sheet. It measures the return on each dollar invested by the common shareholders in a company;  
- **Return on assets** - Return on Assets equals the LTM Net Income from Total Operations divided by the Total Assets from the most recent balance sheet. A measure of profitability, ROA measures the amount earned on each dollar invested in assets;  
- **Total Debt to Equity Ratio**: A measure of a firm’s leverage and is computed by dividing total liabilities by shareholders’ equity. A high ratio makes the firm highly risky;  
- **Total Assets Turnover Ratio**: measures the efficiency of a firm to use its assets to generate its sales;  
- **Medical Benefit Ratio**: It is medical cost as a percentage of premium revenue. The lower this ratio, the better it is for the operational efficiency of a managed care organization.

DATA ENVELOPMENT MODEL SPECIFICATIONS FOR MANAGED CARE ORGANIZATIONS

Besides the mathematical and computational requirements of the DEA model, there are many other factors that affect the specifications of the DEA model. These factors relate to the choice of the DMUs for a given DEA application, selection of inputs and outputs, choice of a particular DEA model (e.g. CRS, VRS, etc.) for a given application, and choice of an appropriate sensitivity analysis procedure (Ramanathan, 2003). Due to DEA’s non parametric nature, there is no clear specification search strategy. However, the results of the analysis depend on the inputs/outputs included in the DEA model. There are two main factors that influence the selection of DMUs – homogeneity and the number of DMUs. To successfully apply the DEA methodology, we should consider homogenous units that perform similar tasks, and accomplish similar objectives. In our study, the organizations are homogenous as they are identified by NetAdvantage to be competitors. Furthermore, the number of DMUs is also an important consideration. In addition, the number of DMUs should be reasonable so as to capture high performance units, and sharply identify the relation between inputs and outputs. The selection of input and output variables is the most important aspect of performance analysis using DEA. In general, the inputs should reflect the level of resources used or a factor that should be minimized. The outputs reflect the level of the economic variable factor, and the degree to which an economic variable contributes to the overall strength (efficiency) of a company.
To study the performance of the managed care organizations, we consider five factors to develop the DEA model: return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio. Out of these five factors, we specify total debt to equity ratio and medical benefits ratio as input, because for a given company the lower these variables are the better the performance of the company is. Similarly, higher total asset turnover ratio, return on equity, and return on assets imply a better-performing company. Thus, we consider these variables as output variables. Finally, the choice of the DEA model is also an important consideration. We should select the appropriate DEA model with options such as input maximizing or output minimizing, multiplier or envelopment, and constant or variable returns to scale. DEA applications that involve inflexible inputs or not fully under control inputs should use output-based formulations. On the contrary, an application with outputs that are an outcome of managerial goals, input-based DEA formulations are more appropriate. In addition, for an application that emphasizes inputs and outputs, we should use multiplier version. Similarly, for an application that considers relations among DMUs, envelopment models are more suitable. Furthermore, the characteristics of the application dictate the use of constant or variable returns to scale. If the performance of DMUs depends heavily on the scale of operation, constant returns to scale (CRS) is more applicable, otherwise variable returns to scale is a more appropriate assumption.

In our study, the comparative evaluation among the organizations is an important consideration. Therefore, we select the envelopment models for our analysis. In addition, the outputs are an outcome of managerial goals. Therefore, output-based formulation is recommended for our study. The objective of the analysis is to suggest a benchmark for the MCOs, to investigate the effect of scale of operations, if any, among the 12 organizations. Therefore, we consider variable returns to scale DEA model. Also, the structure of the DEA model (in envelopment form) uses an equation and separate calculation for every input and output. Therefore, all the input and output variables can be used simultaneously and measured in their own units. In this study, we use the Output-Oriented Variables Return to Scale (VRS) to evaluate the efficiency of 12 MCUs from 2009-2011.

EMPIRICAL ANALYSIS

Each of the MCU is a homogenous unit, and we can apply the DEA methodology to assess the comparative performance of these organizations. This study evaluates the status of the managed care organizations by benchmarking the relative performance of 12 organizations against each other in the industry. Using the DEA methodology, we can calculate an efficiency score for the 12 organizations on a scale of 1 to 100. We analyze and compute the efficiency of these organizations using the financial statements for the years 2009-11. Table 2 illustrates the efficiency scores for the 12 organizations. Further, we also study the peers (model organizations) for inefficient organizations.

Table 2 shows the relative performance of the MCOs benchmarked against each other. Table 2 also shows that five out of twelve organizations were consistently 100% efficient between the years 2009-11. Cigna, Health Net, Magellan, Molina, and Well Care are 100% efficient. On the other hand Aetna, AGP, Centene, Coventry, Humana, United Health Care, and Well Point are inefficient. Figure 1 shows the efficiency frontier graph of the pooled company data. The 100% efficient organizations (blue dots) are on the efficiency frontier, whereas the inefficient organizations (red dots) are inside the efficiency frontier. The DEA Analyzer calculates the level of inefficiency by measuring the distance between the efficiency frontier and the inefficient organizations. Therefore, a manager can use this efficiency
frontier to assess the relative efficiency of the firm in the industry. The DEA model compares the return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio.

We present the 12 MCOs ranked by efficiency for the year 2011 in table 3. We find that the output efficiency of Cigna, Health Net, Magellan, Molina, and Well Care is 100% with rank 1. On the other hand, the output efficiency of the remaining organizations are: AGP (91%), Centene(90%), Humana (83%), Aetna (74%), United Health Care (70%), Coventry (56%), and Well Point (46%) in incrementing rank orders from 2 to 7. This means that the observed levels of return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio for AGP can be achieved with 91% of the current levels of return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio. The same rationale applies to Centene, Humana, Aetna, United Health, Coventry, and Well Point. Table 3 illustrates the efficiency scores and the corresponding ranking of the pooled organizations in the year 2011. The average score is 84%, with five organizations having efficiency levels above average while the remaining five are below the average level. The five 100% efficient organizations turned out to be the best practices organizations within the pooled dataset.

The best practices organizations: Cigna, Health Net, Magellan, Molina, and Well Care are 100% efficient. As AGP, Centene, Humana, Aetna, United Health, Coventry, and Well Point are inefficient; the next step is to identify the efficient peer group or organizations whose operating practices can serve as a benchmark to improve the performance of these organizations. Table 4 illustrates the peer group for the inefficient organizations.

As shown in the Table 5, Well care and Cigna serve as peer for Aetna. In addition, Aetna is more comparable to Well Care (weight 96%) and less comparable to its more distant peer Cigna (4%).Thus, Aetna should scale up its return on equity, return on assets, and total asset turnover ratio. Similarly, AGP has Well Care (71%) as the closest peer that it should emulate and Health Net (29%) as the distant peer company that can also be investigated. Similarly, Coventry is closest in terms of its input-output mix to Well Care with 100% weight. Thus, Coventry should closely follow the policies and management structure of Well Care to improve its efficiency. Finally, Well Care is the most efficient company among the given pool of the organizations as not only is Well Care 100 % efficient, it also serves as a peer for all inefficient countries. Similarly, Healthnet is the next most efficient company among the group of organizations. Healthnet serves as the immediate peer AGP, Centene, and Humana. Finally, Aetna serves as distant peer for AGP. The efficient peer organizations have a similar mix of input-output levels to that of the corresponding inefficient company, but at more absolute levels. The efficient organizations generally have higher output levels relative to the company in question. The features of efficient peer organizations make them very useful as role models that inefficient organizations can emulate to improve their performance. Furthermore, Well Care serves as the immediate efficient peer for all inefficient organizations, so its frequency of use as an efficient-peer, expressed as a percentage of the number of pareto-inefficient organizations, is 100%. Thus, we have enhanced confidence that Well Care is a genuinely well performing organization as it outperforms all the other organizations. Furthermore, these organizations are more likely to be a better role model for less efficient organizations to emulate as their operating practices and environment match the majority of the other organizations quite closely.

After calculating the efficiency of a company using DEA, and identifying the efficient peers, the next step in DEA analysis is feasible expansion of the output or contraction of the input levels of the company within the possible set of input-output levels. The DEA efficiency measure tells us whether or
not a given company can improve its performance relative to the set of organizations to which it is being compared. Therefore, after maximizing the output efficiency, the next stage involves calculating the optimal set of slack values with an assurance that output efficiency will not increase at the expense of slack values of the input and output factors. Once efficiency has been maximized, the model does seek the maximum sum of the input and output slacks. If any of these values is positive at the optimal solution to the DEA model that implies that the corresponding output of the company (DMU) can improve further after its output levels have been raised by the efficiency factor, without the need for additional input. If the efficiency is 100% and the slack variables are zero, then the output levels of a company cannot be expanded jointly or individually without raising its input level. Further, its input level cannot be lowered given its output levels. Thus, the organizations are pareto-efficient with technical output efficiency of 1. If the company is 100% efficient but one slack value is positive at the optimal solution then the DEA model has identified a point on the efficiency frontier that offers the same level on one of the outputs as company A in question, but it offers in excess of the company A on the output corresponding to the positive slack. Thus, company A is not Pareto-efficient, but with radial efficiency of 1 as its output cannot be expanded jointly. Finally, if the company A is not efficient (<100%) or the efficiency factor is greater than 1, then the company in question is not Pareto-efficient and efficiency factor is the maximum factor by which both its observed output levels can be increased without the changing its input. If at the optimal solution, we have not only output efficiency > 1, but also some positive slack, then the output of company A corresponding to the positive slack can be raised by more than the factor output efficiency, without the need for additional input. The potential additional output at company A is not reflected in its efficiency measure because the additional output does not apply across all output dimensions. Table 5 illustrates the slack values identified in the next stage of the DEA analysis. The slack variables for 100% efficient organizations are zero. Therefore, Cigna, Health Net, Magellan, Molina, and Well Care are Pareto-efficient as the DEA model has been unable to identify some feasible production point which can improve on some other input or output level. On the other hand, for Aetna, there is further scope for increasing return on assets by .24 units, return on equity by 3.0 units and decrease total debt to equity ratio by .24 units. Aetna can follow Well Care and Cigna as its role model and emulate their policies. Similarly, AGP can increase its return on equity by 3.0 units and decrease total debt to equity ratio by .31 units and medical benefits ratio by 1.92 units. Table 5 illustrates the slack values of the relevant factors for inefficient organizations.

**SUMMARY AND CONCLUSIONS**

Traditional financial statement analysis techniques use ratio analysis to compare a firm’s performance against its peers in the industry as well as against the company’s historical performance. On the basis of this comparison, analyst will recommend whether the company is doing well or underperforming relative to its peers or relative to its own past performance. DEA employs relative efficiency, a concept enabling comparison of organizations with a pool of known efficient organizations. The DEA model compares a firm with the pool of efficient organizations by creating an efficiency frontier of good firms—a tolerance boundary created by establishing the efficiency of firms in terms of several sets of financial ratios. Organizations lying beyond this boundary can improve one of the input values without worsening the others. We found that Cigna, Health Net, Magellan, Molina, and Well Care 100% efficient and serve as best practices organizations. On the other hand AGP, Centene, Humana, Aetna, United Health, Coventry, and Well Point are inefficient. We also illustrate the areas in which inefficient organizations are lacking behind efficient firms.
We also provide an insight into the benefits of DEA methodology in analyzing managed care industry. The managers can use a decision support system that stores the company’s historical data, competitive firm’s data, and other industry specific data, and uses the DEA methodology to analyze their organization’s performance. Moreover, DEA modeling does not require prescription of the functional forms between inputs and outputs. DEA uses techniques such as mathematical programming that can handle a large number of variables and constraints. As DEA does not impose a limit on the number of input and output variables to be used in calculating the desired evaluation measures, it’s easier for managers to deal with complex problems and other considerations they are likely to confront.

TABLES, FIGURES, & REFERENCES

Tables, figures, references, and full paper available upon request from the authors.