The relationship between boards of directors and initial public offerings in the biotechnology industry

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Utilizing the entire population of public biotechnology firms from 1980-1994, three models were tested to determine if a relationship exists between the size and composition of the board of directors and performance. Results indicate significant positive relationships between director expertise and the size of a firm's initial public offering. Going public during hot markets and larger firms were also related to larger initial public offerings. These findings will benefit practitioners in the formation of boards within the biotechnology industry. Managers of firms within the biotechnology industry who are contemplating a public offering will be able to proactively address the composition of their boards.

One area that has been receiving increasing attention by scholars and practitioners in entrepreneurship is the board of directors and its relationship to initial public offerings (IPOs) and corporate performance. The relationship between boards of directors and corporate financial performance has been investigated over the past five decades in such diverse disciplines as management, economics, finance, and sociology. Zahra and Pearce (1989) state, however, that this research has concentrated on the Fortune 500 population, while neglecting smaller, medium-size, and non-profit businesses, and specific industries. In addition, these studies have used samples of firms primarily in mature industries, failing to investigate board roles in other stages of firm or industry development. MacMillan and Katz (1992) have a call for entrepreneurship scholars to focus on the emergence of new industries and hot IPO markets.

This study attempts to fill a gap in both entrepreneurship and board research by investigating the relationship between the size and composition of boards of directors and both their initial offering size and aftermarket performance of IPOs in the emerging industry of biotechnology. Previous research (Rosenstein, 1987; Tashakori & Boulton, 1985) has shown that the size and composition of a board is important because it influences the quality of directors' deliberation and decisions. Board composition also affects directors' ability to provide strategic direction and performance (Baysinger & Hoskisson, 1990), and determines the ability of directors to control management to protect shareholder interests (Cochran, Wood, & Jones, 1985; Kesner & Johnson, 1990; Kosnik, 1990).

A number of researchers (see Churchill & Lewis, 1983; Flamholtz, 1986; Galbraith & Nathanson, 1978; Greiner, 1972) have studied the life cycle of organizations. The models usually progress from the start-up stage through various intermediate stages into mature organizations. Flamholtz (1986) states that firms pass through four stages of
growth: new venture, expansion, professionalization, and consolidation. Stages one and two, taken together, make up the entrepreneurial phase of organizational development, while stages three and four make up the professional management phase (Clifford, 1973; Whisler, 1988). Daily and Dalton (1992a) term this transitional stage the “threshold” of a firm, when the founder must begin to yield control of operations to other managers and subordinates. Typically, pressures created from firm growth dictate the onset of this transitional stage (Whisler, 1988).

This study examines the biotechnology industry in the threshold or transitional stage as equivalent to the transformation from privately held organizations to public identities. The transitional stage of development can be equated with the “re-birth” or “restart” of organizations. This stage of development is of vital importance in board and small business research due to the requirement by the SEC of a board of directors during an IPO (Wang, 1991). More specifically, this research examines if the size and composition of the boards of directors is related to their initial offering size and aftermarket IPO performance for firms within the biotechnology industry.

The initial offering period is of vital importance to the biotechnology industry due to the capital-intensive nature of the industry. Lee and Burrill (1994) report that the average cost of development for a new drug is $125 million. Furthermore, Hamilton (1994) states that biotech companies need seven to ten years to bring a new product to market. Therefore, these firms tend to be resource dependent. They “are not able to internally generate either all the resources or functions required to maintain themselves” (Aldrich & Pfeffer, 1976). Due to the time lag between the introduction of products in the research pipeline and their actual introduction into the marketplace, biotech firms, at the time of their initial offering, need large amounts of capital to support their future research endeavors. Therefore, the initial offering period plays a crucial role in the survival and success of firms in the biotech industry.

The study examines the entire population of public biotech firms from 1980-1994.

INITIAL PUBLIC OFFERINGS AND BIOTECHNOLOGY

Going public provides a firm with key additional resources for continued growth and survival. It also provides a firm with an increased level of legitimacy in the business community, which improves its access to debt financing, creates a means for expansion of operations, and a means for exit by major shareholders (Sutton & Benedetto, 1988).

Before a firm goes public it will generally seek an underwriter or syndicate of underwriters. When the firm and the underwriter agree to an IPO, both parties must agree with the Securities Act of 1933. The Act was designed to disclose information to potential investors, giving investors the right to see if there is misleading information or material omission of fact. The restrictions are stricter for S-1 offerings (greater than $7.5 million in gross proceeds) than they are for S-18 offerings (less than $7.5 million). The smallest offerings (less than $1.5 million in gross proceeds) are eligible for a regulation A offering, which involves fewer requirements (Ibbotson, Sindelar, & Ritter, 1988).

The underwriter and firm then file the appropriate paperwork (e.g., type of business, nature of security, financial statements) with the SEC in the preliminary prospectus. The SEC then reviews the application, and, if approved, both underwriter and firm agree upon an initial offering price the day before the IPO. It is at this point that this study investigates the relationship between the size and composition of the board of directors and the market valuation and subsequent performance of public biotech firms.

A major study was recently conducted on the factors contributing to IPOs in the biotech industry (see Deeds, DeCarolis, & Coombs, 1997). They found four significant positive relationships with larger IPOs. First, they found that firms that went public
during hot versus cold markets were able to raise an extra $8.9 million (an average IPO in their sample raised $20 million). 1

Second, firms that had a larger number of products in their research pipeline were able to raise more capital. Their results indicate that each additional product in a firm’s research pipeline (in pre-clinical or clinical trials) adds almost $700,000 to the IPO.

Third, the initial market capitalization of the firm increases when it has a larger number of citations, as an indication of the reputation of the company’s scientists (top executives and scientific consultants). A firm’s IPO increased by $2.6 million for every increase of 138 citations.

Finally, their results indicate that a firm’s location plays a significant role in its ability to raise capital. They found that most biotech firms were located in eight areas: San Francisco, New York Tri-State area, Boston, San Diego, Washington, D.C., Los Angeles/Orange County, Philadelphia/South Jersey, and Seattle. According to their findings, if a firm not located in one of these aforementioned areas relocated to San Francisco, it would be able to raise an additional $6.3 million in capital. This is probably due to the added value of research at universities, larger labor pool, and information overflow from other firms.

NEW FIRMS AND RESOURCE DEPENDENCE

Stinchcombe (1965) and other researchers (e.g., Aldrich & Auster, 1986; Aldrich & Pfeffer, 1976) have emphasized that young organizations have a higher propensity to die than old organizations. Stinchcombe termed this occurrence “liability of newness.” He stated that this liability of newness occurs because younger organizations face the following barriers to entry that may make movement into a new domain prohibitive: product differentiation, technological barriers, licensing, barriers due to vertical integration, illegitimate acts by competitors, and experiential barriers. Additionally, Aldrich and Auster (1986) state that new organizations face difficulty in the acquisition of resources that may lead to the dissolution of the organization.

Another factor linked to the performance of new firms has been termed “liability of smallness.” Organizational researchers suggest that larger organizational size is associated with increases in the pool of resources available for organizational use. It has been proposed that larger organizations are more likely to possess the resources necessary to acquire control over the environmental entities that mediate critical resources (Aldrich & Pfeffer, 1976; Pfeffer & Salancik, 1978). Larger organizations are thought to have access to more critical resources (e.g., people, money, and knowledge) that might enhance the survivability of the firm. Despite the previous conclusions, research into the organizational size-performance relationship has produced contradictory findings. This study utilizes resource dependence theory (Pfeffer & Salancik, 1978; Pfeffer, 1987) to investigate how biotech firms, at the time of their initial public offering, search their environment for critical resources to enhance their initial offering size and aftermarket IPO performance.

Resource dependence theory is rooted in sociology (Selznick, 1949), and is built upon open systems theory (Katz & Kahn, 1966) and contingency theory (Lawrence & Lorsch, 1967). According to resource dependence theory, a firm scans the environment to extract resources to enhance its legitimacy in society and to help it achieve its goals of efficiency and improved performance (Pfeffer, 1972, 1973; Price, 1963; Provan, 1980; Zald, 1967). Resource dependence theory proposes that a firm’s survival is contingent on its ability to gain control over critical environmental resources.

1. Ritter (1984) defined hot markets as a period when investors tend to be over optimistic about the earnings of young growth companies.
To accommodate for the lack of resources in an organization, Selznick (1949) proposed that the creation of boards of directors is an important way in which organizations attempt to co-opt important external constituencies to enhance the survival of the firm. According to Selznick (1949), organizations have the capacity to develop distinctive competencies, then draw upon actors external to the organization to support these central tasks through co-optation. Through co-optation, organizations have the ability to extract critical external resources that might enhance the survival of the firm. According to Pfeffer (1972), co-optation is likely to be used by business organizations "when total absorption is (1) legally prescribed, (2) impossible due to resource constraints, or (3) when partial inclusion is sufficient to solve the organization's problems of dealing with the external organization" (p. 22).

Resource dependence theory suggests that firms that extract critical external resources may outperform those that do not. Specifically, outside directors on a corporate board are seen to provide valuable scarce information and/or resources, which might enhance the performance of the organization. The resource dependence perspective views boards as vehicles through which organizations "co-opt, or partially absorb, important external organizations with which they are interdependent" (Pfeffer, 1972, p. 222).

One of the first to examine the resource value of outsiders on the board, Selznick's (1949) study of the Tennessee Valley Authority concluded that an organization that is faced with strong opposition could partially neutralize its situation by bringing representatives of hostile groups onto the organization's governing boards. Burt (1980) found previous research that suggested that outsiders absorbed from such external groups as customers, suppliers, and competitors enable firms to facilitate resource exchange agreements and reduce vertical and horizontal external constraints.

AGENCY THEORY AND BOARDS

Deeply rooted in economics and developed in the domain of finance, "agency theory" was formed from the literature on property rights (see Alchian, 1965, 1968; Alchian & Demsetz, 1972; Coase, 1937, 1959, 1960; Jensen & Meckling, 1976). Agency theory emerged in the 1970s as a powerful means of examining the conflicting relationship between owners and managers. Jensen and Meckling (1976) define an agency relationship as follows: "a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent."

Agency theory assumes that principals and agents have different self-interests and that they try to enhance their own utility, although principals (e.g., shareholders) and agents (e.g., board of directors) are both profit oriented. Another assumption of agency theory is that principals and agents have different attitudes towards risk. Agents tend to be more risk averse because they are unable to diversify their jobs. Principals have a more liquid position due to their ability to liquidate their holdings within the firm. This difference has led researchers to believe that principals and agents have conflicting goals, which leads to different attitudes towards risk and different self-interests. However, there are likely to be less agency problems within entrepreneurial companies because the managers (often) are the shareholders.

Agency theory is among the most recognized approaches to studying boards of directors (Zahra & Pearce, 1989). It argues that agency relationships should be the focal point in analyzing and studying corporate governance. For instance, an important role that boards play is corporate control (Kosnik, 1987, 1990). This includes the selection of executives (e.g., CEOs), monitoring and rewarding top executives, and using board
power to protect shareholders' interests (Brickley & James, 1987). Through corporate control, boards can attempt to limit the agency costs that may arise within their company (Pearce & Zahra, 1992).

The board’s most important role is to scrutinize the highest decision-makers in the firm. Fama and Jensen (1983) assert that boards can fulfill the monitoring function because they have the power to hire, fire, and compensate the top-level managers and to ratify and monitor important decisions.

Board contribution to organizational performance occurs by reducing agency costs arising from noncompliance of executives with established goals and procedures, by articulating shareholders’ objectives and focusing the attention of key executives on company performance, and through strategic decision making and control (Mizruchi, 1983).

Board Size

Chaganti, Mahajan, and Sharma (1985) and Gales and Kesner (1994) have investigated the relationship between board size and corporate performance and found that large board size was related to effective performance. Chaganti et al. (1985) found that small boards were associated with a higher rate of corporate bankruptcy in retailing firms. The average board size for the non-failed firms was between 10 and 15. Pearce and Zahra (1992) found larger board size to be positively associated with corporate performance. Gales and Kesner (1994) found that firms that filed bankruptcy had smaller boards of directors as compared to a matched group of firms not filing bankruptcy.

Overall, research indicates that there is a relationship between larger boards and enhanced company performance. Larger boards were assumed to have directors with diverse educational and industrial backgrounds and skills and with multiple perspectives, which improved the quality of actions taken by the firm. Larger boards were viewed as being essential to co-opt resources from a firm’s environment, thus establishing a favorable image for the company. Finally, as board size increases, CEO domination of the board becomes more difficult and directors are in an improved position to increase their power in governing the organization (Zahra & Pearce, 1989). Considering the previous findings, I hypothesize that there will be a positive significant relationship between larger boards and both the initial offering size and aftermarket IPO performance of public biotech firms.

H1a: There will be a positive linear relationship between the size of the boards of directors and the initial offering size of public biotech firms.

H1b: There will be a positive linear relationship between the size of the boards of directors and the aftermarket IPO performance of public biotech firms.

BOARD COMPOSITION

Functional backgrounds of directors have been investigated by several researchers (see Bacon & Brown, 1973; Baysinger & Butler, 1985; Heidrick & Struggles, 1981; Korn/Ferry, 1983; Pearce & Zahra, 1992; Vance, 1983). Overall, past research utilizing resource dependence theory and functional backgrounds of boards of directors and corporate performance has been sparse. Previous empirical studies have contradictory findings. For instance, Pfeffer (1972) found a positive relationship between higher debt-to-equity ratios and outside directors with financial backgrounds. Vance (1978) found that a reliance on the expertise of outside directors was associated with negative performance. Other studies (Baysinger & Butler, 1985; Schellenger, Wood, & Tashakori, 1989) found a positive relationship between the percentage of outside directors and
increased financial performance. Finally, Stearns and Mizruchi (1993) found a significant positive relationship between the presence of representatives of financial institutions on firms' boards and borrowing decisions.

More recently, researchers have focused their attention on entrepreneurial (high-growth) firms (see Daily & Dalton, 1992, 1994a; Ford, 1988). Daily and Dalton's (1992b, 1994a) study on the Inc. 100, found that outside directors were positively associated with firm performance. Ford (1988) and Daily and Dalton (1994a) found contradictory results. Ford's (1988) study on the Inc. 500 reported that firms that had more outsiders on their board had slightly less influence or importance with respect to strategic planning, the budget process, crisis management, and the board's ability to assist in operating the firm in the event of CEO disability; however Ford did not investigate performance differences based upon these findings (Daily & Dalton, 1992b). Daily and Dalton's (1994a) study on both small and entrepreneurial companies concluded that firms with lower proportions of outside directors outperformed their counterparts.

One of the primary reasons for the previous inconclusive findings in this stream of research is the lack of consistency on the operationalization of inside and outside representation. Several approaches have been used. For example, one stream of research has focused on the ratio of inside directors to total directors (see Baysinger, Kosnik, & Turk, 1991; Goodstein & Boeker, 1991). Others have used the ratio of outside directors to total directors (Kesner & Johnson, 1990; Kesner, Victor, & Lamont, 1986; Pearce & Zahra, 1992; Singh & Harianto, 1989). Another method is the independent-interdependent method used by Wade, O'Reilly, and Chandratat (1990) and Boeker (1992), where independent directors are outside directors who were appointed to a board prior to a current CEO's appointment; interdependent directors are either inside board members or outside directors appointed by the current CEO.

Daily and Dalton (1994b) used another method to classify the board, the Securities and Exchange Commission's regulation 14A, item 6b. This regulation requires a firm to disclose a director's affiliation with a firm in its proxy statement. Under this regulation, close personal or professional relationships with the corporation or its CEO must be disclosed. Directors with the following relationships must be identified: (1) employment by the corporation or an affiliate within the last five years; (2) any family relationship by blood or marriage closer than second cousin; (3) affiliation in the last two years with a concern that has a customer, supplier, banker, or creditor relationship with the corporation; (4) affiliation with an investment banker who has performed services for the corporation within the last two years or will do so within one year; (5) holding control of corporate stock, with control based on the extent of shareholdings (federal securities law sets forth exact amounts and conditions); and (6) association with a law firm engaged by the corporation (Daily & Dalton, 1994b). Other researchers (see Boeker & Goodstein, 1993; Cochran, Wood, & Jones, 1985; Johnson, Hoskisson, & Hitt, 1993; Pearce & Zahra, 1991) have used a similar method to classify affiliated directors, however, it was not the specific SEC 6(b) method.

Similar to Daily and Dalton's (1994b), this study uses the premise of the SEC item 6b approach. This method captures the essence of the board. I assume that firms that have a larger percentage of affiliate directors are characterized by little independence from the firm. In other words, a larger percentage of affiliated directors, as defined by the SEC 6b method, will have a greater vested interest in how the firm performs.

**Financiers**

A stream of research has developed on venture capital-backed high-tech companies (see Barry, Muscarella, Peavy, & Vetsuypons, 1988, 1990; Bygrave & Stein, 1989; Rosenstein, Bruno, Bygrave, & Taylor, 1989, 1990; Sapienza & Timmons, 1989; Stein
The notion of value-added has been investigated in several studies with varying results. For example, Sapienza and Timmons’ (1989) study implied a strong value-added link between the activities of venture capital firms and a portfolio company’s outcome. Bygrave and Stein (1989) and Stein and Bygrave (1990) found a positive association between the post-IPO performance of venture capital-backed high-tech companies and the prestige of the lead underwriter and venture capital firm.

In contrast to these findings, Rosenstein et al. (1989) found that CEOs of venture capital-backed IPOs did not perceive that venture capitalists added more value than other board members. There was also no correlation between value-added and performance. In a follow-up study, Rosenstein et al. (1990) reported that CEOs with top-20 high-tech venture capital firms as lead investors on their boards perceived they added more value than other outside directors. Barry et al. (1990) examined venture capital-backed IPOs and found that venture capitalists take concentrated equity positions and serve on the board of their portfolio firms. Other researchers (see Allen & Faulhaber, 1989; Barry et al., 1988) suggest the importance of the underwriter.

More recently, a study by Stearns and Mizruchi (1993) examined the presence of representatives of financial institutions on firms’ boards and how that presence relates to the firms’ borrowing decisions. They found that the type of financial institution represented on the board was associated with the amounts and types of financing a firm obtains. Furthermore, Baker (1990) found that 57% of the firms in his study did business with the investment banks represented on their board.

In this study, the prestige of venture capitalists and investment banks (lead underwriters) on a firm’s board is examined. I hypothesize that firms that have more prestigious financiers on their boards will have larger IPOs and enhanced aftermarket IPO performance. The prestige of a venture capitalist or lead underwriter on a board might influence how others perceive the company. Prestige suggests that a director has gilded qualifications and powerful friends (Finkelstein, 1992). More prestigious directors could enhance a firm’s legitimacy and reduce its uncertainty in the institutional environment (Selznick, 1957). These directors could also act as key links with the business community, providing access to customers, suppliers, financial institutions, and other people who could collaborate with the venture (Roure & Keeley, 1990). They can also oversee financial activities within the firm that might reduce agency costs. This leads to the second and third hypotheses:

H2a: There will be a positive linear relationship between affiliated directors from top 20 venture capital firms and the initial offering size of public biotech firms.

H2b: There will be a positive linear relationship between affiliated directors from top 20 venture capital firms and the aftermarket IPO performance of public biotech firms.

H3a: There will be a positive linear relationship between affiliated directors from prestigious underwriters and the initial offering size of public biotech firms.

H3b: There will be a positive linear relationship between affiliated directors from prestigious underwriters and the aftermarket IPO performance of public biotech firms.

University Scientists

Another critical resource for biotech firms might be university scientists. Biotechnology is a highly technical and scientifically oriented discipline. New research methodologies, techniques, and findings are occurring daily. One way these firms might gain a competitive edge is through the co-optation of directors specializing in science from universities. Scientists could provide the firm with valuable research techniques, infor-
mation, and data, information on experienced workers, and the ability to review other scientists’ work.

The ability of outside scientists to review others’ work has been exemplified in the literature on board professionalism. Professionalism is characterized by the accumulation of specific, often unique, knowledge over a long period of time (Sebora, 1993). March and Simon (1958, p. 70) state: “To the extent that a job is professionalized, techniques and standards of performance are defined by the other members of the profession.” Thompson (1967, p. 113) notes “Because such occupations rest on specialized skills, there is basis for contention that assessment standards should be established and performance evaluated by peers in the occupation. . . .” Outside board members who are scientists can review the work of other scientists and contribute to better overall performance for the firm.

I propose that the reputation of the affiliated directors who are university scientists on a firm’s board will have a significant impact on the company’s ability to raise capital at their IPO and the subsequent performance of the firm. I use a common method to measure the reputation of the university scientists, citation analysis. Citation analysis uses the number of times an author or article is cited as an indication of the importance of the work to the field. More important papers tend to be cited more frequently.

Citation analysis has been used in a variety of scientific endeavors. For instance, Brown and Gardner (1985), Gamble and O’Doherty (1985), Robinson and Adler (1981), and Wallmark, McQueen, and Sedig (1988) used citations to assess the performance of academic departments. Other researchers (Mullins, 1987; Narin, 1987; Narin & Rozek, 1988; Vinkler, 1986), used citations to assess the quality of scientific and technical research programs. A review of citation analysis studies in other fields, including entrepreneurship and small business, can be found in Romano and Ratnatunga (1996).

In their study on biotech IPOs, Deeds et al. (1997) used citations as an indication of the reputation of the company’s scientists (top executives and scientific consultants). They found that firms that had a larger number of citations had larger IPOs. My study focuses on a subset of Deeds et al.’s (1997) scientific population, directors who are affiliated university scientists. This leads to the fourth hypothesis:

\[ H4a: \text{There will be a positive linear relationship between the reputation of directors who are affiliated university scientists and the initial offering size of public biotech firms.} \]

\[ H4b: \text{There will be a positive linear relationship between the reputation of directors who are affiliated university scientists and the aftermarket performance of public biotech firms.} \]

Chief Executive Officers

CEO characteristics and differences among them have emerged as topics of considerable interest in both the academic and popular business literature (Rajagopalan & Datta, 1996). Research (see Finkelstein, 1988; Gupta, 1988) stems from the assumption that CEOs have a significant impact on both organizational activities and performance. Extant research on the relationship between CEOs and organizational outcomes has taken two perspectives. The first focuses on the CEOs’ psychological attributes and their relationship to organizational outcomes (see Miller, Kets de Vries, & Toulouse, 1982; Hage & Dewar, 1973). The second focuses on CEOs’ demographic characteristics (such as age, functional background), with the assumption that such characteristics are related to cognitive abilities, attitudes, and expertise (Bantel & Jackson, 1989).

This study focuses on the functional backgrounds of CEOs. Although CEOs are presumed to have a generalist’s view, they are often functionally specialized (Gupta,
1984). Their functional expertise allows them to make significant contributions to the overall strategic direction of the firm. I hypothesize that there will be a positive relationship between CEOs who were former university scientists and the size of their firm’s IPO and subsequent performance. I assume that a majority of these biotech firms are founded in laboratories at universities. After many years of dedicated research and development, these professors decide to start their own company. The expertise they bring to the company should greatly enhance the performance of the firm.

I also hypothesize that CEOs with functional backgrounds in finance will have a significant impact on a firm’s ability to raise capital and its subsequent performance. Similar to affiliated venture capitalists and underwriters, CEOs with functional backgrounds in finance could act as key links with financial institutions or other businesses that might increase the ability of the firm to raise capital. This leads to the fifth and sixth hypotheses:

H5a: There will be a positive linear relationship between CEOs who were former university professors and the initial offering size of public biotech firms.
H5b: There will be a positive linear relationship between CEOs who were former university professors and the aftermarket performance of public biotech firms.
H6a: There will be a positive linear relationship between CEOs who have financial backgrounds and the initial offering size of public biotech firms.
H6b: There will be a positive linear relationship between CEOs who have financial backgrounds and the aftermarket performance of public biotech firms.

METHOD

Sample

The sample consists of all biotech firms that made IPOs from 1980 to 1994. The initial offering date was chosen for a number of reasons. Singh, Tucker, and House (1986) use a similar time period as their founding period, the year of formal incorporation. I assume that formal incorporation reflected a strong commitment by the founder(s) to build and maintain an ongoing organization. In addition, when a firm transforms itself into a public corporation, it is required by corporate law to have a board of directors. This legal requirement, along with the listing requirements of the SEC and the stock exchanges, ensures that IPO firms have boards and that information on these boards is publicly available.

The number of IPOs during this period was 265; however, the final sample size was 125 firms. One hundred forty firms were eliminated due to lack of data. The final sample consisted of 47% of the public biotech firms during this period. A database was developed through the following sources: Disclosure Inc., Securities and Exchange Commission, and an extensive literature search. The focus of the research was on an emerging industry of which most firms were young (under 15 years old) (Kazanjian & Drazin, 1990).

Table 1 shows the means, standard deviations, and correlations for the variables in the study. The average value of an IPO in my sample was $18.76 million. Average returns for MP1 and MP2 were -12.9% and -9.0%. The average firm was 4.7 years old and had $7.56 million in total assets. Fifty-seven percent of the firms went public during hot markets. Twenty-two percent of the firms had a private placement or secondary offering one year after their IPO. Thirty-three percent of the firms had a private placement or secondary offering two years after their IPO.

The percentage of firms that had an affiliated top-20 venture capitalist on their board was 46%. Only four firms in the sample had an affiliated director from a prestigious underwriting firm. The work of the average affiliated university scientist was cited 294
<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. dev.</th>
<th>IOS</th>
<th>MP1</th>
<th>MP2</th>
<th>TOT</th>
<th>HOT</th>
<th>OA</th>
<th>SEC1</th>
<th>SEC2</th>
<th>SIZE</th>
<th>AFVC</th>
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<td>16.094</td>
<td>1.000</td>
<td>-0.031</td>
<td>0.078</td>
<td>0.530**</td>
<td>0.323**</td>
<td>0.092</td>
<td>0.073</td>
<td>0.313**</td>
<td>0.194*</td>
<td>0.487**</td>
<td>0.394**</td>
<td>0.198*</td>
<td>0.288**</td>
<td>0.205*</td>
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<td>Aftermarket Performance Year</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1 (MP1)</td>
<td>-12.9</td>
<td>25.2</td>
<td>-0.031</td>
<td>1.000</td>
<td>0.421**</td>
<td>0.027</td>
<td>-0.034</td>
<td>-0.107</td>
<td>0.283**</td>
<td>0.311**</td>
<td>0.182*</td>
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<td>0.078</td>
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<td>0.095</td>
<td>0.125</td>
<td>-0.088</td>
<td>0.163</td>
<td>0.184</td>
<td>0.143</td>
<td>0.192*</td>
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<td>(Log) Total Assets (TOT)</td>
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<td>0.530**</td>
<td>0.027</td>
<td>0.095</td>
<td>1.000</td>
<td>0.101</td>
<td>0.237*</td>
<td>0.116</td>
<td>0.255**</td>
<td>0.261**</td>
<td>0.404**</td>
<td>0.05</td>
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<td>0.323**</td>
<td>-0.034</td>
<td>0.125</td>
<td>0.101</td>
<td>1.000</td>
<td>0.096</td>
<td>0.002</td>
<td>0.067</td>
<td>0.065</td>
<td>0.351**</td>
<td>-0.014</td>
<td>0.160</td>
<td>0.019</td>
<td>0.055</td>
</tr>
<tr>
<td>(Log) Organizational Age (OA)</td>
<td>1.43</td>
<td>0.58</td>
<td>0.092</td>
<td>-0.107</td>
<td>-0.088</td>
<td>0.237*</td>
<td>0.096</td>
<td>1.000</td>
<td>-0.099</td>
<td>-0.099</td>
<td>0.152</td>
<td>0.183*</td>
<td>0.022</td>
<td>0.071</td>
<td>0.063</td>
<td>-0.088</td>
</tr>
<tr>
<td>Private Placements and</td>
<td>0.216</td>
<td>0.413</td>
<td>0.073</td>
<td>0.283**</td>
<td>0.163</td>
<td>0.116</td>
<td>0.002</td>
<td>-0.099</td>
<td>1.000</td>
<td>0.715**</td>
<td>0.025</td>
<td>0.085</td>
<td>-0.157</td>
<td>-0.098</td>
<td>0.027</td>
<td>-0.055</td>
</tr>
<tr>
<td>Secondary Markets (SEC1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Placements and</td>
<td>0.327</td>
<td>0.471</td>
<td>0.313**</td>
<td>0.311**</td>
<td>0.184</td>
<td>0.255**</td>
<td>0.067</td>
<td>-0.099</td>
<td>0.715**</td>
<td>1.000</td>
<td>0.12</td>
<td>0.183</td>
<td>-0.048</td>
<td>0.069</td>
<td>0.212*</td>
<td>-0.018</td>
</tr>
<tr>
<td>Secondary Markets (SEC2)</td>
<td>6.68</td>
<td>1.785</td>
<td>0.194*</td>
<td>0.182*</td>
<td>0.143</td>
<td>0.261**</td>
<td>0.065</td>
<td>0.152</td>
<td>0.025</td>
<td>0.12</td>
<td>1.000</td>
<td>0.256**</td>
<td>0.11</td>
<td>-0.019</td>
<td>0.105</td>
<td>0.214*</td>
</tr>
<tr>
<td>Size of the Board (SIZE)</td>
<td>0.464</td>
<td>0.501</td>
<td>0.487**</td>
<td>0.029</td>
<td>0.192*</td>
<td>0.404**</td>
<td>0.351**</td>
<td>0.183</td>
<td>0.085</td>
<td>0.183</td>
<td>0.256**</td>
<td>1.000</td>
<td>0.050</td>
<td>0.109</td>
<td>0.065</td>
<td>0.194*</td>
</tr>
<tr>
<td>Affiliated Top-20 Venture</td>
<td>2.04</td>
<td>3.19</td>
<td>0.394**</td>
<td>-0.06</td>
<td>0.059</td>
<td>0.05</td>
<td>-0.014</td>
<td>0.022</td>
<td>-0.157</td>
<td>-0.048</td>
<td>0.11</td>
<td>0.050</td>
<td>1.000</td>
<td>0.104</td>
<td>0.332**</td>
<td>0.001</td>
</tr>
<tr>
<td>Capitalists (AFVC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Log) Reputations of</td>
<td>0.032</td>
<td>0.177</td>
<td>0.198*</td>
<td>0.027</td>
<td>0.008</td>
<td>-0.04</td>
<td>0.160</td>
<td>0.071</td>
<td>-0.098</td>
<td>0.069</td>
<td>-0.019</td>
<td>0.109</td>
<td>0.104</td>
<td>1.000</td>
<td>0.055</td>
<td>-0.071</td>
</tr>
<tr>
<td>Affiliated University</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scientists (AFUS)</td>
<td>0.142</td>
<td>0.35</td>
<td>0.288**</td>
<td>0.091</td>
<td>0.161</td>
<td>0.146</td>
<td>0.019</td>
<td>0.063</td>
<td>0.027</td>
<td>0.212*</td>
<td>0.105</td>
<td>0.065</td>
<td>0.332**</td>
<td>0.055</td>
<td>1.000</td>
<td>-0.162</td>
</tr>
<tr>
<td>Affiliated Directors</td>
<td>0.135</td>
<td>0.343</td>
<td>0.205*</td>
<td>0.085</td>
<td>0.13</td>
<td>0.048</td>
<td>0.055</td>
<td>-0.088</td>
<td>-0.055</td>
<td>-0.018</td>
<td>0.214*</td>
<td>0.194*</td>
<td>0.001</td>
<td>-0.071</td>
<td>-0.162</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*p < .05, **p < .01
The average size of a firm's board was 6.68 directors (ranging from 2 to 12). This is similar to Daily and Dalton's (1993) study that found the mean board size of smaller companies to be 6.1. Seventeen firms had a CEO who was a former university scientist and 16 firms had a CEO with a financial background.

**Dependent Variables**

Three dependent variables were utilized in the study: (1) initial offering size (IOS); (2) aftermarket performance in year 1 (MP1); and (3) aftermarket performance in year 2 (MP2). IOS was used as an indication of how the market values a company at the time of its initial offering. Similar to Deeds et al. (1997), IOS was calculated by subtracting the underwriter's fees from the total value of capital raised during a firm's IPO. The measurement of IOS was controlled for inflation using the Consumer Price Index. Information on IOS was obtained from each firm's prospectus.

The measurement of performance after the IPO was a little more complicated. Only a handful of public firms had products on the market or were profitable. Therefore, traditional accounting measures (e.g., ROI, ROE, EPS) were inappropriate. It is obvious, however, that the performance of firms is being measured. Investment in biotech firms soared to record heights as 131 companies raised a staggering $5 billion in U.S. stock offerings in an 18-month period between 1991 and 1992 (Burrill & Lee, 1993) and biotech stocks as a group rose 230% in 1991 and 1992 (Morganthaler, 1992).

Two of the dependent variables represent aftermarket stock return performance. MP1 is the performance in the first year following the IPO and MP2 is the performance over two years after the IPO. Each is a risk-adjusted performance measure and estimated using the following regression using Jensen's (1969) model:

\[
R_i - r = a_j + b_j (R_i - r) + u_j
\]

Where:
- \( R_i \) = the quarterly return of stock \( i \),
- \( r \) = the risk-free rate of interest (return on a one-month U.S. Treasury bill),
- \( R_i \) = the quarterly return of a portfolio of stocks (S&P 500 index) \( i \)
- \( a_j \) = the measure of performance (MP) for stock \( j \)
- \( b_j \) = the systematic risk (beta coefficient) of the portfolio of stocks \( j \), and
- \( u_j \) = a random disturbance term.

*All returns were computed on a continuous by compounded basis. Utilizing least squares regression, this formula estimates \( a_j \) (alpha), the risk-adjusted return in excess of the riskless return earned by each stock in the sample. If a stock earns more than the normal risk premium for its level of risk, \( a_j \) will have a positive intercept. A negative \( a_j \) indicates a less-than-normal return. Two alphas were calculated for each firm in the sample: an alpha for one (MP1) and two years (MP2) after each firm went public.

**Independent Variables**

There are six independent variables in this study: (1) size of the board (SIZE); (2) affiliated directors from top-20 venture capital firms (AFVC); (3) affiliated directors from prestigious underwriting firms (AFUN); (4) reputation of directors who are affiliated university scientists (AFUS); (5) CEOs who were former university scientists (CEOUS); and (6) CEOs with financial backgrounds (CEOFI).

There were 114 venture capital firms that held 133 seats on the boards of directors in the sample of 125 companies. Directors from top-20 venture capital firms held 58
Board Seats Held by Top 20 Venture Capital Firms

<table>
<thead>
<tr>
<th>Company</th>
<th>Number of Seats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain Associates</td>
<td>11</td>
</tr>
<tr>
<td>Venrock Associates</td>
<td>9</td>
</tr>
<tr>
<td>Montgomery Medical Ventures</td>
<td>8</td>
</tr>
<tr>
<td>HealthCare Partners Corporation</td>
<td>6</td>
</tr>
<tr>
<td>Kleiner, Perkins, Caufield, and Byers</td>
<td>5</td>
</tr>
<tr>
<td>JH Whitney and Company</td>
<td>5</td>
</tr>
<tr>
<td>Sutter Hill Ventures</td>
<td>5</td>
</tr>
<tr>
<td>Adler and Company</td>
<td>4</td>
</tr>
<tr>
<td>Advent International</td>
<td>4</td>
</tr>
<tr>
<td>EM Warburg, Pincus and Company</td>
<td>4</td>
</tr>
<tr>
<td>Greylock Ventures Limited</td>
<td>4</td>
</tr>
<tr>
<td>Hambrecht &amp; Quist Venture Capital Funds</td>
<td>4</td>
</tr>
<tr>
<td>Alan Patricoff Associates</td>
<td>3</td>
</tr>
<tr>
<td>Biovest Partners</td>
<td>3</td>
</tr>
<tr>
<td>Boston University/Common Fund</td>
<td>3</td>
</tr>
<tr>
<td>CW Group</td>
<td>3</td>
</tr>
<tr>
<td>Mayfield Fund</td>
<td>3</td>
</tr>
<tr>
<td>Prince Ventures, L.P.</td>
<td>3</td>
</tr>
<tr>
<td>Sequoia Capital</td>
<td>3</td>
</tr>
<tr>
<td>US Venture Partners</td>
<td>3</td>
</tr>
</tbody>
</table>

Seats or 44% of the total number of venture capital seats. Table 2 lists the top-20 venture capital firms. Twenty-two different lead underwriters held 31 seats on the boards of directors in the sample. Affiliated directors from prestigious underwriting firms held four seats or 13% of the lead underwriting seats. The top eight lead underwriters, number of IPOs, and their respective directors can be seen in Table 3.

There were 81 university scientists in the sample. Fifty-seven companies or 46% of the sample had at least one professor on their board. The percentage of firms that had CEOs who were former university professors was 14%. Sixteen directors or 14% of the firms had CEOs with financial backgrounds.

Number of IPOs & Board Seats by the Top Eight Lead Underwriters

<table>
<thead>
<tr>
<th>Company</th>
<th>Number of IPOs</th>
<th>Number of Seats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montgomery Securities</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Alex Brown and Sons</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Hambrecht and Quist Incorporated</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Robertson, Colman, and Stephens</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>DH Blair</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Smith Barney Upham Harris</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Morgan Stanley and Company Incorporated</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Lehman Brothers, Inc.</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>
The size of the board of directors was measured by counting the number of directors on the board at the time of the initial offering. The affiliation aspect of independent variables two through four (top-20 venture capital firms, prestigious underwriting firms, and the reputation of university scientists) was measured through the SEC 6(b) method. As stated earlier, to be classified as an affiliated director, the board member had to have met at least one of the following requirements: employed by the corporation or an affiliate within the last five years; any family relationship by blood or marriage closer than second cousin; affiliated in the last two years with a concern that has a customer, supplier, banker, or creditor relationship with the corporation; affiliated with an investment banker who has performed services for the corporation within the last two years or will do so within one year; held control of corporate stock, with control based on the extent of shareholdings (federal securities law sets forth exact amounts and conditions); or associated with a law firm engaged by the company (Daily & Dalton, 1994b).

Similar to Stein and Bygrave's (1990) study, the variable AFVC was measured in the following manner. First, a database of all the directors who were venture capitalists and their respective companies was developed. Second, 20 venture capital firms that held the most seats (top-20 venture capital firms) were identified and all directors who worked for these firms were coded as one. All other venture capital firms and their respective directors were coded as zero.

The AFUN variable was measured in a similar manner to Stein and Bygrave (1990). A database of the lead underwriting firms and the number of IPOs for which they were lead underwriter was developed. The top four lead underwriting firms were called "the four horsemen." Each firm that had a director from one of the top four horsemen was coded as one. All other directors from the remaining lead underwriting firms were coded as zero.

Citation analysis was used as an indication of the reputation of university scientists on a firm's board (AFUS). This was measured by counting the total number of citations that each affiliated university scientist had before the IPO. A logarithmic transformation was used to control for the skewness of the distribution.

CEOs who were former university scientists, the CEOUS variable, was operationalized through a dummy coding system where directors who were former university professors in the sciences received a one and all others received a zero. Finally, the CEOs with financial backgrounds, the CEOFI variable, was also operationalized through a dummy coding system. If a director's primary functional background was in finance, it was coded as one, if not it received a zero. Prospectuses, proxy statements, Moody's Industrials OTC Manual, and the Science Citation Index were used to collect data on the independent variables.

**Control Variables**

Five control variables were used in the study: total assets (TOT); hot versus cold markets (HOT); organizational age (OA); private placements or secondary offerings one year after the IPO (SEC1); and private placements or secondary offerings two years after the IPO (SEC2). I argue that larger firms provide critical resources because biotech firms are subject to the liability of smallness. Larger firms have been found to have such advantages as economies of scale, experience, brand name recognition, market power, and access to critical resources (Aldrich & Pfeffer, 1976; Hambrick, MacMillan, & Day, 1982; Pfeffer & Salancik, 1978; Woo & Cooper, 1981, 1982). Total assets was operationalized as the natural log of the total amount of assets a firm had before going public.

As stated earlier, investors periodically tend to be overoptimistic about the earnings of young growth companies. Therefore, firms that went public during hot markets are expected to have larger IPOs. Hot versus cold markets was operationalized by dummy
coding hot markets as one and cold markets as zero. Markets were categorized as hot if the S&P 500 had a return greater than 10%.

Older firms might have an advantage over younger firms by having more information, resources, citations, and experience. In addition, they might have established relationships that could give them a competitive advantage. Due to the long lag time in getting products to market, older firms might have more products in their research pipeline (Finkle, 1993). This is an important note, since previous research by Deeds et al. (1997) also found a significant relationship between larger biotech IPOs and the number of products in their pipeline. Organizational age was operationalized as the total number of years from the founding of the firm until its IPO. To control for skewness, a logarithmic transformation was used.

The final control variables were private placements or secondary offerings. These variables were used after the firm went public. Firms that have a private placement or secondary offering might have more resources that will assist in various activities that could enhance the market value of the firm. For instance, a larger quantity of funds could be invested into research endeavors, thus increasing the scientific capabilities of the firm. Two separate measures of private placements or secondary offerings were used in the study. The first measure, SEC1, indicated that a firm had a private placement or secondary offering one year after the firm’s IPO. The second measure indicated that a firm had a private placement or secondary offering during the two-year period after the firm’s IPO. Both measures were operationalized through dummy coding where a one signified that a firm had a private placement or secondary offering and a zero indicated that it did not. Prospectuses, proxy statements, and Moody’s Industrials OTC Manual were used to collect data on each control variable.

ANALYSIS

Three models were tested with hierarchical regression analyses and correlational analysis to establish the various relationships identified in the hypotheses. The hierarchical regression models were used with each of the dependent variables: initial offering size and aftermarket IPO performance in years one and two. The control variables were entered first into all models. For the IOS model, total assets, organizational age, and hot versus cold markets were entered first. For the MP1 & MP2 models, the same control variables were entered along with secondary offerings or private placements. After entering the control variables, their relative contribution to the models was examined. I then entered the size and composition of the board variables in the second block and noted the incremental contribution of these variables.

RESULTS

Models & Hypotheses

Table 4 reports the results of the three hierarchical regression analyses with IOS, MP1, and MP2 as the dependent variables. These equations were used to assess the direct effects of the size and composition of the board on the market capitalization of a firm’s IPO and the subsequent performance of the firm. Step 1 enters the control variables and step 2 is a test of each model.

The IOS model was significant (p < .00). The control variables accounted for the largest amount of variance, R squared = .303. The independent variables increased the R squared to .448 with a F-statistic of 9.208. The results indicate that total assets, hot markets, CEOs who were former university professors were all significant at the .01 level. Affiliated top-20 venture capitalists and affiliated directors from prestigious un-
Table 4

Regression Results for the Three Dependent Variables (N = 125)*

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>IOS</th>
<th>MP1 Model #1</th>
<th>MP2 Model #2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>beta</td>
<td>beta</td>
<td>beta</td>
</tr>
<tr>
<td>(Log) Total Assets (TOT)</td>
<td>4.32**</td>
<td>-0.006</td>
<td>-0.0012</td>
</tr>
<tr>
<td>1.07</td>
<td>1.07</td>
<td>0.023</td>
<td>0.012</td>
</tr>
<tr>
<td>Hot Markets (HOT)</td>
<td>7.23**</td>
<td>-0.041</td>
<td>0.011</td>
</tr>
<tr>
<td>2.49</td>
<td>2.49</td>
<td>0.053</td>
<td>0.029</td>
</tr>
<tr>
<td>(Log) Organizational Age (OA)</td>
<td>-1.13</td>
<td>-0.056</td>
<td>-0.022</td>
</tr>
<tr>
<td>2.20</td>
<td>2.20</td>
<td>0.05</td>
<td>0.025</td>
</tr>
<tr>
<td>Private Placements and Secondary Offerings (SEC1)</td>
<td></td>
<td>.142*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Placements and Secondary Offerings (SEC2)</td>
<td>0.02</td>
<td>0.029</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>0.69</td>
<td>0.015</td>
<td>0.029</td>
</tr>
<tr>
<td>Affiliated Top-20 Venture Capitalists (AFVC)</td>
<td>6.71*</td>
<td>-0.019</td>
<td>0.031</td>
</tr>
<tr>
<td>2.72</td>
<td>2.72</td>
<td>0.058</td>
<td>0.03</td>
</tr>
<tr>
<td>Affiliated Directors From Prestigious Underwriting Firms (AFUN)</td>
<td>13.87*</td>
<td>0.128</td>
<td>-0.005</td>
</tr>
<tr>
<td>6.42</td>
<td>6.42</td>
<td>0.134</td>
<td>0.07</td>
</tr>
<tr>
<td>(Log) Reputation of Affiliated University Scientists (AFUS)</td>
<td>0.14</td>
<td>-0.0047</td>
<td>0.0003</td>
</tr>
<tr>
<td>0.38</td>
<td>0.38</td>
<td>0.008</td>
<td>0.004</td>
</tr>
<tr>
<td>CEOs Who Were Former University Professors (CEOUS)</td>
<td>10.11**</td>
<td>0.079</td>
<td>0.049</td>
</tr>
<tr>
<td>3.53</td>
<td>3.53</td>
<td>0.07</td>
<td>0.039</td>
</tr>
<tr>
<td>CEOs Who Have a Background in Finance (CEOFIN)</td>
<td>7.34*</td>
<td>0.073</td>
<td>0.051</td>
</tr>
<tr>
<td>3.55</td>
<td>3.55</td>
<td>0.078</td>
<td>0.04</td>
</tr>
<tr>
<td>R squared</td>
<td>0.488</td>
<td>0.134</td>
<td>0.108</td>
</tr>
<tr>
<td>F-Statistic</td>
<td>9.208</td>
<td>1.481</td>
<td>1.034</td>
</tr>
<tr>
<td>p</td>
<td>&lt;.000</td>
<td>&lt;.158</td>
<td>&lt;.422</td>
</tr>
</tbody>
</table>

* p < .05.

** p < .01.

*** p < .001.

All beta weights are from final step in hierarchical regression. Standard errors are under the beta weights.

All results from one-tailed significance levels.

underwriting firms were significant at the .05 level. The change in R squared between the addition of the control and independent variables was also significant.

The MP1 model was not significant (p < .158). The control variables accounted for the largest amount of variance, R squared = .08. The independent variables accounted for only an increase of .05. The only significant variable was private placements or secondary offerings at the .05 level. The overall MP2 model was also not significant (p < .422). The control variables accounted for .05 of the variance in R squared and the independent variables increased the variance accounted for to .108.

It was hypothesized (H1a and H1b) that larger board size would be related to IOS, MP1, and MP2. This was not significant at the .05 level for all three models (p < .98; p < .06; p < .56). However, larger boards were moderately significant with MP1 at the
Hypotheses 2a and 2b examined the relationship between affiliated top-20 venture capitalists and the dependent variables. Hypothesis 2a was supported (p < .05). Firms that had a top-20 venture capitalist on their boards had larger IPOs. However, hypothesis 2b was not significant (p < .75; p < .31). This is a signal that the markets value the type of venture capital firm that has taken a vested interest in the IPO.

Hypotheses 3a and 3b examined the relationship between affiliated directors from prestigious underwriting firms with the dependent variables. Hypothesis 3a was significant with IOS at the .05 level. However, it was not significant (p < .34; p < .94) for both measures of aftermarket IPO performance.

There was no support for hypotheses 4a and 4b. The relationship between the reputation of affiliated university scientists with performance did not significantly affect the firm's ability to raise capital during its IPO and its subsequent performance.

Hypotheses 5a & 5b and 6a & 6b examined the relationship between the functional backgrounds of CEOs with the dependent variables. CEOs who were former university professors (H5a), was significant with IOS at the p < .005 level. Hypothesis 5b was not significant with both measures of aftermarket IPO performance (p < .29 and p < .22). Hypothesis 6a, CEOs who had financial backgrounds, was significant with IOS at the p < .04 level, but no significant relationship was found with both measures of aftermarket IPO performance (p < .35 and p < .21).

All data were analyzed for autocorrelation. The Durbin-Watson statistic was used to test whether the error terms associated with different observations were correlated, thereby violating the regression assumption. Results of this test found no evidence of autocorrelation for all three models.

DISCUSSION

This study evaluated data on 125 biotech firms that made IPOs from 1980 to 1994. The study fills a gap in board and entrepreneurship research by determining if there is a relationship between director expertise and performance in the emerging industry of biotechnology.

Specifically, this study finds those biotech firms with either affiliated top-20 venture capitalists or affiliated directors from prestigious underwriting firms will have larger IPOs. Results also support the importance of the CEO's functional background. There was a significant positive relationship between CEOs who were former university professors and CEOs who had financial backgrounds with larger IPOs. The results for the IOS model are consistent with the major theoretical thrusts of this study, resource dependence theory (Pfeffer & Salancik, 1978, 1981) and agency theory (Jensen & Meckling, 1976). No relationship was found between the size and composition of the board and the aftermarket IPO performance of the sample.

The results support my assertion that younger firms tend to have resource deficiencies that need to be satisfied. The emerging industry of biotechnology is a prime example of an industry that is cash poor. Firms need large amounts of capital resources in order to survive the long process of getting a product to market. By bringing individuals who specialize in financially related areas onto their boards, biotech firms should be able to enhance their abilities to raise capital.

Furthermore, the affiliative nature of the directors from top-20 venture capital firms and prestigious underwriting firms indicates that these directors have a vested interest in how the organization performs. Venture capitalists tend to be very active in monitoring their portfolios, often giving assistance in managerial activities due to their vested interest in the company. Furthermore, venture capital firms, which tend to specialize in
specific industries (Warne, 1988), can use industry contacts to help the company recruit key employees to assist in various activities. For example, a top-20 venture capital firm should be sophisticated enough to choose a more prestigious underwriting firm. Often, a venture capitalist's expertise and experience in monitoring investments can send important signals to investors at the time of an IPO (Barry et al., 1990). These results support the notion that certain venture capital firms add value to firms at the time of their IPO.

The lack of a relationship between the reputation of affiliated university scientists and IPOs was puzzling. Despite this finding, the variable CEOs who were former university scientists was positively related to larger IPOs. These results partially support the theoretical basis for the study. CEOs who were former university professors might give the biotech firm access to: valuable research techniques, information, and data, information on experienced workers, and the ability to review other scientists' work. However, the markets do not appear to value the reputation of the university scientists on a firm's board. Previous research (see Deeds et al., 1997), indicates that the markets value the full scientific capacity (top executives and scientists) of the firm.

The results also indicate that the size of a firm’s board of directors had no relationship with a firm’s IPO and aftermarket IPO performance. This finding differs from extant research that found a positive relationship between larger boards and performance. A possible explanation for this might be the inverted "U" effect. Hiner (1967) has argued that there is an optimum number of directors on the board that is conducive to corporate performance. Zahra and Pearce (1989) have termed this the inverted "U" effect where at a specific point, performance is optimal.

The significant relationship between total assets and IOS is consistent with previous research, which states that larger organizations are associated with increases in the pool of resources available for organizational use (see Gooding & Wagner, 1985). Aldrich and Pfeffer (1976) and Pfeffer and Salancik (1978) proposed that larger organizations are more likely to possess the resources necessary to acquire control over environmental entities that mediate critical resources. More specifically, biotech firms with a larger quantity of assets might have an increased capacity to perform R&D or a greater access to external information that might enhance the firm's performance. More assets might give a firm the ability to hire a larger number of quality employees with varying backgrounds.

Similar to Deeds et al. (1997), this study found that firms that went public during hot markets had larger IPOs. Markets for IPOs can be unpredictable, however, hot markets can last for several months or longer. If firms time their IPO correctly, they can significantly enhance their ability to raise capital. No relationship was found between the age of the firm and either its IPO or subsequent performance.

The lack of any relationships between the independent variables and MP1 & MP2 indicates that other factors are influencing the performance of these firms after their IPO. The biotech industry tends to be a very volatile industry. Positive or negative announcements about new drug developments can have momentous effects on the industry. For example, when a positive announcement is published in an article, there is a "halo effect" on the industry. This announcement usually increases the value of that stock and the entire industry usually moves in that direction. In essence, there exists an "irrational exuberance" in the biotech industry.

On a positive note, firms that had a private placement and secondary offering one year after their IPO tended to have better aftermarket IPO performance. However, there was no relationship between firms that had a private placement and secondary offering within two years after their IPO.
IMPLICATIONS FOR RESEARCH AND PRACTICE

The results of this study provide strong statistical support for the IOS model. The findings indicate that affiliated top-20 venture capitalists, affiliated directors from prestigious underwriting firms, CEOs with financial backgrounds, and CEOs who were former university professors are important in the valuation of public biotech firms. This suggests that entrepreneurs need to be very selective when choosing their lead venture capital firms, lead underwriters, and CEOs.

Despite the significant findings, there is still a large amount of unexplained variance in a firm’s IPO and aftermarket IPO performance. Research on the value of biotech IPOs has now been performed in the following areas: timing of the IPO, location of the firm, reputation of scientific personnel (scientific advisors and consultants), products in the pipeline, R&D spending, size and composition of the board of directors, functional backgrounds of CEOs, age and size of the firm, aftermarket IPO performance, and private placements or secondary offerings.

Research still needs to be performed on the remuneration and demographics of the top management team. Additionally, how are the following factors related to aftermarket IPO performance: location of the firm, reputation of scientific personnel (scientific advisors and consultants), products in the pipeline, and R&D spending? Another interesting area to investigate would be the effect of public announcements on the performance of these firms.

Research also needs to be done on the range of contributions that boards of directors make to firms in other emerging industries. While these may be important in the biotech industry, other backgrounds are expected to be valuable in other industries. Board interlocks (the number and type of directorships; Pennings, 1980) on boards in the biotech industry need to be investigated. It may be that the “connections” some directors bring to the board also serve to provide access to critical resources other than money and science.

Replications of this study could be performed with other emerging industries to check the validity of the resource dependency and agency conclusions. In addition, comparative studies should be performed, contrasting how boards differ in other industries and stages of their industry life-cycles. Finally, not all the firms that went public during this period survived. A study that compares board issues in the surviving and failing firms may provide additional insight into the value of boards within the biotech industry.

The results of this study will benefit practitioners in the formation of boards in the biotech industry. Clearly, this study indicates that managers of firms contemplating a public offering should proactively address the composition of their boards. The findings indicate that the market does value who serves on a board of directors. Stinchcombe (1965) introduced the importance of “imprinting.” He argued that organizations, at the time they are founded, have incorporated elements of the larger societal structure of the period into their basic structures. That is, the social conditions present at the time of founding become imprinted into the newly founded organizations. Moreover, Boeker (1989) indicates that the founding of the organization has an especially influential effect on the structure, processes, and strategy the organization develops and continues to exhibit over time. This study suggests that directors can matter. The choice of who and how directors are selected for service on boards may be one of the early decisions that can impact a firm throughout its existence.

Some current theories of competition point to the importance of the concept of “divergence” in competitive behavior. Technically, according to Oliva, Day, and MacMillan (1988, p. 377), divergence indicates that “a slight difference in the initial starting point can result in quite different forms of system behavior.” Practically, it suggests that
early decisions influence a firm's later competitive position. To the extent that boards can contribute to a firm's competitive advantage, it is advisable that firms pay early attention to who serves on the board.

It is important to acknowledge the three limitations in this study. First, the archival investigation of the functional backgrounds of directors may not have captured the core relationship between boards and performance. Due to the time-lag associated with product development, the associations between directors and IOS may not be applicable. Second, the characteristics of the firms studied and the biotech industry, discussed above, mean that the findings of this study cannot be generalized to non-IPO firms or to industries in other stages of their development or even to firms in other emerging industries. Finally, I only measure association. I cannot claim that director expertise causes better performance.

REFERENCES


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