

**NEW PERSPECTIVES ON THE STRATEGIC LINKAGES BETWEEN
MARKETING FACTORS, R & D ACTIVITY, AND FIRM PERFORMANCE IN THE
U.S. PHARMACEUTICAL INDUSTRY**

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ABSTRACT

The purpose of this study is to explore the impact of various market structure elements in the pharmaceutical industry in the United States, such as research and development (R&D), advertising, capital intensity, inventory turnover, and firm size on the financial accounting performance measurements, return on equity (ROE), and return on assets (ROA). The results indicate that two elements of market structure, firm size and R&D intensity, are associated significantly and positively with the financial performance indicators (ROA and ROE), advertising intensity and capital intensity are significantly and positively associated with ROE, and inventory turnover is not statistically significant for both ROA and ROE. Because these variables are not correlated, they have not been as proven explanatory elements in the determination of the financial performance.

INTRODUCTION

Substantial empirical studies have been performed to analyze the variables that affect the financial success of the pharmaceutical industry. These studies have used various financial indices such as asset-to-net-worth, return on net profit, sales growth, and ROE (Trombetta, 2003). They have also tried to explain and measure the financial indices and independent variables such as brand power, sales per sales representative, and percentage of revenues from new products, gross sales, and product success rate. During the current study, we discovered that many of these studies used R&D and advertising expenses as independent variables.

A plethora studies was performed on the pharmaceutical industry for two reasons. First, the growth of the industry as a whole has been sizeable. The pharmaceutical industry in the United States grew 6.2% in revenue, compared with the average Fortune 500 growth of 1.2% (Trombetta, 2003). Market investors wanted to know the causes of this success and whether it

could be sustained. Studying the variables that might have caused the success would be key to forecasting future success and, therefore, would be key to deciding whether to invest in these companies.

Second, many studies have been performed because the pharmaceutical industry has consistently performed well regarding profits. Thus, it has been observed that several new rainmaker drugs contribute heavily to a drug manufacturer's overall success. This is true both for firms in which pharmaceutical production is the major source of operations and in which it is only a section of manufacturing operations, denoted other. The successful launch of a new drug can sustain a pharmaceutical company's profitability for many years; conversely, a failed new drug can cause significant financial difficulties. Because a vast number of new product candidates fail (Miller, 2006), a successful launch elevates a company to a higher echelon of profitability. This success is especially important considering the average of \$1.2 billion that biotech companies have spent to market a single new treatment (Prescott, 2006) and that fewer than 1 in 3 drugs that began human clinical trials ever reach the market.

Third, interest in the pharmaceutical industry is overwhelming because, although it has had sustained profitability, the determinants of its success are subject to volatility. A single determinant, such as R&D or advertising expense can cause drastic swings in profitability and company image. This volatility is reminiscent of the in the technology sector in the 1990s when, although the industry might appear to be continuously profitable, it was actually quite risky.

The purpose of this study was to identify the relative significance of six, selected market structure elements: research and development, advertising expense, capital intensity, inventory turnover, firm size, and industry type (drug manufacturer-major vs. drug manufacturer-other). It describes whether these elements explain the profitability of a pharmaceutical company in the United States, as determined by return on equity and return on assets. The analysis empirically examines whether relationships between these market structure elements, which have been established as traditional measures of the pharmaceutical industry and financial performance, are also specifically applied to selected companies in the pharmaceutical industry in the U.S.

LITERATURE REVIEW AND PROPOSED HYPOTHESES

Some empirical studies on industrial organizations have taken various elements of the market structure as given and other studies have related these elements to various aspects of financial accounting performance. Bowman, Navissi, Burgess (2000) analyzed the vulnerability of pharmaceutical companies with respect to regulatory requirements. Bowman et al. demonstrated that pharmaceutical companies with higher advertising expenses experience more negative, abnormal returns and those firms with higher R&D expenses experience less negative abnormal returns. Although our empirical study is not consistent with this finding, we understand how this hypothesis could hold true.

FIRM SIZE

Firm size is one of the most acknowledged determinants of a firm's profits affecting

competitive market power in a given industry (Beard & Dess, 1981). Large firm size affords companies several economic benefits because of their ability to exercise financial leverage in their respective markets. Economies of scale, raw material costs, and production strategy are a few of the benefits larger firms employ because their structure allows for the minimization of operational costs. For example, an international firm will generally setup a structure so that the suppliers of raw materials or plant equipment are in relatively close proximity to the manufacturing facilities and employ bulk discounts on the purchases of raw materials. Experts appear to be split in the opinion of the overall affect of firm size on a firm's profitability. With respect to the research presented above, we propose the following hypothesis:

Hypothesis 1: Firm size is significantly associated with accounting performance.

RESEARCH AND DEVELOPMENT

Our empirical study measured R&D-by-R&D expenses as a percentage of the company's gross sales. The most important expenditure in the profitability of a pharmaceutical firm is R&D expenditures. This is illustrated by the fact that "total spending on health-related R&D by the drug industry and the federal government has tripled since 1990 in real terms" (Austin, 2006:4). R&D investment in United States grew 5.2 times whilst it also grew 3.3 times in Europe between 1990 and 2007 (European Federation of Pharmaceutical Industry Association [EFPIA], 2008). The U.S. federal government spent more than \$25 billion on health-related R&D even in 2005 (Congressional Budget Office, 2006). The concept of the role of R&D in individual firms has also played a major role in the firm's ability to attain or sustain profitability. The role of R&D in larger firms is usually to expand upon the usefulness or effectiveness of the current market products and not investigate new molecular entities (Austin, 2006). Another major focus of R&D studies is cost reduction initiatives to prevent and to detect failures sooner by "finding technologies that can identify toxicity and efficacy problems during the discovery and preclinical stages" (Miller, 2006, p. 6).

One might also be concerned that the profitability of the firms in the pharmaceutical industry could be significantly overstated because the R&D expenditure is generally omitted from a firm's asset base. This omission might overstate profitability using typical indicators by as much as two or three times, when the industry actually remains above the average for profitability in the United States. Even though conventional accounting measures (such as annual approvals of new drug applications or either in total or per dollar of R&D spending) overstate the financial profitability, a strong growth in R&D spending in the pharmaceutical industry implicitly indicates that the returns on pharmaceutical R&D has been attractive (Congressional Budget Office, 2006). As we previously proposed that the firm size was related positively to a company's profitability, R&D expenditure in the pharmaceutical industry would also be positively related to firm profitability.

In the empirical study on the relationships between R&D expenditure and financial profitability in the pharmaceutical industry, Joos (2000) demonstrates that (a) Pioneering drug manufacturers have a higher coefficient on ROE and lower coefficient on R&D than generic drug firms, (b) firms with more patents per dollar R&D investment have a high valuation multiple on a scaled R&D, (c) higher growth in R&D positively affects the ROE valuation coefficient and does not affect the R&D multiple. These supporting findings explain

the differences of the effect of R&D as it relates to new products versus generic, market share, patents and increased R&D expenditures. The pharmaceutical industry is not only one of the most research-intensive industries (e.g., pharmaceutical firms invest as much as five times more in R&D, relative to their sales, than the average U.S. manufacturing firms), but also has consistently ranked as one of the most profitable industries in the United States. (Congressional Budget Office, 2006). With respect to the research presented above, we proposed the following hypothesis:

Hypothesis 2: R&D Intensity is significantly associated with accounting performance

ADVERTISING EXPENSES

Our empirical study measured advertising intensity in terms of advertising expense as a percentage of the company's gross sales. With respect to the social image of consumer drug advertising, Abboud (2005) analyzed whether lobbying efforts by pharmaceutical companies affected their public image and advertising expense. Like the tobacco industry and other chemical industry lobbyists, pharmaceutical industry lobbyists are aware that, although achieving their desired legislation is important, their public image is just as vital. If the public perception were that the pharmaceutical industry is only interested in making money, a poor public image would result. This study also revealed that advertising drugs on television emphasizing their safety and that pharmaceutical companies consciously balance in their advertising the risks and benefits of drugs.

If the public perception of the pharmaceutical industry is important, the perception of the regulatory agencies of the industry is equally important. For example, the Vioxx failure exposed many flaws in the FDA's drug approval process (Prescott, 2006). Therefore, additional time and money will be spent to create safeguards for the pharmaceutical market. Pharmaceutical companies have also expanded the role that their procurement departments play in awarding contracts to advertising agencies (Walter, 2004). This expansion is further evidence that the pharmaceutical companies together concentrate on the importance of advertising expense, which includes striking a balance between its cost and its benefit. With respect to the research presented above, we proposed the following hypothesis:

Hypothesis 3: Advertising Intensity is significantly associated with accounting performance.

CAPITAL INTENSITY

Our empirical study measured capital intensity by capital expenditures as a percentage of the company's capital expenditures as a percentage of the gross sales. The results the study show that capital intensity was not statistically significant, as it relates to the ROE of pharmaceutical companies. This concept also holds true in an empirical study on Compustat firms. The study showed that capital intensity was not a strong predictor of future ROE and that it actually negatively affects unrecognized net assets (Joos, 2000). With respect to the research presented above, we proposed the following hypothesis:

Hypothesis 4: Capital Intensity is significantly associated with accounting Performance.

INVENTORY TURNOVER

Our empirical study used inventory turnover as a variable to explain a pharmaceutical company's ROE. Inventory turnover was calculated using cost of goods sold as a percentage of the company's ending or average inventory. An empirical study of the Indian pharmaceutical industry attempted to compare its performance with that of selected multinational corporations (Sankaran, 2002). In this study, the inventory turnover of the multinational companies was shown to be less than the pharmaceutical industry average due to strong brand equity and distribution network. One could conclude from this result that established companies benefit from their brand equity and that the volatility in the pharmaceutical industry might result in weakened brand equity. This is consistent with the fact that the unpredictable success of new products in the pharmaceutical industry decreases the likelihood of establishing brand equity. The pharmaceutical industry in the United States could use this study to improve brand equity. With respect to the research presented above, we proposed the following hypothesis:

Hypothesis 5: Inventory Turnover is significantly associated with accounting performance.

RESEARCH METHODS

Conventional economic theory, including those proven with empirical research studies, conclude that key economic indicators of a company, are significantly related with some corresponding performance measurements. This study was designed predominantly to examine the appropriateness of applying various previous studies and empirical research to the pharmaceutical industry in the U.S. The results of the empirical study are presented through an analysis of the pharmaceutical industry in the United States via the relationship of six selected variables to two financial performance indicators.

SAMPLE AND DATA COLLECTION

Using SIC 2834 a systematic sample, 332 pharmaceutical firms were selected. The initial sample was comprised of 365 firms listed in Disclosure, Inc. (2006). The data for advertising expenditure was additionally extracted from the research insight and matched with the initial data for other variables. Some firms were eliminated because data on them was lacking. Only firms for which complete data were available were included in the study. Each of the variables used in the study were calculated as a simple average of the 5-year period of 2001–2005.

A 5-year period was chosen to avoid any issues that might be associated with 1-year fluctuations. We decided to use 5-year averages because previous research studies in the strategy literature had been accepted as valid long-term measures (Bettis, 1981; Bettis & Hall, 1982; Bettis & Mahajan, 1985). By using averages, we could minimize the effects of any outliers or idiosyncratic variations and, thereby, more accurately assess the effects of the variables being studied.

EMPIRICAL MODEL AND VARIABLE SPECIFICATIONS

An empirical model that captures the essence of the relationships hypothesized above can be stated as follows:

Profitability = f (firm size, R&D intensity, advertising intensity, capital intensity, inventory turnover).

Firm size is an algebraic expression of the natural log value of the firm's total sales.

Research and development intensity is a ratio of the R&D expense to the total sales.

Advertising intensity is a ratio advertising expense to the total sales volume.

Capital intensity is the ratio of total sales to the total sales volume.

Inventory turnover is a ratio of the average Inventory volume to the total sales volume.

EMPIRICAL RESULTS AND STATISTICAL ANALYSIS

Table 1 reports the correlation matrix with the means and standard deviations of the six independent variables as related to the dependent variables of ROE and ROA. This is a brief illustration of a large collection of data using a few key statistical parameters. The mean, or average, and the standard deviation express the values that are calculated given the data applied. It is necessary to remember that many of these data points are expressed as ratios that lead to lower numerical values.

The correlation matrix shows the relationship between the independent and dependent variables with respect to ROA and ROE. As presented in Table 1, firm size and R&D intensity are positively correlated with ROA and ROE, but other strategic market factor such as advertising intensity and capital intensity are significantly and negatively correlated with ROE at 0.001 level. One obstacle that presents difficulty in proving the hypotheses above is the existence of multicollinearity. The standard statistical method for testing data for multicollinearity is analyzing the individual variance inflation factors (see Table 2). There is no existence of multicollinearity.

TABLE 1. CORRELATION MATRIX

Variables	1	2	3	4	5	6	7
ROA							
ROE	.189***						
Firm size	.456***	.128					
R&D intensity	.233***	.332***	.118*				
Advertising intensity	-.054	-.321***	.049				
Capital intensity	-.047	-.453***	.304***	.401***			
Inventory turnover	.121	.055	-.057	-.038	-.042	.119*	
Mean	2.432	3.046	1.099	1.222	0.178	1.245	0.132
Standard deviation	1.027	1.283	2.712	0.598	0.568	2.140	0.301

Note. $N = 332$. + $P < 0.1$; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

To consider the impact of each independent variable on the dependent variables, multiple regression was used to provide information about the degree of explained variation of predicted values from the predicted trend-line. Table 2 shows the result of the multiple regression analysis.

The first piece of information derived from the multiple regression data is that only one of the five major marketing strategic variables tested demonstrates statistical significance. The only variable that influences the profitability of a pharmaceutical firm in the United States is firm size and R&D intensity. These results are problematic and unfortunate because the above hypotheses were designed to demonstrate the statistical significance of R&D intensity on the profitability of pharmaceutical firms. Firm size and R&D intensity are statistically significant at the 0.01 level and positively associated with both ROA and ROE. More importantly, the result shows that two other strategic variables (advertising intensity and capital intensity) are also highly significant at 0.001 level, but are negatively associated with ROE.

TABLE 2. OLS MULTIPLE REGRESSION ANALYSIS

Variables	ROA	V.I.F.	ROE	V.I.F.
Constant	-1.883 (.207)***		-4.778 (1.28)**	
Firm size (in sales)	0.136 (.017)***	1.029	0.658 (.268)**	1.029
R&D intensity	0.011 (.003)***	1.544	0.588 (.041)***	1.544
Advertising intensity	-0.044 (.024)+	2.235	-2.042 (.043)***	2.235
Capital intensity	0.004 (.001)*	1.950	-0.469 (.024)***	1.950
Inventory turnover	0.001 (.002)	1.009	0.008 (.025)	1.009
Adjusted <i>r</i> -square	0.3842		0.4013	
<i>f</i> -ratio	29.3851***		18.5326***	

Note. *N* = 332. Values indicate unstandardized regression coefficients and within parentheses indicate standard error. V.I.F. indicates variance inflation factor used to check multicollinearity.

* *P* < 0.05; ** *P* < 0.01; *** *P* < 0.001.

Contrary to other strategic variables, inventory turnover does not relate to all financial accounting performance.

CONCLUSION AND IMPLICATIONS

The purpose of this report was to illustrate what expenditures, common to the pharmaceutical industry, affect a firm's accounting profitability with respect to ROE and ROA. Using the selected strategic variables employed in this study, firm size and R&D intensity were uniformly and positively associated with all accounting financial performance related to ROA and ROE in the pharmaceutical industry in the United States. However, advertising intensity and capital intensity were shown to contribute significantly to a firm's profitability. Nevertheless, inventory turnover did not show a strategic relationship with any accounting profitability measures.

The purpose of this report was to show the statistical significance of a company's commitment to continual expansion, with specific attention to R&D expense. Many technical documents have used similar statistical analysis and have proven that R&D is indeed statistically significant in expressing a firm's profitability. However, our results were not consistent with the other empirical studies in the literature. In this case, R&D was positively and significantly associated with ROE and ROA.

With respect to firm size, our empirical research shows a positive relationship between firm size, ROE, and ROA. This result was consistent with previous research showing that larger firms should be more profitable and reap other economic benefits because they have more employees to perform the work. Intuitively, this relationship makes conceptual sense because firms with more available financial resources would be expected to invest more heavily in research and development expenditures, and in the other variables analyzed. The presence of the statistical significance of this relationship further supports the theory for developing the hypotheses for the analysis.

One interesting result from the statistical analysis is that advertising intensity was found to not be statistically significant with respect to both ROA, yet was found to be statistically significant with respect to ROE at the 0.01 level. With conflicting evidence both empirically and in research, Hypothesis 5 must also be accepted because the analysis has failed to prove the existence of a relationship between inventory turnover and ROE or ROA. Authors of studies conducted on similar subject matter differ in their opinions regarding whether this variable is a predictor of a firm's profitability.

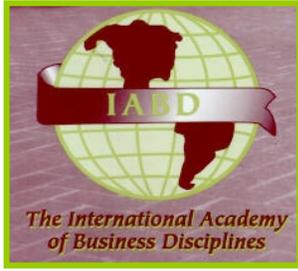
The references used to support our empirical study obviously used different sample data sets. Many of these references did not focus on firms that have pharmaceutical operations, yet they are not the main focal point of their manufacturing operations. The majority of our data was obtained from approximately 67% of this section of the industry. The source of the data in many of the references was also obtained by a different methodology. These differences have greatly affected the ability of the presented regression analysis to prove the initial hypotheses.

Therefore, the resulting application of our hypotheses to the pharmaceutical industry in the United States is not advised or prudent. Several assumptions have been made throughout the analysis and data retrieval so that the results obtained in references would be reproducible. These referenced results indicate completely different findings, are more applicable to the industry, and represent a higher confidence level of the findings. Investigation of the reference material provided further reinforces the concepts that were hypothesized and indicate that a relationship should be found that is significant if different data were examined.

In this highly competitive industry, further exploration must be performed on this regression analysis to determine why relationships were found to be insignificant. The pharmaceutical market in the United States is very large and a vast amount of financial gain in the industry should be possible. The exact measure of a firm's profitability might better be illustrated with another dependent variable.

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