Corporate Governance and Technical Efficiency: Evidence from the Chemical and Business Service Industries

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We examine the association between corporate governance and technical efficiency in the chemical industry (SIC=28) and the business service industry (SIC=73). We rely on Data Envelopment Analysis (DEA) to calculate the technical efficiency score and measure corporate governance by using the corporate governance index provided by Brown and Caylor (2008). Regression analysis documents evidence to support a positive association between corporate governance and technical efficiency in both industries. The results should interest managers who engage in behavior leading to or maintaining strong corporate governance mechanisms, financial analysts who conduct research on corporate governance and firm performance, and policy makers who design and implement guidelines on corporate governance mechanisms. Moreover, results in this study can increase individual investors' confidence in investing in companies with stronger corporate governance.

INTRODUCTION

Due to notorious business scandals such as Enron and WorldCom, corporate governance has become an important research topic. Prior studies document that strong corporate governance leads to enhanced operating performance of a firm. Operating performance in prior studies is often measured by traditional accounting-based ratios, like return on assets (ROA) and return on equity (ROE). For example, Gompers et al. (2003) document a positive relationship between corporate governance and return on equity (ROE), while Brown and Caylor (2008) report a positive association between corporate governance and return on assets (ROA) and return on equity (ROE). However, Feroz et al. (2008) argue that accounting ratios like ROA may generate inconclusive performance results, since these measures are measure-specific and can be affected by non-value-added factors.

The purpose of this study is to examine the association between corporate governance and firm operating performance by using a more comprehensive firm performance measure. Specifically, the firm performance measure in our study is technical efficiency, which is

calculated by Data Envelopment Analysis (DEA). Since DEA requires that sample firms have similar production functions, we apply DEA to firms on an industry-by-industry basis. We select two industries, the chemical industry (SIC=28) and the business service industry (SIC=73), in our analysis. Regression analysis documents evidence to support a positive association between corporate governance and technical efficiency in both industries. In addition, consistent with Brown and Caylor (2008), we document a significantly positive relation between corporate governance and two ratios – ROA and ROE. Our results should interest managers who engage in behavior leading to or maintaining strong corporate governance mechanisms, financial analysts who conduct research on corporate governance and firm performance, and policy makers who design and implement guidelines on corporate governance mechanisms. Moreover, results in this study can increase individual investors' confidence in investing in companies with stronger corporate governance.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Many prior studies have examined the association between corporate governance and firm performance. Beasly et al. (2000) examine the association between corporate governance and financial statement fraud instances in the technology industry, the heath care industry, and the financial service industry. Beasly et al. (2000) report that these sample fraud firms have very weak corporate governance mechanisms. Similar to Beasly et al. (2000), Farber (2005) uses 87 fraud firms identified by the SEC and examines the association between the quality of governance mechanisms and the credibility of a firm's financial reporting system. Farber (2005) documents that the 87 sample fraud firms have weak corporate governance relative to a control sample. The above findings suggest that stronger corporate governance is associated with lower incidence of financial fraud.

Klein (2002) investigates the association between corporate governance and earnings management and documents that audit committee independence and board independence both are negatively related to abnormal accruals. Findings in Klein (2002) suggest that stronger corporate governance leads to lower levels of earnings management. Gompers et al. (2003) examine the association between corporate governance and long-term equity return, firm value and accounting-based performance measures. Their results indicate a significantly positive relationship between corporate governance and these variables. In their study, they use net profit margin and return on equity as proxies for operating performance of a firm.

Based on the above studies, Brown and Caylor (2008) suggest that good corporate governance creates a system of greater controls over managerial actions, which in turn should reduce principal-agency problems. Reduced principal-agency problems will improve a firm's operating performance. Relying on data from Institutional Shareholder Service (ISS), Brown and Caylor (2006, 2008) create a firm-specific corporate governance index, known as Gov-Score. Unlike other governance indexes, Gov-Score is based on both internal and external factors. Using return on assets (ROA) and return on equity (ROE) to measure a firm's operating performance, Brown and Caylor (2008) document a significant and positive relationship between Gov-Score and a firm's operating performance. Empirical results support the notion that better-governed firms have better operating performance.

We extend the prior work by examining the relationship between corporate governance and technical efficiency, a more comprehensive measure of firm performance. We predict a positive link between corporate governance and technical efficiency.

H: Corporate governance is positively associated with technical efficiency.

RESEARCH DESIGN

Measurement of the Primary Variable – Technical Efficiency

This study uses a nonparametric model–Data Envelopment Analysis (DEA)—to measure firm efficiency. As pointed out by Charnes et al. (1978), DEA is "a mathematical programming model applied to observational data that provides a new way of obtaining empirical estimates of relations that are cornerstones of modern economics." Cooper et al. (2000) suggest that compared to traditional methods, DEA is a better method to measure performance in the following ways. First, unlike the typical parametric approach that compares each decision making unit (DMU) to an average DMU, DEA compares each DMU to the 'best' DMU. Second, DEA does not require a prescribed functional form, such as the Cobb-Douglas production function. Third, DEA does not require users to assign weights to each input and output. Due to its simplicity and flexibility, we use DEA to measure firms' technical efficiency in our study.

For each DMU, DEA forms the input and output by weights (v_i) and (u_i):

Input = $v_1 x_{10} + \ldots + v_m x_{m0}$

Output = $u_1 y_{10} + \ldots + u_s y_{s0}$

By using linear programming techniques, DEA attempts to determine the weights so as to maximize the (output/input) ratio. Each DMU is assigned a 'best' set of weights with values that may differ from one DMU to another. The term 'best' is used here to mean that the (output/input) ratio for each DMU is maximized, relative to all other DMUs. Figure 1 shows a simple example of DEA. Assume one input and one output. The production function of each DMU is variable-return-to-scale. Suppose there are only 5 DMUs, (A, B, C, D, and E).

DMUs (A, B, C, D) are on the production efficiency frontier, and thus their values of the (output/input) ratio are one. The values of the (output/input) ratio for DMUs, which operate beneath the production efficiency frontier, are between zero and one. For instance, the efficiency of DMU (point) E is GF/GE.

The first step in a DEA analysis is to select a specific DEA model. This study applies the variable-return-to-scale DEA model, also known as the BCC model (Banker et al., 1984). It is recommended by Cooper et al. (2000) to use the BCC model if there are multiple inputs or outputs involved in DEA studies. The BCC model estimates the efficiency of DMUs by solving the following linear program:

$$\text{Max } z = u \cdot y_0 - u_0$$

Subject to

$$v \cdot x_0 = 1$$

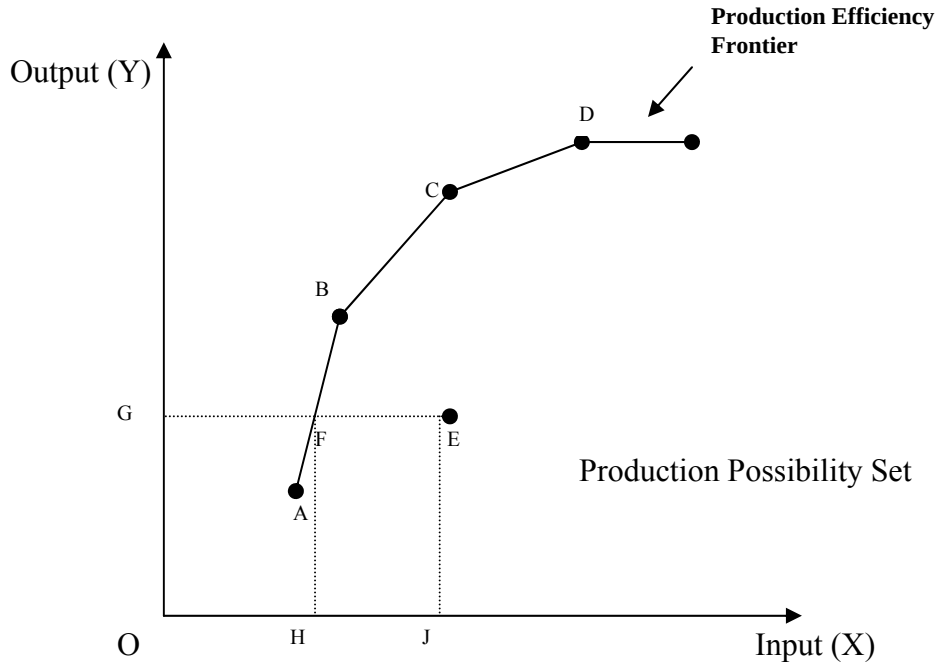
$$-v \cdot x + u \cdot y - u_0 e \le 0$$

$$v \ge 0, \quad u \ge 0, \quad u_0 \text{ free in sign}$$

Where

x, y represent vectors of inputs and outputs respectively,
z and u_0 are scalars,
u_0 may be positive or negative,
e denotes a row vector in which all elements are equal to 1,
v and u denote weights associated with a particular DMU.

FIGURE1
AN EXAMPLE OF DEA



Selecting input and output variables to use in the DEA model is the next task. Physical measures and monetary measures are common types of input/output variables. This study uses monetary measures for the following three reasons. First, it is difficult to obtain variable information in physical units. Second, Battese and Coelli (1995) suggest that it is preferable to use monetary measures to measure efficiencies at the firm level since a firm is often engaged in many different activities. Third, using monetary measures may capture more information. Feroz et al. (2008) argue that accounting measures like ROA and ROI may generate inconclusive performance results, since these measures are measure-specific and can be affected by non-value-added factors. Instead, Feroz et al. (2008) suggest that incorporating traditional accounting variables, such as sales and cost of goods sold, into a DEA model may produce a more comprehensive measure of firm performance. Consistent with Feroz et al. (2008), we include two conventional input variables (cost of goods sold and selling, general and administrative expenses) and one conventional output variable (sales) in our DEA. Table 1 summarizes these variables.

TABLE 1
VARIABLE SELECTION FOR EFFICENCY MODEL

Panel A: Output Variable

Variable Name	Measurement	Description
Sales (Compustat Item #12)	in dollars	This variable represents sales after any discounts, returned sales and allowances for which credit is given to customers.

Panel B: Input Variables

Variable Name	Measurement	Description
Cost of Goods Sold (COGS) (Compustat Item # 41)	in dollars	This item represents all costs directly allocated to production, such as direct materials, direct labor and overhead.
Selling, General and Administrative Expenses (XSGA) (Compustat Item #189)	in dollars	This item represents non-production expenses incurred in the regular course of business.

Measurement of the Primary Variable – Corporate Governance

Institutional Shareholder Services (ISS) has developed a tool to measure the strength of corporate governance. The ratings are based on eight areas, which are (1) board structure and composition, (2) audit issues, (3) charter and bylaw provisions, (4) laws of the state of incorporation, (5) executive and director compensation, (6) qualitative factors, (7) director and officer stock ownership, and (8) director education. There are 61 variables in the above 8 areas. ISS gathers data from public resources, and companies can also provide ISS with updates or corrections that may cause ISS to recalculate the ratings.

Based on the ratings from ISS, Brown and Caylor (2006, 2008) created a summary score, known as Gov-Score, to measure the strength of corporate governance. They selected 51 variables, and coded each of 51 variables either 0 or 1 depending on whether or not ISS considers the firm's governance to be minimally acceptable. Brown and Caylor (2006, 2008) then summed those 51 binary variables to create a firm-specific summary score. Thus, a Gov-Score ranges from 0 to 51. Gov-Scores are generously provided by Brown and Caylor (2006, 2008). Interested users can freely download the data from their website. The data file contains Gov-Score for 2,538 firms as of February 1, 2003, 2,749 firms as of February 1, 2004 and 3,258 firms as of February 1, 2005.

Empirical Specification

This study uses the following regression to test the association between corporate governance and technical efficiency. Three control variables are included to control for firm size, leverage ratio, and market-to-book ratio. The model is as follows:

$$GOV = \alpha_0 + \alpha_{1*}EFF + \alpha_2*LTA + \alpha_3*LEV + \alpha_4*MTB + \varepsilon \qquad \text{[Equation 1]}$$

Where

GOV = Corporate governance index score as of Feb. 2005, created by Brown and Caylor (2006, 2008);
EFF = Technical efficiency score of a firm;
LTA = natural log of total assets in 2004;
LEV = Leverage ratio (total liabilities/total assets) in 2004;
MTB = Market-to-Book ratio (ending market value/net book value of the firm) in 2004;

SAMPLE SELECTION AND DESCRIPTIVE STATISTICS

We obtain the list of firms with Gov-Scores from the website described in Brown and Caylor (2006, 2008). Gov-Scores are available for 3,258 firms as of February 1, 2005. Consistent with Brown and Caylor (2008), we use the prior year (2004) as the testing period. Data then is collected from Compustat. These variables include sales, cost of goods sold, selling, general and administrative expense, total assets, total liabilities, market-to-book ratio, returns on assets and return on equity.

DEA studies assume that all sample firms have similar production functions. That is, sample firms should all come from the same industry. In this study, we select the chemical industry (SIC =28) and the business service industry (SIC =73) to test the association between corporate governance and technical efficiency. For chemical firms, we match the chemical firms with Gov-Scores to all chemical firms on Research Insight, and then remove those observations with missing values. We identify 158 chemical firms with complete data. For business service, we perform the same matching procedure, and identify 300 business service firms with complete data.

Table 2 summarizes the descriptive statistics of the sample firms from the chemical industry. We select 9 variables, including Gov-Score, efficiency score, revenue, cost of goods sold, selling, general and administrative expense, total assets, total liabilities, leverage ratio and market-to-book ratio. For instance, the mean value of Gov-Score is 29.892, while the mean value of efficiency score is 0.737.

TABLE 2
DESCRIPTIVE STATUSTICS FOR CHEMICAL FIRMS (SIC =28)

Variables	Mean	Standard Deviation	Minimum	25th Percentile	Median	75th Percentile	Maximum
GOV	29.892	5.216	19.000	26.000	30.000	34.000	41.000
EFF	0.737	0.224	0.087	0.626	0.795	0.896	1.000
REV	2848.077	8186.925	0.000	24.400	239.260	1605.110	52516.000
COGS	1179.922	3487.875	0.000	11.220	78.125	881.670	32301.000
XSGA	965.818	3175.047	2.080	22.790	93.270	425.000	24523.000
TA	4221.976	13292.449	2.580	57.300	357.445	2426.000	123684.000
TD	2348.989	7101.711	0.560	14.590	137.150	1262.000	55406.000
LEV	0.436	0.237	0.030	0.226	0.441	0.606	0.964
MTB	4.963	5.427	0.890	2.110	3.270	5.170	28.200

Variable Definitions:
GOV = Corporate governance index score as of Feb. 2005, created by Brown and Caylor (2006, 2008);
EFF = Technical efficiency score of a firm;
REV = Revenues in 2004;
COGS= Cost of goods sold in 2004;
XSGA = Selling, general, and administrative expenses in 2004;
TA = Total assets in 2004;
TD = Total liabilities in 2004;
LEV = Leverage ratio (total liabilities/total assets) in 2004;
MTB = Market-to-book ratio (ending market value/net book value of the firm) in 2004;

Table 3 reports the descriptive statistics of sample business service firms in our study. For instance, the mean value of Gov-Score is 27.003, while the mean value of efficiency score is 0.617.

TABLE 3
DESCRIPTIVE STATUSTICS FOR BUSINESS SERVICE FIRMS (SIC =73)

Variables	Mean	Standard Deviation	Minimum	25th Percentile	Median	75th Percentile	Maximum
GOV	27.003	4.694	16.000	24.000	26.000	30.000	40.000
EFF	0.617	0.150	0.184	0.516	0.591	0.690	1.000
REV	1106.884	6211.441	0.760	47.740	146.260	594.800	96293.000
COGS	556.163	3509.193	0.240	13.545	48.140	230.340	55504.000
XSGA	341.853	1812.303	1.370	21.100	66.035	172.765	24612.000
TA	1600.017	8592.863	2.220	17.190	197.465	662.405	109183.000
TD	754.810	4871.995	0.290	18.215	64.940	261.700	79436.000
LEV	0.413	0.201	0.025	0.246	0.380	0.570	0.967
MTB	4.633	8.282	0.640	1.825	3.005	4.555	103.200

Variable Definitions:
GOV = Corporate governance index score as of Feb. 2005, created by Brown and Caylor (2006, 2008);
EFF = Technical efficiency score of a firm;
REV = Revenues in 2004;
COGS= Cost of goods sold in 2004;
XSGA = Selling, general, and administrative expenses in 2004;
TA = Total assets in 2004;
TD = Total liabilities in 2004;
LEV = Leverage ratio (total liabilities/total assets) in 2004;
MTB = Market-to-book ratio (ending market value/net book value of the firm) in 2004;

Table 4 reports Pearson correlation matrix for the variables of chemical firms. For each pair of variables, the Pearson correlation coefficient and related p-value are provided. The coefficient measures the strength and direction of a linear relationship between two variables. In particular, we include ROA and ROE in our Pearson correlation analysis. Based on the findings in Brown and Caylor (2008), we expect a positive and significant relation between Gov-Score and these two ratios. Results from Table 4 indicate that some variables are correlated at a significant level. For instance, Gov-Score is positively correlated with efficiency, natural log of total assets, leverage ratio, ROA and ROE at 0.01 level (two-tailed test). The significant association between Gov-Score and ROA (or ROE) is consistent with Brown and Caylor (2008).

TABLE 4
PEARSON CORRELATIONS AMONG SECECTED VARIABLES
CHEMICAL FIRMS (SIC =28)

	GOV	EFF	LTA	LEV	MTB	ROA
EFF	0.373					
(p-value, two-tailed)	<0.0001					
LTA	0.626	0.421				
(p-value, two-tailed)	<0.0001	<0.001				
LEV	0.373	0.246	0.434			
(p-value, two-tailed)	<0.0001	0.0019	<0.001			
MTB	-0.035	-0.141	-0.124	0.334		
(p-value, two-tailed)	0.6615	0.0773	0.1218	<0.0001		
ROA	0.326	0.660	0.501	0.127	-0.258	
(p-value, two-tailed)	<0.0001	<0.0001	<0.001	0.1130	0.0011	
ROE	0.218	0.403	0.349	-0.194	-0.562	0.645
(p-value, two-tailed)	0.0059	<0.0001	<0.001	0.0146	<0.0001	<0.0001

Variable Definitions:
GOV = Corporate governance index score as of Feb. 2005, created by Brown and Caylor (2006, 2008);
EFF = Technical efficiency score of a firm;
LTA = Natural log of total assets in 2004;
LEV = Leverage ratio (total liabilities/total assets) in 2004;
MTB = Market-to-Book ratio (ending market value/net book value of the firm) in 2004;
ROA= Return on Assets ratio in 2004;
ROE= Return on Equity ratio in 2004;

Table 5 reports Pearson correlation matrix for variables of business service firms. Results from Table 5 indicate that some variables are correlated at a significant level. For instance, Gov-Score is positively correlated with efficiency, natural log of total assets, and ROE at 0.01 level (two-tailed test), while Gov-Score is positively correlated with ROA at 0.05 level (two-tailed test). The significant association between Gov-Score and ROA (or ROE) is also consistent with Brown and Caylor (2008).

TABLE 5
PEARSON CORRELATIONS AMONG SECECTED VARIABLES
BUSINESS SERVICE FIRMS (SIC =73)

	GOV	EFF	LTA	LEV	MTB	ROA
EFF	0.275					
(p-value, two-tailed)	<0.0001					
LTA	0.551	0.331				
(p-value, two-tailed)	<0.0001	<0.0001				
LEV	0.068	0.005	0.065			
(p-value, two-tailed)	0.2418	0.9257	0.2597			
MTB	0.084	0.234	0.002	0.334		
(p-value, two-tailed)	0.1453	<0.0001	0.9780	<0.0001		
ROA	0.127	0.308	0.285	-0.053	0.017	
(p-value, two-tailed)	0.0275	<0.0001	<0.001	0.3571	0.7653	
ROE	0.185	0.260	0.312	-0.083	0.172	0.757
(p-value, two-tailed)	0.0013	<0.0001	<0.001	0.1534	0.0029	<0.0001

Variable Definitions:
GOV = Corporate governance index score as of Feb. 2005, created by Brown and Caylor (2006, 2008);
EFF = Technical efficiency score of a firm;
LTA = Natural log of total assets in 2004;
LEV = Leverage ratio (total liabilities/total assets) in 2004;
MTB = Market-to-Book ratio (ending market value/net book value of the firm) in 2004;
ROA= Return on Assets ratio in 2004;
ROE= Return on Equity ratio in 2004;

In addition, results from both Table 4 and 5 indicate that the efficiency score is positively correlated with the following variables - ROA and ROE at 0.01 level (two-tailed test). The above evidence suggests that firm efficiency, ROA and ROE are highly correlated. To avoid potential multicollinearity among independent variables, we exclude ROA and ROE from the regression model.

RESULTS

This study predicts a significantly positive association between corporate governance and technical efficiency. To test the hypothesis, we run the regression model (Equation 1) for both industries. Panels A and B of Table 6 report the results of regression analysis for the chemical industry and the business service industry, respectively. As shown in Panel A of Table 6, α_1 is 2.9291, which is significant at p = 0.0696. For business service firms, Panel B of Table 6 reports that α_1 is 2.7797, which is significant at p = 0.0948. Thus, our regression results indicate significant evidence ($p<0.10$) to support a positive association between corporate governance and technical efficiency.

This study includes three control variables in the regression analysis. Results from Table 6 report a significantly positive relation between corporate governance and firm size, measured as natural log of total assets. The above findings suggest that larger firms tend to have stronger corporate governance mechanisms. In addition, based on the variance inflation factors (VIFs), multicollinearity is not an issue.

TABLE 6
REGRESSION ANALYSIS
Chemical Industry (SIC =28) and Business Service Industry (SIC =73)

Model: $GOV = \alpha_0 + \alpha_1 EFF + \alpha_2 LTA + \alpha_3 LEV + \alpha_4 MTB + \varepsilon$ [Equation 1]

Panel A: Chemical Firms (SIC =28)
N = 158 Adjusted R^2 = 0.4024

Results:

Variable	Parameter Estimate	Standard Error	t Value	Pr > l t l	Variance Inflation
Intercept	19.6918	1.2700	15.51	<0.0001	
EFF	2.9291	1.6030	1.83	0.0696***	1.2494
LTA	1.1712	0.1684	6.96	<0.0001*	1.5105
LEV	2.4203	1.6896	1.42	0.1570	1.5436
MTB	0.0011	0.0670	0.16	0.8695	1.2777

Panel B: Business Service Firms (SIC =73)
N = 300 Adjusted R^2 = 0.3076

Results:

Variable	Parameter Estimate	Standard Error	t Value	Pr > l t l	Variance Inflation
Intercept	18.1225	1.1316	16.01	<0.0001	
EFF	2.7797	1.6583	1.68	0.0948***	1.2114
LTA	1.3004	0.1286	10.11	<0.0001*	1.4309
LEV	0.3249	1.2002	0.27	0.7868	1.1450
MTB	0.0329	0.0301	1.09	0.2750	1.2142

Notes: significance level: *$\rho \leq 0.01$, ** $\rho \leq 0.05$, ***$\rho \leq 0.10$

Variable Definitions:
GOV = Corporate governance index score as of Feb. 2005, created by Brown and Caylor (2006, 2008);
EFF = Technical efficiency score of a firm;
LTA = Natural log of total assets in 2004;
LEV = Leverage ratio (total liabilities/total assets) in 2004;
MTB = Market-to-Book ratio (ending market value/net book value of the firm) in 2004;

CONCLUSION

We examine the association between corporate governance and technical efficiency in the chemical industry (SIC =28) and the business service industry (SIC =73). We rely on Data Envelopment Analysis (DEA) to calculate the technical efficiency score, and measure corporate governance using the corporate governance index provided by Brown and Caylor (2006, 2008). Regression analysis documents a positive and significant ($p<0.10$) association between corporate governance and technical efficiency for both industries. Results from Pearson correlation tables also confirm this significant and positive association. The results suggest that business entities with strong corporate governance mechanisms operate more efficiently. This research further supports the efforts toward improving corporate governance in U.S. corporations. The primary limitation of our study includes using only two industries in the analysis. Whether the results from these two industries can be generalized to other industries still remains unknown. We would recommend that different industries be tested to investigate the association between corporate governance and technical efficiency.

REFERENCES

Banker, R.D., Charnes, A. & Cooper, W.W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. Management Science, 30, 1078-1092.

Battese, G. E. & Coelli, T. J. (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. Empirical Economics, 20, 325-332.

Beasley, M., Carcello, J., Hermanson, D. & Lapides, P.D. (2000). Fraudulent financial reporting: consideration of industry traits and corporate governance mechanisms. Accounting Horizons, 14, 441-454.

Brown, L. & Caylor, M. L. (2006). Corporate governance and firm valuation. Journal of Accounting and Public Policy, 25, 409-434.

Brown, L. & Caylor, M. L. (2008). Corporate governance and firm operating performance. Review of Quantitative Financial and Accounting, forthcoming.

Charnes, A., Cooper, W.W. & Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. European Journal of Operational Research, 2, 429-444.

Cooper, W.W., Seiford, L.M. & Tone, K. (2000). Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software. Kluwer Academic Publishers, Boston, MA.

Farber, D.B. (2005). Restoring trust after fraud: does corporate governance matter? The Accounting Review, 80, 239-261.

Feroz, E. H., Goel, S., & Raab, R. L. (2008). Performance measure for accountability in corporate governance: a data envelopment analysis approach. Review of Accounting and Finance, 7, 121-130.

Gompers, P.A., Ishii, J., & Metrick, A. (2003). Corporate governance and equity prices. The Quarterly Journal of Economics, 118, 107-155.

Klein, A. (2002). Audit committee, board of director characteristics, and earnings management. Journal of Accounting and Economics, 33, 375-400.