The Impact of Timing and Firm Capabilities on the Amount of Capital Raised in an Initial Public Offering: Evidence from the Biotechnology Industry

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THE IMPACT OF TIMING AND FIRM CAPABILITIES ON THE AMOUNT OF CAPITAL RAISED IN AN INITIAL PUBLIC OFFERING: EVIDENCE FROM THE BIOTECHNOLOGY INDUSTRY

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ABSTRACT

This paper develops a model of the total level of capital raised by biotech IPOs based on the timing of the offering and the scientific capabilities of the firm. The results indicate a positive relationship between the amount of capital raised by an IPO and the timing of the offering and the scientific capabilities of the firm.

INTRODUCTION

Going 'public' has a magical sound to most entrepreneurial managers. According to a survey of 542 entrepreneurs who had just taken their firm public, by far the most important reason for going public was to infuse a significant amount of investment capital into the firm (Arkebauer, 1991). Clearly, if access to capital is the major goal of going public, then the success of an offering is measured by the amount of capital raised by the firm.

Issuing and Initial Public Offering (IPO) is problematic for entrepreneurial managers of high technology firms. This challenge is particularly acute for entrepreneurs in biotechnology. These firms are years away from any significant revenue stream, have very few tangible assets, are usually sustaining significant accounting losses, and require large amounts of capital (Burill & Lee, 1992). The preceding arguments make it clear that positioning a small biotechnology firm to go public is a major strategic challenge. This paper presents a normative model of the amount of capital a biotechnology company is able to raise in its IPO which includes the following strategic variables: (a) the timing of the IPO, (b) geographic location, (c) products in development, (d) research and development expenditures, and (e) the publication record of the firm's top researchers.

THEORY AND HYPOTHESES

Timing and IPO Value

It has been well documented that the market for initial public offerings experiences periods in which the value of firms going public is substantially higher (Ibbotson and Jaffe, 1975; Ritter, 1984). What appears to happen is that investors are periodically over optimistic about the earnings potential of young growth companies (Ritter, 1984). These so-called "hot" markets are windows of opportunity which entrepreneurs may use to improve their access to capital.

Hypothesis 1: The issuing of an initial public offering during a hot market will have a direct positive relationship with the amount of capital raised by the company's IPO.

Location and IPO Value

March and Simon (1958) have suggested that "borrowing" is the catalyst for innovation, not "invention". Innovation then, to a large extent, is dependent on a firm's "absorptive capacity". The "absorptive capacity" of an organization is the ability of an organization to evaluate and assimilate external knowledge and is a function of the level of a firm's prior related knowledge (Cohen & Levinthal, 1990). Geographic clusters of organizations with similar interests promote the exchange of ideas through social and professional networks (Saxenian, 1990). Therefore, a firm located in a geographic area with a high concentration of similar firms will have access to information, personnel and support structures which are unavailable to firms which are geographically isolated (Krugman, 1991). This increased access to scientific and technological resources enhances a firm's absorptive capacity. Thus, the location of a firm is an indicator of its ability to develop the scientific capabilities required to succeed.

Hypothesis 2: The concentration of biotechnology firms located in a firm's geographic area will have a direct positive relationship with the amount of capital raised by the company's IPO.

Products in Development and IPO Value

A common indicator of technological competence or expertise in the pharmaceutical industry is the number of drugs in development or in the "pipeline". The amount and type of new drugs in a company's research pipeline reveals to the financial markets the future value of the company's current capabilities. Therefore, the number of products under development by a firm should influence the amount of capital the firm will be able to raise through its IPO.

Hypothesis 3: The number of new drugs in a biotechnology company's research pipeline will have a direct...
positive relationship with the amount of capital raised by the company's IPO.

**Research and Development Expenditures and IPO Value**

The amount of expenditures on research and development has traditionally been used as an indicator of innovative activity in many industries (Scherer, 1980). Therefore, the market will view the level of R&D expenditures as an indication of the intangible scientific assets of the firm and a predictor of the probability of the firm successfully completing the R&D process.

**Hypothesis 4:** A biotechnology companies R&D expenditures will have a direct positive relationship with the amount of capital raised by the company's IPO.

**Citation Analysis and IPO Value**

Product development in high technology environments is increasingly being driven by basic scientific research (Dasgupta & David, 1994). Therefore, the quality of a firm's scientific team is critical to the product development process and critical to an investors evaluation of the firm's future prospects. One method of judging research quality is well known in the academic community - citation analysis. Citation analysis uses the number of times a paper or an author is cited as an indication of the importance of the work to the field. The more frequently a paper, or an individual's body of work, is cited the more important, and hence, the higher the quality of the work. Therefore, the number of citations a firm's scientists have is an indication of the quality of the firm's scientific capabilities and will increase the value of the firm.

**Hypothesis 5:** The total number of times the works of a firm's top scientists have been cited will have a direct positive relationship with the amount of capital raised by the firm's IPO.

**METHODOLOGY**

Our sample consisted of 92 biotechnology firms representing 41% of the total population of public biotechnology firms. The data used in our analysis was gathered from (1) the prospectus for each of the initial public offerings by the firms in our sample, (2) Ernst and Young's industry annual reports on the biotechnology industry, (3) the CRSP data tapes and (4) The Institute for Scientific Information's Science Citation Index.

**Variables**

**IPO Value.** We defined the value of a firm's IPO as the amount of capital from the offering which is actually transferred to the firm and its owners. This was calculated by subtracting the underwriter's fees from total value of the capital raised by the initial public offering.

**Hot Market Dummy.** The years 1983, 1986, 1991 and 1992 were hot markets for biotechnology IPO's (Burrill & Lee, 1994). Those firms which made offerings during those years were coded as "1" and all other firms were coded as "0".

**Location.** Based on the location of the firm's headquarters, firms were coded into geographic territories based on zip code and MSA (Metropolitan Statistical Areas). The location variable is the percentage of the nation's total biotechnology firms located in the firm's specific MSA. A "0" was recorded for firms which were not in a geographical area which had over 2 percent of the nation's biotechnology firms.

**Total Products.** In the business section of each prospectus the companies report the number of products under development or which have reached the market. Only products which had reached the pre-clinical stage of development or beyond were included. Multiple applications of the same product were counted as a single product.

**Research and Development Expenditures.** The measure of total research and development expenditures was defined as the total R&D spending by the firm in the 5 years prior to the initial public offering.

**Citation Data.** The names of the top scientists employed by each firm were gathered from the prospectus of the firm's initial public offering. Only full time employees were included in the list. We then used the Science Citation Index to gather the total number of citations for each scientist during their career prior to the IPO and summed them to create a measure of the quality of the firm's scientific team at the time of its initial public offering.

**RESULTS & CONCLUSIONS**

The data was analyzed using ordinary least squares regression. Descriptive statistics of the variables and the correlation matrix are presented in Table 1.

Table 2 presents the results of the regression analysis with value of the IPO as the dependent variable. Three different models were run. Model #1 presents the base case controlling only for the percentage of equity offered and the total asset value of the firm. Model #2 examines the impact of timing the market on the value of the IPO. Model #3 presents the full model adding in the measures of the firm's scientific
### Table 1
Descriptive Statistics and Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IPO Value</td>
<td>20382170</td>
<td>12839872</td>
<td>1.00</td>
<td>0.32*</td>
<td>0.34*</td>
<td>0.33*</td>
<td>0.18*</td>
<td>0.30*</td>
<td>0.15*</td>
<td>0.45</td>
</tr>
<tr>
<td>2. Hot Market</td>
<td>0.79</td>
<td>0.41</td>
<td>1.00</td>
<td>0.09</td>
<td>0.03</td>
<td>0.21*</td>
<td>-0.01</td>
<td>-0.05</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>3. Location</td>
<td>7.52</td>
<td>5.14</td>
<td>0.09</td>
<td>1.00</td>
<td>0.19*</td>
<td>0.07</td>
<td>0.07</td>
<td>-0.03</td>
<td>0.20*</td>
<td></td>
</tr>
<tr>
<td>4. Products</td>
<td>3.12</td>
<td>4.19</td>
<td>0.03</td>
<td>0.19*</td>
<td>1.00</td>
<td>0.05</td>
<td>0.17</td>
<td>-0.16</td>
<td>0.18*</td>
<td></td>
</tr>
<tr>
<td>5. Log (R&amp;D Spending)</td>
<td>6.69</td>
<td>0.71</td>
<td>0.18*</td>
<td>0.21*</td>
<td>0.07</td>
<td>0.05</td>
<td>1.00</td>
<td>0.26*</td>
<td>-0.41*</td>
<td>0.16</td>
</tr>
<tr>
<td>6. Firm Citations</td>
<td>125.28</td>
<td>138.04</td>
<td>0.30*</td>
<td>-0.01</td>
<td>0.17</td>
<td>0.26*</td>
<td>1.00</td>
<td>-0.07</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>7. % of Equity</td>
<td>0.29</td>
<td>0.12</td>
<td>0.15*</td>
<td>-0.05</td>
<td>-0.03</td>
<td>-0.16</td>
<td>-0.41*</td>
<td>-0.07</td>
<td>1.00</td>
<td>-0.24*</td>
</tr>
<tr>
<td>8. Log (Assets)</td>
<td>6.77</td>
<td>0.58</td>
<td>0.08</td>
<td>0.20*</td>
<td>0.18*</td>
<td>0.16</td>
<td>0.09</td>
<td>-0.24*</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

N=92
* P<0.05

### Table 2
Regression Results with IPO Value as Dependent Variable

<table>
<thead>
<tr>
<th></th>
<th>Model #1</th>
<th>Model #2</th>
<th>Model #3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant</td>
<td>% of Equity</td>
<td>Log(Assets)</td>
</tr>
<tr>
<td></td>
<td>-67,177,751*** (14,760,825)</td>
<td>28,463,624** (9,673,829)</td>
<td>11,741,119*** (2,030,092)</td>
</tr>
<tr>
<td></td>
<td>-77,164,628*** (13,968,823)</td>
<td>30,155,937** (9,008,364)</td>
<td>12,074,864*** (1,890,182)</td>
</tr>
<tr>
<td></td>
<td>-85,093,207*** (15,751,190)</td>
<td>38,999,456*** (8,532,677)</td>
<td>9,566,064*** (1,710,141)</td>
</tr>
<tr>
<td>Hot Market</td>
<td>9,608,417*** (2,478,214)</td>
<td>8,896,249*** (2,242,704)</td>
<td>421,573* (187,339)</td>
</tr>
<tr>
<td>Location</td>
<td>696,691** (231,721)</td>
<td>2,215,372 (1,528,466)</td>
<td>19,194** (7,105)</td>
</tr>
<tr>
<td>Products</td>
<td>421,573* (187,339)</td>
<td>19,194** (7,105)</td>
<td>421,573* (187,339)</td>
</tr>
<tr>
<td>Log (R&amp;D Spending)</td>
<td>696,691** (231,721)</td>
<td>2,215,372 (1,528,466)</td>
<td>19,194** (7,105)</td>
</tr>
<tr>
<td>Firm Citations</td>
<td>19,194** (7,105)</td>
<td>421,573* (187,339)</td>
<td>19,194** (7,105)</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.269</td>
<td>0.367</td>
<td>0.525</td>
</tr>
<tr>
<td>F-Statistic</td>
<td>17.91</td>
<td>18.81</td>
<td>15.34</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

*p < 0.05  ** p < 0.01  *** p<0.001
n = 92
capabilities. All of the variables except the level of R&D spending are significant. The adjusted R2 for the model is 0.524 and the F-statistic is 15.35.

The results support all of our hypotheses except for hypothesis #4. There appears to be no relationship between IPO value and R&D expenditures.

The results for our timing variable may seem to beg the so what question, because the market by assumption is efficient and therefore unpredictable. However, part of preparing a firm to go public is getting the firm into the process earlier enough and with adequate reserves so that the firm is prepared to wait out a significant slowdown in the market for IPO's (Arkebauer, 1991). In addition, Ritter (1984) documents a high degree of first order autocorrelation for the time-series of average monthly returns for IPO's (0.62) and for the monthly volume of IPO's (0.88). Therefore, the market for IPO's may be subject to entrepreneurs strategically timing the offering. Firm's which issued IPO's during hot markets were able to increase the capital they raised by almost $8.9 million, all other variables remaining constant.

Our results provide some evidence to support the capabilities position in the current debate between the industry and resources/capabilities schools within the field of strategy. Except for R&D expenditures all of our measures of firm specific scientific capabilities were significantly positively related to the value of a firm's IPO. In addition, the magnitude of the coefficients indicates investors place a significant value on indicators of firm specific capabilities. A firm which moved from outside of a geographic cluster to the Silicon Valley and increased by one standard deviation the number of citations and number of products in the pipeline (138 citations and 3 products) could increase the amount of capital it raised in its IPO by over $11.8 million.

Finally, important implications for entrepreneurs follow from our results. First, entrepreneurs need to understand that issuing an IPO is a serious strategic challenge and requires significant preparation over a long period of time. Second, the market values as deep a product pipeline as possible given a firm's resource constraints. Third, the market conditions under which the firm issues the IPO matter and the entrepreneur needs to provide the firm with as wide a window of time as possible within which to issue the IPO. Fourth, location matters. Choice of geographic location is a key strategic decision that should not be over looked. Finally, the market values a quality team and will increase the capital it is willing to invest in a firm if key members of the firm have a superior reputation in their field.

REFERENCES


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