

*The Economic Value of Software Firms' Strategies and Capabilities
in the Internet Boom and Bust: An Empirical Study*

--- EXTENDED ABSTRACT ---

Sandra Slaughter**
Tepper School of Business
Carnegie Mellon University
Tech & Frew Streets
Pittsburgh, PA 15213
sandras@andrew.cmu.edu

Shanling Li
McGill University
Montreal, Quebec Canada
shanling.li@mcgill.ca

Jennifer Shang
Katz Graduate School of Management
University of Pittsburgh
shang@katz.pitt.edu

September 8, 2006

** contact author for this submission. Please do not cite, quote or distribute without contacting authors for permission.

Software plays a critical role in today's global economy. Software enables many products and services, from large and complicated enterprise systems to desktop applications like word processing. According to the International Data Corporation (IDC), the worldwide software market generates more than \$200 billion in revenues each year. Perhaps no other industry segment has been as affected by the Internet as the software industry. The emergence of the Internet has changed everything in the world of software: it has affected how products are developed, distributed, marketed and implemented. Firms with traditional software products must make them Internet-enabled or develop new Internet products. The Internet has revolutionized the software development process allowing producers to make smaller, specific program applets that can be sold to customers via Web sites. The Internet also facilitates open source software development, allowing customers to move away from proprietary software to less costly open source alternatives. Finally, the Internet has emerged as an effective delivery mechanism that contributes to innovative software delivery models such as software-as-service or software-on-demand.

Given the software industry's susceptibility to the Internet, the inflating and deflating of the Internet bubble provides an interesting opportunity to examine how successful software firms are at competing in two dramatically different environments. During the Internet bubble, the software industry posted double-digit annual growth rates; however, after the bubble "burst" the software industry posted its first-ever decline in revenues (Standard & Poor's 2006). The dramatic changes in software industry before and after the Internet boom raises an interesting question: *are different competitive strategies of firms in the software industry more or less effective in different economic environments?* This is an important question both theoretically and practically. A firm's strategy involves the attempt to create a unique and valuable position, using a distinctive mix of capabilities (Porter 1996). Miles and Snow (1978) have characterized firms' strategies into distinctive types such as Prospectors, Defenders, Analyzers and Reactors. An implicit assumption in the strategy literature is that a firm's strategy, if well executed, should be successful (Miles and Snow, 1978). That is, different strategies should be equally effective when well executed. However, some studies have suggested that this assumption may not always hold. For example, Zajac and Shortell (1989) found that Prospectors outperformed Defenders in the healthcare industry. However, there have been few, if any, studies investigating the performance of different strategies in different environments.

A related issue concerns firms' capabilities. The resource-based view of the firm (RBV) views a firm as a bundle of resources and capabilities that can enable it to achieve competitive advantage and superior performance (Wernerfelt 1984). As defined by Wade & Hulland (2004), capabilities transform inputs into more valuable outputs. Because capabilities can be difficult to copy or transfer, it is thought that having superior capabilities can help to create long-term competitive advantage. As firms have different endowments of these capabilities, the RBV literature attributes variations in firms' performance to variations in their levels of capabilities (Dutta 1999). However, it may be that differences in firms' performance occur because their capabilities (even if superior) are not as well suited to particular environmental conditions. Organizational contingency theorists have long argued that different organizational structures, actions and outcomes fit certain environmental conditions such as uncertainty (e.g., Hannan & Freeman 1977, Pfeffer & Salancik 1978, Thompson, 1967). However, there has been relatively little research exploring which capabilities are better suited to which environments (Shenhar 2001). This suggests an additional question: *are different capabilities of firms in the software industry more or less effective in different economic environments?*

In this study, we empirically examine the performance of different strategies and capabilities of software firms during the Internet boom (1995-1999) and the Internet bust (2000-2004). We adopt the Miles and Snow (1978) typology to characterize software firms' strategies into Software Analyzers, Defenders, Prospectors or Reactors. In addition, we identify three important capabilities: marketing, R&D, and operations, and use Data Envelopment Analysis to analyze software firms' capabilities in these areas. Finally, we relate software firms' strategies and capabilities to their financial performance (as assessed by Tobin's Q) in the Internet boom and bust. The following sections briefly describe our main hypotheses, methods, analysis and results.

Hypotheses

One of the most enduring strategy typologies in the literature is that of Miles and Snow (1978) that classifies firms' strategies into Prospectors, Defenders, Analyzers and Reactors. Prospectors have a strong interest in product or market innovation, and continually search for new product/market opportunities. Such companies are often identified as instigators of change, and as such are not always deemed to be efficient operators. In contrast, Defenders have narrow product market domains, and by concentrating on this narrow focus seek to improve the efficiency of their existing operations. Defenders stress operational efficiency and economies of scale. Analyzers share traits of Prospectors and Defenders. Analyzers operate in different product market domains, defending their

positions in some domains, but analyzing and following promising new product or market developments in other domains. An Analyzer must have substantial resources to compete effectively using both defensive and prospecting strategies. Finally, Reactors often lack a stable and consistent strategy and do not always react effectively to change.

As we have noted, the strategy literature generally assumes that different strategies should be equally effective when well executed. However, at the same time, researchers acknowledge that sometimes firms' strategies – even if well executed – may not lead to superior financial performance. In particular, different environments may be more conducive to certain strategy types (Hambrick, 1983). According to Walker (2003) and DeSarbo (2004), Analyzers are favored when a large number of competitors exist but the industry structure is evolving, and Prospectors are favored when products, markets and industry are all new and emerging and there are few established competitors. Defenders are favored when the industry, products and markets are more mature.

In the software industry, the PC era had reached its peak by the mid-1990's and was maturing. However, the emergence and growth of the Internet during the Internet boom in the latter 1990's created new products and market segments that were rapidly growing and evolving. In addition, the financial venture capital necessary for growth and innovation in the software industry was readily available in the Internet boom, as evidenced by the large numbers of IPOs in the mid- to late 1990's (Standard & Poor's 2006). Industry conditions in the Internet boom should therefore favor software Analyzers because Analyzers can continue to defend market segments where products are more mature (e.g., PC operating systems), but can also explore new segments inspired by the Internet where there may be synergies with more mature products (e.g., e-commerce applications and tools). Further, the financial resources needed to effectively sustain such a dual strategy were readily available at that time. Although Prospectors may do well in the new segments of the software industry created by the Internet, Prospectors may not be able to compete effectively in the existing and more mature segments. Defenders and Reactors are not as well suited to take advantage of new market segments in the software industry; Defenders are defending mature products, and Reactors are not effective in taking advantage of new opportunities in the emerging industry segments. Thus, we would expect that: *Software Analyzers should have the highest financial performance in the Internet boom.*

After the Internet bubble burst in 2000, the availability of financial capital in the information technology industry was more uncertain and unpredictable (Standard & Poor's 2006). Numerous Internet firms went bankrupt when venture capital funds were no longer available to finance their operations. In addition, Internet-related technologies became more "mature". Such an environment is challenging to all software firms in the industry. However, Defenders may be best positioned relative to the other strategy types because a narrow product market focus allows them to make the most efficient use of limited resources (Conant et al. 1990). This leads us to expect that: *Software Defenders should have the highest financial performance in the Internet bust.*

For a firm to enjoy superior financial performance relative to the competition, it must be able to deploy resources and other productive factors more efficiently (Amit & Shoemaker 1993). The RBV literature distinguishes three critical capabilities: R&D, marketing and operations (Dutta 1999). R&D capabilities are thought to be particularly important in high technology industries such as the software industry. The software industry, like other high technology industries is characterized by a high rate of new product introductions. In this industry, being first to market is often essential to becoming the de facto standard. Companies must have the flexibility and leadership to adapt quickly to key changes in the marketplace. Those that lag and adapt too slowly may lose market share to competitors that are more nimble or to start ups offering new technology. Given the rapid rate of change in the software industry, we would expect that firms having higher R&D capabilities would have a distinct advantage. This would be particularly true during the Internet boom when the market and technologies were changing rapidly. For example, because of switching costs, lock in and network effects for software products, firms that are effective innovators are more likely to capture market share during periods of rapid technological innovation such as in the Internet boom (Shapiro & Varian 1999). Indeed, economists have found a strong relationship between software patent activity and firm financial performance during the Internet boom (Hall & MacGarvie 2004)

However, after the Internet bubble burst, the economic environment became more uncertain, Internet products and markets became more mature, and financial resources were more constrained. In an environment characterized by maturing product markets and where resources are constrained, being efficient in marketing and operations may be more important than the ability to rapidly innovate. After 2000, the weak economy negatively affected software sales, increasing pressure on software firms' gross margins (Standard & Poor's 2006). To remain profitable during the Internet bust, software firms needed to be more efficient in generating sales and in their use of resources. This suggests that higher marketing and operational capabilities should be more important than R&D capabilities in the

Internet bust. This leads us to hypothesize that: *Higher R&D capabilities increase financial performance more than higher operating and marketing capabilities in the Internet boom*; and: *Higher operating and marketing capabilities increase financial performance more than higher R&D capabilities in the Internet bust*.

Method

We analyzed data over the time period from 1995-2004 on 178 software firms in the industry SIC code of 7372 (the pre-packaged software industry). This industry covers firms primarily engaged in the design, development and production of prepackaged computer software. The main products include operating, utility and application software. The industry also includes software-related services such as the preparation of software documentation, software support, software installation and training. Examples of firms in this industry include Microsoft, Oracle, Adobe, Symantec, SPSS, Verisign, Ariba, RedHat and the SAS Institute. The software firms included in our study are publicly-owned and file 10-K reports with the SEC. The data on these firms were collected from a variety of sources, including financial data from COMPUSTAT, company annual 10-K reports filed with the SEC, and data on software patents, copyrights and trademarks from the U.S. Patent and Trademark Office (USPTO). The following paragraphs briefly describe our methodology for classifying the strategy type of the software firms, calculating each firm's R&D, marketing and operations capabilities, and operationalizing firm financial performance.

Strategy Classification of the Software Firms. To identify the Miles & Snow (1978) strategy type for each software firm, we employed a two-pronged approach. First, following Rajagopalan (1996), we content analyzed the software firms' SEC 10-K reports for the period of 1995-2004 to discern their "stated" strategies. Altogether more than 1,800 firm-year reports were perused and coded (for each firm in each year). The coding scheme used was based upon the Strategic Type Instrument developed by Conant (1990) for classifying firms' strategies into Analyzer, Prospector, Defender or Reactor. Two coders (the second and third author) independently read a firm's 10-K report, and when key words in the report matched the definition of particular strategy type, the firm was assigned that strategy type for a particular year. The coders then compared their codes for each firm-year, and found that they agreed on over 90% of the coding assignments. Any differences in coding were discussed and reconciled. Second, to help validate the content-based coding, we also used a quantitative approach to classify each firm's strategy. Following the approach of Thomas & Ramaswamy (1996), we used objective financial data to identify firms' "realized" strategies, analyzing their marketing expenditures, R&D expenditures, production expenditures, and total assets. To minimize the impact of firm size differentials, we normalized each variable by the number of employees in each firm. We also used 95% winsorization to avoid the heavy influence of extreme outliers. We then computed the Z score for each variable, and used the Z scores to identify strategic types as outlined in Thomas & Ramaswamy (1996). For example, Prospectors exhibit higher than average levels of R&D and marketing expenditures while Defenders have higher asset intensity and lower production expenditures. After using the quantitative data to classify the firms, we then compared the subjectively coded strategies to the objectively determined strategies. Only 18 firms had different strategy type codes from the two approaches, and non-parametric tests suggested no significant differences in coding from the two approaches. Nevertheless, the authors further discussed and resolved any differences in coding between the content analysis and quantitative approaches.

Measuring Software Firms' Capabilities. There are several approaches in the literature to measure marketing, operating and R&D capabilities of firms. One of these approaches is Data Envelopment Analysis (DEA). DEA (Charnes, Cooper & Rhodes 1981; Banker, Charnes & Cooper 1984) is a non-parametric, deterministic method of estimating the technical efficiency or capability of a firm in converting inputs into outputs. It is based on linear programming techniques, and identifies the frontier or maximum level of output that can be obtained given a certain level of input for efficient units. DEA yields relative measures of efficiency ranging from 0 (least efficient) to 1 (most efficient) where a given unit is compared against the others in the sample. While most DEA models deal with static conditions, DEA window analysis can analyze more complex, or time-dependent data (Klopp 1985). DEA window analysis evaluates the efficiency performance of each unit in each time period or "window". We used DEA window analysis and the BCC model to compute the measure for each type of efficiency (marketing, R&D and operations) for each firm in each year. Following the approach of Dutta (1999), marketing efficiency assessed the firm's capability in converting marketing-related inputs (e.g., SGA) into marketing related outputs (e.g., Sales); operations efficiency, each firm's capability in converting operating-related inputs (e.g., Capital Expenditure) into operations-related outputs (e.g., Operating Income); and R&D efficiency, each firm's capability in converting R&D-related inputs (e.g., R&D expenditures) into R&D related outputs (e.g., average number of patents).

Software Firms' Financial Performance. We measured software firms' financial performance using Tobin's q . **Tobin's q** is the ratio of the market value of a firm's assets (outstanding stock and debt) to the replacement cost of

the firm's assets (Tobin 1969). If a firm is worth more than what it would cost to rebuild it, then profits are being earned, and the firm can remain in the industry. Using Tobin's q avoids the difficulty of estimating rates of return or marginal costs. If Tobin's q is above 1, the firm is earning a rate of return higher than that justified by the cost of its assets. Therefore, the higher the Tobin's q the better the company's performance. Many methods have been proposed for computing Tobin's q. Perfect & Wiles (1994) concluded that most approaches generate comparable results. Bharadwaj et al. (1999) make use of Chung & Pruitt's (1994) method to calculate q. Their method is straightforward since it only requires data from the Compustat database and is highly correlated with the q calculated by Lindenberg & Ross (1981), a well-known theoretically correct model. We thus follow Bharadwaj et al. (1999) to define Tobin's q as: $Tobin's\ q = (MVE + PS + DEBT)/TA$, where: MVE = (Closing price of share at the end of the financial year)*(Number of common shares outstanding); PS = Liquidating value of the firm's outstanding preferred stock; DEBT = (Current liabilities - Current assets) + (Book value of inventories) + (Long term debt), and TA = Book value of total assets.

Analysis, Results & Discussion

We pooled the data on firms' strategy types, capabilities and financial performance, creating a cross-sectional, time-series data panel of 1,237 total observations for 178 software firms over 10 years (note that the panel is unbalanced as some firms entered the panel later in the time period, and some firms dropped out of the panel as they went bankrupt or became acquired by another firm). We also identified two time periods, using a dummy variable to identify observations in years 1995-1999 as the Internet boom (=0) and observations in years 2000-2004 as the Internet bust (=1). According to Standard & Poor's software industry report (2006), the software industry experienced the crash in the year 2000; thus, we identified the years prior to 2000 as the boom, and those starting with 2000 and after as the bust. We also added a variable for firm size, to control for a relationship between firm size and performance (Dutta 1999). We then estimated a model relating each firm's Tobin's q value in each year (log transformed to mitigate skewness) to the firm's strategic type (represented as dummy variables, one each for Analyzer, Defender or Prospector, with Reactors as the base), measures of the firm's marketing capabilities, R&D capability and operations capabilities (using the DEA efficiency scores for each type of capability, and centering each efficiency score for each type of capability year-by-year so that the scores are comparable across years), the dummy variable for Internet boom/bust, and interactions between the Internet boom/bust variable with strategy types and capabilities, and controlling for firm size. We used feasible generalized least squares (FGLS) to estimate the model, correcting for cross-sectional heteroscedasticity and for serial correlation using a panel-specific AR(1) procedure (Greene 2003). The results from the FGLS estimations of our panel are shown in Table 1. Because our model includes interaction effects, we must differentiate it with respect to the particular variable of interest to determine the coefficient to be evaluated for comparing values in the Internet boom and bust; however, as we have a dummy variable representing the Internet boom/bust, this process is simplified, since the respective coefficients can be added together as appropriate. Table 2 shows the computed coefficients in the Internet boom and in the Internet bust exponentiated for ease of interpretation as the marginal value of each variable associated with Tobin's q.

Table 1

Variable Name	Estimated Coefficient	Std Error	z value
Intercept	0.780571	0.053883	14.49***
Firm Size	0.213666	0.03558	6.01***
Prospector	0.174619	0.091618	1.91*
Defender	0.30776	0.123764	2.49**
Analyzer	0.530334	0.075933	6.98***
Operations	0.141353	0.110194	1.28
R&D	-0.20439	0.108205	-1.89
Marketing	-0.17717	0.125563	-1.41
Internet Bust	-0.21227	0.063021	-3.37***
Bust x Prospector	-0.11693	0.108729	-1.08
Bust x Defender	-0.07249	0.134093	-0.54
Bust x Analyzer	-0.47629	0.091943	-5.18***

Table 2

INTERNET BOOM: Marginal Effects relating to Tobin's q						
Defender	Analyzer	Prospector	Reactor	Operations	R&D	Mktg
2.969313	3.709529	2.599165	2.182718	1.151831	0.815147	0.837636
INTERNET BUST: Marginal Effects relating to Tobin's q						
Defender	Analyzer	Prospector	Reactor	Operations	R&D	Mktg
2.233513	1.863291	1.870102	1.765270	1.227331	0.861166	1.394938

Bust x Operations	0.063489	0.140195	0.45
Bust x R&D	0.054919	0.147231	0.37
Bust x Marketing	0.510022	0.167777	3.04***

DV = \ln Tobin's q, n = 1,237. Log-likelihood = -1040.52, Wald chi2(14) = 251.61, p < 0.001, Pseudo-R² = 0.133, *** p < 0.001, ** p < 0.01, * p < 0.05

Our results suggest that the financial performance of software firms differs by the type of strategy they execute. Figure 1 illustrates our empirical results, graphing the relationship between financial performance and strategy type in the Internet boom and bust. As shown in Figure 1, Software Reactors are valued least relative to the other strategy types in both the Internet boom and bust. The financial performance for some strategy types also differs in different environments. As we hypothesized, Software Analyzers have the highest market value in the Internet boom while Software Defenders have the highest market value in the Internet bust. Of all the strategy types, Software Analyzers lose the most market value from the Internet boom to bust, as their Tobin's q value declines almost 50% compared with declines ranging from 20-28% for the Tobin's q value of other strategy types. In terms of capabilities, we hypothesized that R&D capabilities would be associated with higher financial performance in the Internet boom while marketing and operations capabilities would have higher value in the Internet bust. Our hypotheses are partially supported. Figure 2 graphs the financial performance implications of the interactions between capability type and Internet boom or bust. As shown in Figure 2, operating and marketing capabilities are related to higher values of Tobin's Q in the Internet bust, as we expected; however, operating capabilities (not R&D capabilities) are related to higher values of Tobin's Q in the Internet boom.

Figure 1.

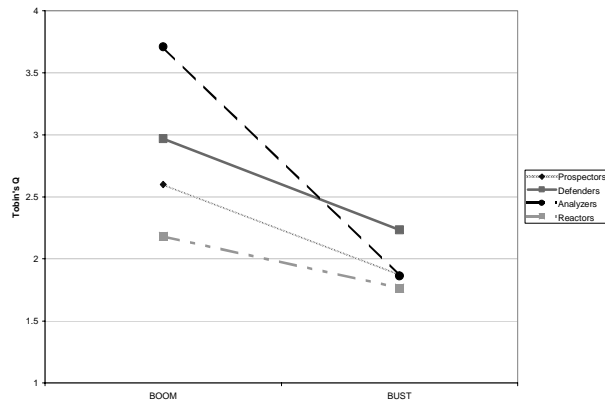
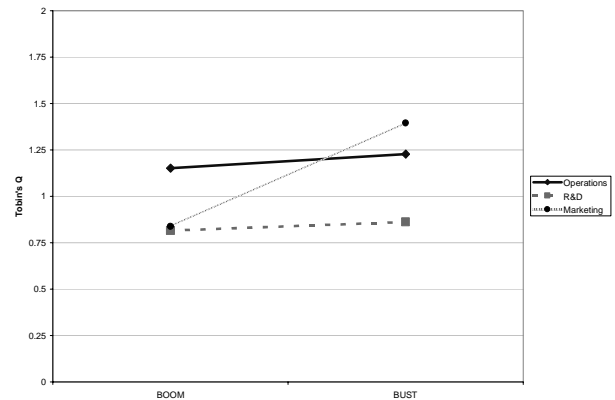


Figure 2.



Our study contributes by providing unique insights into the economic value of firms' strategic choices and capabilities in different economic environments. A general assumption is that strategies and capabilities, if superior, should be equally effective in different environments. However, our results suggest otherwise. Beyond that, our results have important implications for strategy selection and execution for software producing firms. In particular, our results reveal the difficulty in sustaining and executing a software Analyzer strategy – this strategy clearly does not perform as well in an environment where resources may be constrained or uncertain. Our results also suggest that operating and marketing capabilities are generally more valuable, at the margin, than R&D capabilities. This was surprising to us, as we would expect innovation to be highly valued in the software industry. One potential explanation is that firms must have innovative capability to enter this industry, so there may be no special reward for higher levels of efficiency in R&D. In contrast, perhaps high levels of operations and marketing capabilities are relatively rarer in the software industry, and thus, more valued by investors, especially when environmental conditions require such capabilities.

[References are available upon request from authors]