Market Value, Intangibles, and Security Analysts: A Stochastic Frontier Analysis

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ABSTRACT

Efficiency of a company's operations determines the optimal use of inputs that create cash flows, which--in turn--are affected by firm factors pertaining to the company. Those firm factors include, but are not limited to, production characteristics (i.e., R&D and advertising), forecast characteristics (consensus forecast error and dispersion) and identity measures (book-to-market, BE/ME and size). This study links company efficiency to these firm factors by benchmarking the actual value of the company relative to its optimal value and studying the impact of the factors on their efficiency score. The findings suggest that firm factors make an impact on the level of firm efficiency, which has a direct effect on the ability of a firm to optimally use the inputs that create cash flows, implying that there is value for firms in setting a goal of operating at a high level of efficiency.

Keywords: Stochastic Frontier; Efficiency; Firm Factors

INTRODUCTION

The efficiency of a firm's operations determines the optimal use of inputs that create cash flows, which -- in turn -- are affected by the relating characteristics (firm factors), associated with the firm. These firm factors include, but are not limited to, production characteristics (R&D and advertising), forecast characteristics (consensus forecast error and dispersion) and identity measures (book-to-market and size). Research has shown that more efficient firms tend to have more stable levels of output when compared to other firms in the same industry (Mills & Schumann, 1985). No study is, as yet, known to have investigated the full or combined effects of several of these factors on the efficiency of the firm.

This study will provide a nexus between a firm's level of efficiency and the firm's characteristics by benchmarking the actual value of the firm relative to its optimal value, and studying the impact of the factors on the calculated benchmark efficiency score. The efficiency score is obtained by using the Stochastic Frontier Method (SFM), first introduced by Aigner, Lovell, and Schmidt (1977). Although SFM is widely used to measure firm efficiency in production economics, its use is not as widespread in finance. One may suggest that it should be used much more. The benefits of using the SFM are twofold: (1) It provides a clear picture of the true market value of the firm relative to its optimally scientifically determined value; and (2) It provides statistics against which other variables' effects can be measured. In other words, the SFM dominates traditional techniques by developing robust and reliable measures of firm performance.

The importance of firm efficiency cannot be overstated. Existing literature supports this finding without contradiction. Demsetz (1973, 1974) finds that more efficient firms tend to have greater market shares and larger profits as a result of their low production costs. Because of their higher efficiency levels, these firms are better able to withstand economic demand shocks as well as outside competition. Margaritis and Psillaki (2007) surmise that more efficient firms have an incentive to limit their risk exposure and, as a result, they choose lower debt to equity ratios relative to less efficient firms. As such, the franchise value enjoyed by the higher level of firm efficiency is protected. Nguyen and Swanson (2007) hypothesize that the level of firm efficiency should affect the riskiness of a firm's cash flows and cash flows should, in turn, affect firm equity returns. Specifically, the authors find that the level of firm efficiency is extremely significant in explaining average stock returns in cross-sectional regressions. Thus, they conclude that the level of firm efficiency has a significant impact on the level of stock returns and should be incorporated into asset-pricing models.

This study first examines the effect of the firm factors on the market value. It finds that firm size, leverage, capital intensity and capital expenditure--all have a negative effect on the market value. Profitability, on the other hand, is positively related to market value. These observations are in line with findings by Palia (2001). From the results of the diagnostic tests of the SFM regression, we also find ample evidence to support our contention that there are distinct advantages to our use of the stochastic frontier method. In examining the effect of the firm characteristics on the level of firm efficiency, we find that advertising has a negative effect on firm efficiency, while R&D has a positive effect on firm efficiency. The negative effect of advertising on efficiency is decreasing at an increasing rate (i.e., the negative effect becomes smaller as firm efficiency climbs), while the negative effect tends to be larger for value stocks and large firms. Conversely, the positive effect of R&D spending on firm efficiency is diminishing (the positive effect becomes smaller) and tends to be larger for value as well as larger firms.

In terms of book-to-market (BE/ME) and firm size, we find that these two factors have a positive effect on firm efficiency. This means that firm values, as well as the size of the firm, have a positive impact on firm efficiency. However, it is found that dispersion and forecast error have a negative effect on firm efficiency. The study also examines a set of industry dummies and finds that the coefficient on the industry dummy is positive for all specifications. This implies that firm efficiency is industry-specific. The rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 discusses the data and testing methodology. Section 4 reports the empirical results. Section 5 summarizes the findings and conclusions.

RELATED LITERATURE

There is a substantial body of research which examines firm efficiency in corporations, with the vast majority dealing specifically with financial institutions. Not surprisingly, with the changing economic landscape, this research has evolved over time. Barr, Killgo, Siems, and Zimmel (2002) use a constrained-multiplier, input-oriented data envelopment analysis (DEA) model to quantifiably benchmark the productive efficiency of U.S. commercial banks. Following the DEA model developed by Siems and Barr (1998), the authors measure relative productive efficiency of these institutions over the 15-year period from 1984 to 1998. They find strong and consistent relationships between firm efficiency and inputs and outputs, as well as independent measures of bank performance. Also, they find that a close association exists between firm efficiency and soundness, as determined by bank examiner ratings. Finally, the authors conclude that the impact of different economic conditions is partially dependent on the relative efficiencies of the banks that operate in these conditions.

Zhang, Zhang, and Luo (2006) investigate the technological progress, efficiency and productivity of the US securities industry between 1980 and 2000 using a data envelopment analysis (DEA) approach. In general, they find that the US securities industry is not as efficient as allowed by the existing technology. Moreover, their results indicate that the relative productivity of the US securities industry actually declined during the years studied. The authors also conclude that the failure of many firms to catch up with the production frontier pushed forward by a few large investment banks is the primary reason for the decrease in relative productivity. Equally important, they find that smaller regional firms, as a result of their inability to respond to technological innovation, experienced significant declines in both efficiency and productivity.

Habib and Ljungqvist (2005) examine the relationship between firm value and managerial incentives during the period 1992-1997 using a sample of 1,487 U.S. firms, for which the separation of ownership and control is complete. Departing from previous studies, the authors use a measure of relative performance which compares a firm's actual Tobin's Q to the Q_ of a hypothetical, fully-efficient firm having the same inputs and characteristics as the original firm. They find that the Q of the average firm in our sample is around 10% lower than its Q_, equivalent to a $1,340 million reduction in its potential market value. After further investigation, they find that more-efficient firms have higher CEO stock holdings and option holdings. Also, the authors find that CEO options are more sensitive to firm risk. Finally, they surmise that boards respond to firm inefficiency by strengthening incentives or replacing inefficient CEOs.

Hermalin and Wallace (1994) examine the efficiency and solvency of savings and loan institutions (thrifts) using a nonparametric method. They find that inefficient thrifts (according to the nonparametric measure) are 4 ½ times more likely than efficient thrifts to fail in the future. They also find that in the absence of controls, stock institutions are both less efficient and more likely to fail than mutuals (i.e., depositors are the owners). However, with the presence of controls, the authors note that the results are reversed. As an explanation, they posit that stock institutions are better at resolving the standard agency conflict between shareholders and managers, but worse at resolving the "asset-substitution" conflict between shareholders and debt holders (depositors).

The research also shows that firm efficiency is linked to corporate governance. Klapper and Love (2004) use data on firm-level corporate governance rankings across 14 emerging markets. They find that there is wide variation in firm-level governance and that the average firm-level governance is lower in countries with weaker legal systems. Further, they examine the determinants of firm-level governance and find that corporate governance is correlated with the extent of the asymmetric information and contracting imperfections that firms face. Upon investigating corporate governance as it relates to firm efficiency, the authors find that better corporate governance is highly correlated with better operating performance and market valuation, or a higher level of firm efficiency. Their study corroborates the findings of previous studies by La Porta, Lopez-de-Silanes, Schleifer, and Vishny (1998, 2000), which show a positive relationship between firm value/efficiency and the level of corporate governance.

Despite the documented importance of firm efficiency on the overall optimal value of a firm, there has been limited research on the full effect of firm characteristics on the efficiency of the firm. This study is an attempt to bridge the gap in the literature by examining the combined effect of firm characteristics on the firm efficiency of more than 4,000 firms in different industries.

DATA AND METHODOLOGY

To test the hypotheses discussed in the earlier sections, the research obtains cross-sectional time-series data. In particular, it collects data in the entire universe of CRSP, COMPUSTAT and I/B/E/S data from the first quarter of 1989 to the fourth quarter of 2006 and uses it to determine the firm value. It measures the market value of the firm using the stochastic frontier methodology (SFM) (Aigner, Lovell, & Schmidt, 1977). Essentially, SFM estimates the best performance benchmark, or the efficient frontier, after accounting for random stochastic error. Because the resultant benchmark represents the maximized and optimal conversion of operating characteristics into a stock-value outcome, SFM can objectively and scientifically measure the stock-value gap. In business, several studies have successfully applied SFM to advertising, firm value and efficiency, retailing, and other areas (Zhang, Zhang, & Luo, 2006; Nguyen & Swanson, 2009; Luo & Donthu, 2005).

The use of SFM offers three primary advantages over the traditional ordinary least squares (OLS) approach. First, it objectively constructs the benchmark with best performers. In contrast, the traditional OLS approach subjectively provides a benchmark with average performers in an ad hoc, less rigorous manner. Second, SFM is stochastic in nature and is able to not only tease out the biases of outliers, but also realistically capture random statistical errors or pure business luck. Third, in contrast to other basic approaches which assume homogeneity, the SFM model can handle heterogeneity with random parameter modeling (Greene 2003).

The SFM models the market value with a stochastic term for each firm i (i = 1,2,...,I) at time t (t = 1,2,...T), where the stochastic term is the deviation from the best-performing benchmark in Figure 1. Formally, the SFM model in panel data format is as follows:

$$V_{i,t} = \alpha_0 + \sum_{k=1}^{K} \gamma_k X_{i,t} + h_{i,t} - g_{i,t}, \qquad (1)$$

where $V_{i,t}$ is the estimated firm's stock value, calculated as the residual values from the Fama-French (1992, 1993, and 1995) and Carhart (1997) four-factor model; $g_{i,t}$ is the approximated market value with a $[0,\sigma_g^2]$ half-normal distribution, and $h_{i,t}$ is random statistical noise with a normal $[0,\sigma_h^2]$ distribution. Figure-1 shows the graphical representation of the Stochastic Frontier. The point OV shows the optimal value of the firm on the value benchmark line of best-performing peers. The point AV shows the market value relative to the best-performing peers, given their operating characteristics.

The residuals provide a clean and more precise measure of the market value of the firm, which has corrected the biases of common market factors. Fama and French (1992, 1993, & 1995) suggest that a three-factor time-series model might explain the cross-section of returns. Their three factors are *RMF*, the excess return (in excess of the risk-free rate) of the value-weighted market portfolio; *SMB*, the return on an arbitrage (zero-investment) portfolio consisting of the return on the big-firm portfolio subtracted from the return on the small-firm portfolio; and *HML*, the return on an arbitrage portfolio consisting of the return on the portfolio of high-*BE/ME* stocks minus the return on the portfolio of low-*BE/ME* stocks. Carhart (1997) suggests an additional factor, *UMD*, which is the difference between the return on a portfolio of high-return stocks in the prior year and the return on a portfolio of low-return stocks in the prior year. The model can be estimated as follows:

$$R_i = \alpha_i + \beta(RMF) + s(SMB) + h(HML) + m(UMD) + \varepsilon_i, \tag{2}$$

Also in equation (1), $X_{i,t}$ is a vector of firm operating characteristics, including 49 industry dummies, time dummies, sales, EBITDA, long-term debt, PPE, and capital expenditures, while γ_k is the model coefficient (k = 1,2,..., K). The 49 industry dummies can be found on Kenneth French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/). This study measures sales as the log of reported sales revenue from COMPUSTAT to capture the firm size effect. It is also expected that sales have diminishing returns and the research includes sales-squared terms into the vector of firm operating characteristics. EBITDA is income before extraordinary items, interest, taxes and depreciation scaled by total assets. Long-term debt, PPE and capital expenditures are all scaled by total assets. The efficiency score, S_i is calculated from all the estimated parameters in equation (1). For each firm, the relative distance from the best-performing benchmark is determined as follows:

$$S_i = \frac{E(V_{i,t} \mid g_{i,t}, X_{i,t})}{E(V^*_{i,t} \mid g_{i,t} = 0, X_{i,t})}, \tag{3}$$

where E is the expected value operator and $V^*_{i,t}$ is the frontier estimated firm value given no or minimum inefficiency. The efficiency score, S_i is the normalized measure between 0 and 1. A score of 0.10 indicates that the firm is valued at a 10 percent level compared to its best-performing peers, *ceteris paribus*.

In the data analysis, the dependent variable is the efficiency score, while our independent variables are R&D expense, advertising expense, book-to-market ratio (BM), size, earnings forecast errors, and earnings forecast dispersion and moderators. R&D expense is a firm's R&D scaled by total assets. Advertising expense is a firm's total advertising expense scaled by total assets. BM is the book value of common equity, plus balance sheet deferred taxes in December of the previous year, over current market equity in July of the current year for each year in the sample. Size is the stock's current market value at July of the current fiscal year. Earnings forecast error is the absolute difference between the one-quarter-ahead consensus earnings forecast and the actual earnings-per-share (EPS) per quarter scaled by the end-of-quarter stock price. Finally, the dispersion is the standard deviation of consensus one-quarter-ahead earnings forecast of two or more analysts scaled by the end-of-quarter stock price. Because the independent variable has a censored distribution of an upper limit of 1 and a lower limit of 0, we use combinations of a two-limit robust Tobit model to eliminate this sample censoring bias (Greene, 2003). The parameter $s_{i,t}^{*}$ denotes the efficient score at time t, $Z_{i,t}$ is the vector of independent variables, while β denotes the vector of coefficients. The study specifies the efficient score model as follows:

$$\begin{aligned} s_{i,t} = s_{i,t}^{*} = \beta Z_{i,t} + \varepsilon_{i,t} = \beta_0 &+ \beta_1 ADV_{i,t} + \beta_2 RD_{i,t} + \beta_3 ERR_{i,t} + \beta_4 DISP_{i,t} \\ &+ \beta_5 ADV_{i,t}^2 + \beta_6 RD_{i,t}^2 + \beta_7 BM_{i,t} + \beta_8 ADV_{i,t} xBM_{i,t} \\ &+ \beta_9 SIZE_{i,t} + \beta_{10} ADV_{i,t} xSIZE_{i,t} + \beta_{11} RD_{i,t} xBM_{i,t} \\ &+ \beta_{12} RD_{i,t} xSIZE_{i,t} + \beta_{13} Dummies + \varepsilon_{i,t}, \text{ and} \qquad (4) \end{aligned}$$

$\varepsilon_{i,t} = \omega_{i,t}, \text{if } 0 < s_{i,t}^{*} < 1,$

$s_{i,t} = 0 \text{ if } s_{i,t}^{*} \leq 0$ (lower bound), and

$s_{i,t} = 1 \text{ if } s_{i,t}^{*} \geq 1$ (upper bound),

where $ADV_{i,t}$ is advertising expense, $RD_{i,t}$ is the R&D expense, $ERR_{i,t}$ is the earnings forecast error, $DISP_{i,t}$ is consensus earnings dispersion, $BM_{i,t}$ is the book-to-market ratio and $SIZE_{i,t}$ is the market capitalization. Table II reports the summary statistics for the final sample. There are 4,810 firms in 49 industries over the period of 1989 to 2006 for a total of 12,859 firm-year observations. The summary statistics indicate that the sample is diverse and that none of the firms place undue influence on the sample distribution. However, the descriptive statistics in Table II indicate that the sample is left-skewed,. For instance, market capitalization (size) ranges from $1.4 million to approximately $430,000 million, with a mean and median of $6,539 million and $627 million, respectively. The efficiency score ranges from 0.10 (very inefficient) to 0.998 (very efficient), with a mean of 0.621 and a median of 0.653

EMPIRICAL RESULTS

SFM Diagnostics

Panel A of table III reports the parameter estimates for the OLS and the SFM regressions. The dependent variable is the log of the Fama-French and Carhart 4-factor residuals. The independent variables are sales, squared sales, EBITDA, long-term debt, PPE, capital expenditures and industry dummies. The industry dummies ensure that the resulting efficiency score for the individual firm is computed relative to the best-performing peer in the same industry. For robustness, the OLS parameter coefficients are also reported and, except for the intercept term as well as the coefficient on PPE, there are no other appreciable differences. Besides the coefficient on sales in the SFM regression, all other parameter coefficients are statistically significant. The economic rationale behind the signs of the parameters in the SFM regression is as follows:

1. The relationship between the log of sales and market value is positive since sales measures firm size. However, to control for the diminishing returns on sales, we also included the squared term. The relationship between the squared sales term and market value is therefore negative.
2. Profitability as measured by operating profits to total assets (EBITDA/Total Assets) is positively related to market value (Palia, 2001).
3. Long-term debt scaled by total assets is a proxy for firm leverage. The relationship between firm leverage and market value is negative because higher interest expenses decrease firm's value.
4. The relationship between capital intensity (as measured by PPE/total assets) and market value is negative because firms with high capital intensity incur higher operating leverage, which, in turn, lowers the market value of the firm.
5. The relationship between capital expenditures (scaled by total assets) and market value is ambiguous. Since capital expenditures are expenses incurred to either upgrade or replace property, plant and/or equipment, the overall costs may or may not lead to higher market value. The fact that the parameter coefficient on Capital Expenditures is negative indicates that the increase in units of capital expenditures did not lead to higher market values in this sample.

Panel B in table III shows the results of the diagnostic tests of the SFM regression. The likelihood test, which examines the null that all firms operate at an optimal level, has a value of 30.3894 (p-value < 0.001). Therefore, the null could be rejected. The paper also reports gamma, the ratio of standard deviation of u to the standard deviation of v, which measures the relative influence of the asymmetric error to the symmetric error. The value of gamma is 0.9309 (p-value $<$ 0.001), which validates that there are systematic inefficiencies warranting the use of the stochastic frontier method.

Effect on Efficiency

Table IV shows the parameter values of the two-limit bounded Tobit regression in which the efficiency score is the dependent variable and various other factors (including advertising and R&D etc.) are the independent variables. The model is tested with several different specifications to examine the relationship between efficiency and the specified factors. Column 1 in Table IV shows that advertising has a negative effect (-0.01041; $p<0.01$) on efficiency and that R&D has a positive effect (0.07638; $p<0.01$). These results are confirmed in all other models even when the parameter coefficients are different. Model 4 shows the negative effect of advertising on efficiency is decreasing at an increasing rate (i.e., the negative effect becomes smaller the more efficient the firm), while the negative effect tends to be larger for value stocks as well as large firms (see model 5). However, the positive effect of R&D spending on efficiency is diminishing (the positive effect becomes smaller) and tends also to be larger for value as well as larger firms. These findings are not surprising and are supported in other studies (e.g., Bublitz and Ettredge, 1989).

Column 2 shows that BE/ME (0.13553; $p<0.01$) and Size (0.10129; $p<0.01$) has a positive effect on efficiency, but that dispersion (-.007010; $p<0.01$) and forecast error (-0.00514; $p<0.01$) in model 3 have a negative effect on efficiency. The coefficient on the industry dummy is positive for all specification, which implies that efficiency is industry-specific.

CONCLUSION

This paper has considered the impact of various firm characteristics on market value and firm efficiency for a sample of companies over the period 1989-2006 using the stochastic frontier method. This methodology is advantageous in that it provides more reliable statistics than the normal OLS regressions. The empirical investigation yields the following results: First, the paper document that firm size, leverage, capital intensity and capital expenditure all have a negative impact on the market value, while profitability has a positive impact on market value. These results are consistent across industries and are robust to different specifications.

Second, it is observed that advertising has a negative effect on firm efficiency, while R&D has a positive effect on firm efficiency. Interestingly, the negative effect of advertising on firm efficiency is larger for value stocks and large firms. Also, the negative effect of advertising on efficiency is decreasing at an increasing rate. On the other hand, the positive effect of R&D spending on firm efficiency is diminishing, and is greater for value firms and larger firms. These results are based on the idea that advertising is considered an expense (i.e., decreases the total firm value), while R&D is seen as a long-term investment (one that adds value to the firm in the long run).

Third, the authors document that book-to-market ratio (BE/ME) and firm size have a positive effect on firm efficiency, while dispersion and forecast error have a negative effect on firm efficiency. Further, they find that the coefficient on the industry dummy is positive for all specifications, indicating firm efficiency is industry-specific.

The findings in this paper suggest that firm factors make an impact on the level of firm efficiency, which has a direct effect on the ability of a firm to optimally use the inputs that create cash flows. This implies that there is value for firms in setting a goal of operating at a high level of efficiency. This value can be in the form of higher stock returns/firm value, increased market share or superior corporate governance. All of these represent incentives to the firm for improving efficiency, and these incentives can be more important in markets where there is more competition among firms.

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APPENDIX

Stochastic Frontier Method

This graph is a depiction of the Stochastic Frontier Method (SFM). The Value Benchmark line shows the maximum optimal frontier of the firm, given its operating variables. Any point on this line indicates that the firm is using the inputs sufficiently to obtain maximum efficient output (i.e., 100%). The actual value in this example is a value that deviates from the optimal value. The associated efficiency score will therefore be a number less than 100%, but more than zero.

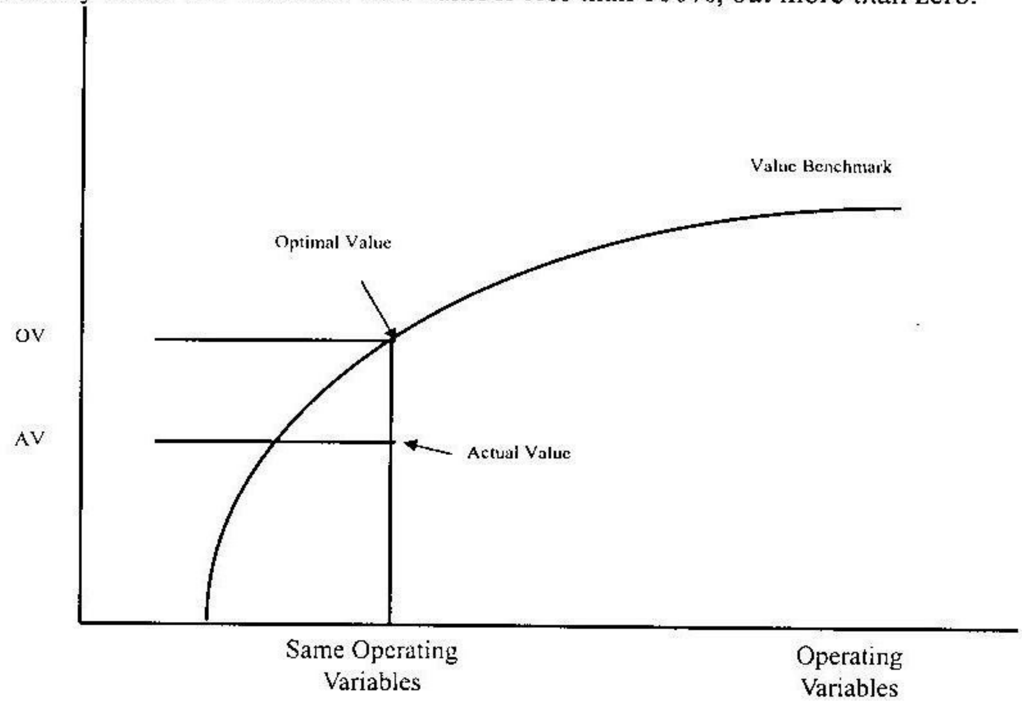

Figure - 1: Stochastic Frontier Method

Breakdown of Firms in Industries

The sample includes all NYSE/AMEX/NASDAQ-listed securities that are contained in the intersection of the CRSP returns file, the COMPUSTAT industrial quarterly file and the I/B/E/S summary file between January 1989 and December 2006. This table reports the number of total observations and the relative representation, as well as the number of firms and the percentage of firms relative to the total sample for each industry according to the Standard Industrial Classification (SIC) codes system.

Table I. Breakdown of Firms in Industries

Firm	Obs.	Perc. Obs.	Firms	Perc. Firms
Food	271	2.11%	95	1.98%
Beer	4	0.03%	5	0.10%
Smoke	48	0.37%	25	0.52%
Toys	209	1.63%	95	1.98%
Fun	419	3.26%	130	2.70%
Books	26	0.20%	15	0.31%
Household	437	3.40%	120	2.49%
Clothes	150	1.17%	60	1.25%
Health	204	1.59%	55	1.14%
Medical Equipment	713	5.54%	300	6.24%
Drugs	1082	8.41%	405	8.42%
Chemicals	284	2.21%	80	1.66%
Rubber	114	0.89%	35	0.73%
Textiles	4	0.03%	5	0.10%
Building Materials	188	1.46%	65	1.35%
Construction	16	0.12%	10	0.21%
Steel	62	0.48%	25	0.52%
Machines	512	3.98%	155	3.22%
Electrical Equipment	242	1.88%	85	1.77%
Autos	282	2.19%	80	1.66%
Ships	44	0.34%	10	0.21%
Guns	24	0.19%	10	0.21%
Mines	20	0.16%	5	0.10%
Oil	38	0.30%	20	0.42%
Telecommunication	116	0.90%	75	1.56%
Personal Services	46	0.36%	15	0.31%
Business Services	190	1.48%	105	2.18%
Hardware	535	4.16%	220	4.57%
Software	1514	11.77%	800	16.63%
Chips	791	6.15%	315	6.55%
Lab Equipment	323	2.51%	135	2.81%
Paper	138	1.07%	50	1.04%
Transportation	2	0.02%	5	0.10%
Wholesale	347	2.70%	165	3.43%
Retail	2691	20.93%	755	15.70%
Meals	751	5.84%	255	5.30%
Banks	4	0.03%	5	0.10%
Insurance	2	0.02%	5	0.10%
Finance	16	0.12%	15	0.31%
Total	**12859**	**100%**	**4810**	**100%**

Summary Statistics

The sample includes all NYSE/AMEX/NASDAQ–listed securities that are contained in the intersection of the CRSP monthly returns file, the COMPUSTAT industrial annual file and the I/B/E/S summary file between January 1989 and December 2006. The Table reports summary statistics of the efficiency score of all firms, production characteristics, earnings forecast measures and firm identity characteristics. The efficiency score is the measure of market efficiency relative to the firm's operating variables. R&D is the research and development expense for the entire fiscal year. Advertising is the advertising expense for the entire fiscal year. B/M is the book value of common equity plus balance sheet deferred taxes for fiscal year t at the second quarter over market equity for the first quarter of year t. Size is the market price at the end of the quarter times the shares outstanding. An earnings forecast error is the firm's most recent one-quarter-ahead consensus earnings forecast average from I/B/E/S minus the actual earnings per share. Earnings Forecast Dispersion is measured as the standard deviation of consensus end-of-fiscal-year earnings forecast for two or more analysts scaled by the stock price. Revenue is the total sales for the entire fiscal year.

Table II. Summary Statistics

Variable	Minimum	Maximum	Mean	Median	Std Dev
Eff. Score	0.100	0.998	0.621	0.653	0.196
R&D	0.000	8000.000	65.662	2.021	422.101
Advertising	0.075	1693.250	31.604	2.600	112.967
B/M	0.000	31.530	0.586	0.395	0.933
Size	1432	429997646	6539702	627343	24451675
Dispersion	0.000	0.667	0.002	0.001	0.015
Forecast Error	0.000	4.033	0.062	0.027	0.146
Revenue	0.008	99078.000	1201.790	160.965	4877.240

Parameter Estimates for OLS and SFM in conjunction with SFM Diagnostics

Panel A shows the parameter estimates for the OLS regression and the SFM technique. The dependent variable for both models is the log of the residuals of the Fama-French (1992, 1992, & 1995) and Carhart (1997) 4-factor model. For comparison purposes, the OLS estimates are reported side-by-side with SFM estimates. Panel B reports the specific diagnostic test to indicate the robustness of the SFM over the standard OLS methodology.

Table III. Parameter Estimates for OLS and SFM in conjunction with SFM Diagnostics

Panel A	Parameters Estimates for OLS and SFM			
	OLS		SFM	
Intercept	-0.8773	***	-0.3017	**
	(0.1368)		(0.1163)	
Sales	0.1140	***	0.1140	
	(0.0305)		(0.0894)	
Squared Sales	-0.5700	***	-0.5700	***
	(0.1526)		(0.0447)	
EBITDA	0.5553	***	0.3248	***
	(0.0789)		(0.0560)	
Long-term Debt	-0.1006	***	-0.1177	***
	(0.0198)		(0.0165)	
PPE	-0.9524	***	-0.1192	***
	(0.2052)		(0.0167)	
Capital Expenditures	-0.1718	***	-0.2371	**
	(0.0139)		(0.1119)	
Industries Dummies	0.2980	***	0.3020	***
	(0.0296)		(0.0245)	
Panel B	**Diagnostics for SFM**			
Likelihood Ratio test	30.3894	***		
Variance of *v*,	0.6335	***		
Variance of *u*,	0.5924	***		
Gamma	0.9309	***		

*** indicates $p<0.01$

Regression Results

The sample includes all NYSE/AMEX/NASDAQ–listed securities that are contained in the intersection of the CRSP monthly returns file, the COMPUSTAT industrial annual file and the I/B/E/S summary file between January 1989 and December 2006. The Table shows the coefficients and respective standard errors for the bounded Tobit regression results for 7 different models, where the efficiency score is the dependent variable. The efficiency score is the measure of market efficiency relative to the firm's operating variables. The independent variables are Advertising expense, R&D expense, Book-to-market ratio, Size, Earnings Forecast Error, Forecast Dispersion, and several squared and interaction terms. R&D is the research and development expense for the entire fiscal year. Advertising is the advertising expense for the entire fiscal year. B/M is the book value of common equity plus balance sheet deferred taxes for fiscal year t at the second quarter over market equity for the first quarter of year t. Size is the market price at the end of the quarter times the shares outstanding. An earnings forecast error is the firm's most recent one-quarter-ahead consensus earnings forecast average from I/B/E/S minus the actual earnings per share. Earnings Forecast Dispersion is measured as the standard deviation of consensus end-of-fiscal-year earnings forecast for two or more analysts scaled by the stock price. Dummy indicates a dummy variable for each industry according to the Standard Industrial Classification (SIC) codes system.

	Column 1			Column 2			Column 3			Column 4			Column 5			Column 6			Column 7		
Variable	Estimate	st.err		Estimate	st.err		Estimate	st.err		Estimate	st.err		Estimate	st.err		Estimate	st.err		Estimate	st.err	
Advertising Expense	-0.01047	(0.0025)	***	-0.01301	(0.0022)	***	-0.00804	(0.0017)	***	0.01619	(0.0019)	***	0.02079	(0.0019)	***						
R&D Expense	0.07636	(0.0026)	***	0.05413	(0.0030)	***	0.01123	(0.0022)	***							0.12751	(0.0042)	***	0.12528	(0.0046)	***
Book-to-Market (BEME)				0.13553	(0.0075)	***															
Size				0.10129	(0.0103)	***															
Earnings Forecast Error							-0.00514	(0.0015)	***												
Consensus Forecast Dispersion							-0.07010	(0.0013)	***												
Squared Advertising										0.01090	(0.0005)	***	0.01560	(0.0006)	***						
Advertising x BEME										-0.00056	(0.0006)	***									
Advertising x Size													-0.00065	(0.0000)	***						
Squared R&D																-0.01162	(0.0008)	***	-0.01219	(0.0009)	***
R&D x BEME																0.00002	(0.0000)	***			
R&D x Size																			0.00002	(0.0000)	***
Dummy Variable	0.01412	(0.0003)	***	0.01272	(0.0003)	***	0.00304	(0.0002)	***	0.01918	(0.0002)	***	0.01764	(0.0002)	***	0.01351	(0.0002)	***	0.01351	(0.0002)	***