Strategic Groupings Of US Biotechnology Initial Public Offerings And A Measure Of Their Market Influence

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Abstract

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Strategic Groupings of U.S. Biotechnology IPOs and a Measure of their Market Influence

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ABSTRACT

This study verifies the existence of strategic groups among biotechnology firms that have filed for an initial public offering (IPO). We found three distinct groupings based on the dimensions of competitive scope and growth. Differences also exist between these groupings and an aspect of market influence—the ability to attract strategic partners. We found that biotechnology IPOs that seek greater breadth in competitive scope and growth also have more alliance partners. This paper adds to our knowledge of the bio-pharmaceutical market-sector and the strategic intentions of firms in an emerging, disruptive industry and their ability to attract strategic coalition partners.

Keywords: Biotechnology, Strategic Groups, Initial Public Offering, Strategic Alliances

INTRODUCTION

Technological innovation is of increasing importance to practitioners and scholars.[1,2,3] It has been suggested that technological innovations can either sustain or disrupt both firms and industries,[4,5] with the creation and adoption of technological innovations mainly being portrayed as leading firms toward competitive advantage[6,7] and profitability.[8] Disruptive innovations or technologies, specifically, are vehicles that new entrants can use to overcome barriers to entry within a market-sector.[9] Disruptive innovations are technologies, products, or processes that creep up from below an existing business or industry and threaten to displace it,[4,10] with disruptive innovations often leading to new industry creation.[4,9] This is because a disruptive innovation fundamentally changes "the nature of the problem pursued, the material technology employed, and/or heuristics used to approach the problem."[11] The purpose of this paper is to examine how new firms in the emerging, disruptive technology industry of biotechnology intend to manage this transformation within the bio-pharmaceutical market-sector.

Prahalad[12] has suggested that researchers need to think differently about new practices in emerging markets. Williams[13] has provided one such view of new practices within the biotechnology industry. Williams[13] has created a typology describing how biotechnology IPOs intend to compete. This typology of biotechnology firm intention and activity, however, has not been verified. The focus of this paper is to briefly describe and test this typology (creating strategic groupings) and use it as a framework to explore an aspect of Prahalad's[12] perspective of market influence in emerging industries.

Typology and Strategic Groups

Hatten, Schendel, and Cooper[14] have noted that a crucial question for the strategist is how to position the firm‟s resources in light of its competitors. A firm‟s initial strategic positioning may affect not only the firm‟s ability to reposition itself subsequently,[15,16] but also its future financial performance.[17] Many biotechnology IPOs are recently formed or newly forming firms. The IPO process gives a rare glimpse into the firm‟s thinking about its strategic positioning within an industry.

Williams[13] explores this positioning question related to biotechnology IPOs and provides a typology based upon the strategic groupings‟ literature[18,19,20,21] as his theoretical basis. As Zinn, Aaronson, and Rosko[22] observe, "[s]trategic group theory assumes that all firms in an industry face the same competitive environment and that differences in organizational capabilities account for differences in strategic behavior." Acknowledging that debate remains within this literature,[23] Williams[13] argues that strategic groups do exist within this industry, and that nascent biotechnology firms choose a positioning strategy early in their formative years.

Williams‟[13] strategic group typology uses the dimensions of growth and competitive scope. By growth, he[13] means that the IPO‟s strategy is concerned with expansion via internal (organic) operations or by way of acquisitions of other firms or technologies. Firm growth is an assumed objective of any entrepreneurial firm.[24,25] Competitive scope relates to the question of how broadly a firm should serve the market they are entering.[26] By broad competitive scope, Williams[13] does not mean

diversification outside of an industry, but rather, "the number of products, technologies, places on the value chain, and also diseases that a particular biotechnology firm seeks to make or pursue." This is consistent with Stern and Henderson's[27] within-business diversification perspective. The healthcare, strategic management, technology, and entrepreneurship literatures are replete with examples of strategic groupings.[28,29,30,31] Yet, the application of the strategic group literature to biotechnology and technologically-oriented healthcare firms remains heretofore unexplored.[13]

Williams'[13] typology consists of four strategic types: Sowers, Appliers, Collectors, and Scavengers (See FIGURE 1). Sowers compete within the strategic dimensions of internal growth and focus. For the sower, the IPO is primarily a means to raise additional capital in pursuit of the discovery and development of a drug for a particular disease. [13] Appliers compete within the strategic dimensions of internal growth and broad competitive scope. For the applier, the IPO may act as a means to raise capital to get it through the clinical trial phase or other embryonic adoption phase while also seeking additional uses of its technology.[13] Collectors compete within the strategic dimensions of acquisition and focus. For the collector, the IPO may represent that (1) its internal technology or process is limited, or (2) it may be acting in a consolidator's role within a market segment (i.e., as a "roll-up" firm that is trying to achieve greater size within its market segment). For example, within the pharmaceutical industry, acquisitions have played a major role for existing firms to gain additional resources.[32,33] Scavengers compete along the strategic dimensions of acquisitions and broad competitive scope. This may be to: (1) acquire technology applicable to multiple market segments, (2) acquire a competitive advantage in an area lacking by the scavenger, or (3) act as a

consolidator, acquiring firms along a given market‟s (e.g. disease‟s) value chain. Thus, we hypothesize:

> *H_1: Biotechnology IPOs will differ based on the strategic dimensions of growth and competitive scope.*

Biotechnology Context

The first biotechnology company to offer an IPO was Genentech in October of 1980.[34] As of the end of 2004 there were approximately 330 publicly traded and 1,100 private biotechnology firms in the U.S.[35] The emergence of the biotechnology industry represents a technological discontinuity or disruptive innovation that has challenged the pharmaceutical industry,[36] with the pharmaceutical industry being a $230 billion industry in the U.S. in 2004[37] and intensely competitive.[33,38] Biotechnology products and services have the potential to supplant other healthcare segments such as radiation oncology and certain surgical procedures. Furthermore, Foster[9] observes that biotechnology has been suggested as part of a new fifth Kondratiev wave. Kondrateiv waves or grand super-cycles are the belief that waves of innovation have occurred over the last 250 years in 50-year cycles that have transformed society, with the first four cycles involving coal and steam power, the mechanization of production, electric power, and electronics.

Pharmaceuticals are drugs for "human consumption, specifically developed to impact a disease, which goes through a regulatory process designed to approve prescription medications for marketing to physicians."[39] Pharmaceutical companies are typically chemistry-based firms that are ordinarily concerned with the identification of small molecules that bind to targets and cause a biological process to stop or start.[39,40] Biotechnology, on the other hand, began as the merger of biology and engineering—"using „molecular scissors‟ to cut out genes and splice them into another organism‟s

DNA."[34] This recombinant DNA segment then interprets the "genetic code and produces large amounts of a protein useful in treating disease."[41] In this sense, biotechnology has a competency destroying effect[42,43] on pure pharmaceutical firms. In 2004, biotechnology firms developed about 15 percent of the top 200 drugs globally.[35] The benefits of biotechnology products have often exceeded the chemical-based products and have treated diseases where previously there have not been pharmaceutical products developed. The biotechnology industry also has evolved beyond genetic engineering to include technology firms in medical therapeutics, diagnostics, agriculture/biological products, and research tools.[44] As Decarolis and Deeds[45] observe, this is "a confluence of disciplines very unlike traditional pharmaceutical companies."

Whether made by pharmaceutical or biotechnology firms, decisions about which drugs or technologies to develop are made in the context of four domains: scientific opportunity, market assessment, resource development requirements, and medical need.[46] The development cost of a new drug is in excess of $800 million, with it taking 12 to 15 years from discovery to commercialization.[47] Because of the time factor, costs, and a lack of core competencies, many pharmaceutical firms have "outsourced" significant portions of their R&D efforts to smaller, newer biotechnology firms.[48] Industry experts suggest that over 65 percent of today"s bio-pharmaceuticals in the clinical "pipeline" exist within the biotechnology industry.[49] These outsourcing efforts or strategic alliances have become the single largest source of financing for biotechnology firms.[50]

Market Influence

Prahalad[12] has observed that new industry formation requires new ways of thinking. This may be especially true for firms in unstructured industries such as

biotechnology.[43] Within this emerging industry paradigm, Prahalad[12,51] has suggested that industries evolve through three phases of competition. These phases include competition for: (1) intellectual leadership, (2) a coalition of partners that support a standard, and (3) market share for end-products and profits. Prahalad[12] also implies that creating market influence within the first two stages may be a good indicator of profitability in the third stage. The creation and ownership of a standard is one method of market influence.

The biotechnology industry remains in this second phase (however without the development of standards) and will be for some time.[37,41,49] Hamel and Prahalad[51] have suggested that during this second phase firms often compete to influence migration paths or trajectories.[3,52] Trajectories are paths from today's market to where the future lies in end-products and profitability. When competing in this manner, the firm's goal is to maximize its "share of influence over the trajectory of industry development."[51] Hamel and Prahalad[51] note that there are four main ways that firms influence their trajectory. These include the firm's: (1) capacity to build coalitions, (2) ability to build core competencies consistent with new opportunities, (3) ability to quickly develop and accumulate market learning (i.e., the ability to understand new industry dynamics), and (4) global share of mind or brand presence. To this list, they[51] add that certain other factors influence the trajectory as well. These include the ability to: (1) shape the regulatory market, (2) influence the development of technical standards, and (3) control intellectual property rights.

Based on the biotechnology literature, we believe that certain factors may be more applicable and attainable than other factors. For example, it is unlikely that the regulatory market for bio-pharmaceutical products in the U.S. is going to change

substantially in the near future.[53] Industry experts[49,54] do not believe that a definitive technological standard (or cluster of standards) will develop in this industry due to its complexity and the organic nature of human beings. We believe that Pammolli and Riccaboni"s[54] observation about pharmaceuticals applies to biotechnology as well: "[t]here does not seem to be a durable, long-term first-mover advantage that can be exported to a different drug class. This has hindered the persistence of dominant positions and limited industry concentrations."

Although firms may not be able to create a standard or change the regulatory market, the outcome related to the building of coalitions remains significant.[33,44] Pharmaceutical firms create strategic alliances with biotechnology firms for two reasons: to block competitors and to act as substitutes for internal innovations.[36] Biotechnology firms, on the other hand, have used strategic alliances to gain access to capital,[34] complementary assets,[50,55] and knowledge.[45] It is within this context that both biotechnology and pharmaceutical firms seek to influence the trajectory of the market.

We agree with Prahalad[12] that gaining access to strategic alliance partners is the first step toward market influence in this market-sector. Williams[13] suggests that biotechnology IPOs may strategically position themselves in order to affect strategic alliance development. Acquisitions, for one, may give the new firm the critical mass to survive and prosper within these alliances.[13,34]

Additionally, for many biotechnology firms, their goal is to use alliances with pharmaceutical firms to gain access to capital long enough to become a fully integrated bio-pharmaceutical company (FIPCO). A FIPCO is a company that controls an innovation from discovery to commercialization.[13,35,49] A FIPCO is then a direct

competitor to many pharmaceutical firms in the bio-pharmaceutical market-sector. For example, Amgen and Genentech (both of which are biotechnology firms) are well known FIPCOs. Today, Amgen and Genentech both invest in other biotechnology firms. FIPCOs may be similar to Williams'[13] Appliers and Scavengers, but without the dimension of acquisitions. In addition to pursuing strategic alliances in order to gain capital, complementary assets, and knowledge, we believe that these firms also use multiple strategic alliances to lessen the influence that investors may have on them. This is to say that these firms by having multiple partners may be able to limit the impact of one partner's withdrawal of funds and/or mitigate the ability of one partner to acquire them. Their goal from the beginning is not to be a niche player, but a FIPCO. Thus, their strategic intent is to use strategic alliances not as a potential exit strategy, but rather as a means to becoming a FIPCO. Given these factors, we hypothesize:

> *H_2: Biotechnology IPOs that seek greater breadth in competitive scope and growth will have more alliance partners.*

The Empirical Study

A number of studies show that filings with regulators reflect management's perceptions, intentions, and actions.[56] Our study represents biotechnology firms that filed with the U.S. Security & Exchange Commission (SEC) to offer common stock to the public for the first time. Our sample represents all known U.S. biotechnology firms that went public in the U.S. between the years 1996 and 2003. We collected names of biotechnology IPOs from several different publicly available sources (e.g. Edgar-Online.com, Ernst & Young's Healthcare Sector, Bio.org, Biospace.com, IPOresources.com, and the sec.gov). Additionally, we reviewed all news articles from

the late 1990s through December 31, 2003 related to public offerings from Biospace.com to ensure that we were capturing all biotechnology IPOs.

As biotechnology does not have its own standard industrial classification (SIC) codes, we then limited the firms in our study to a sub-set of IPOs within the SIC codes of 2834 (Pharmaceutical Preparations), 2835 (In Vitro & In Vivo Diagnostic Substances), 2836 (Biological Products), and 8731 (Services-Commercial Physical & Biological Research). The firms included in the sample represent firms directly involved in the drug or therapeutics discovery/ production segment, but not complements within the industry (i.e., software companies within the biopharmaceutical market-sector) nor pharmaceutical companies or pure contract research organizations (CROs). The firms in the study described themselves as biotechnology or biopharmaceutical firms. It should be noted that we also excluded from our sample companies that were primarily "plant and animal" biotechnology firms (though a few firms included in the study did state in their SEC filings that there may be uses for their technology within the plant and animal segments). Our final sample represents 84 firms.

Language from the Business Overview, Use of Proceeds, and Strategy sections of each IPO's prospectus was compiled. Based on this language, content analysis was performed by five individuals rating the dimensions of competitive scope and growth. Several writers have argued that content analysis is a useful and valid approach to organizational analysis.[57,58] Three raters had over 10 years direct healthcare business experience, including extensive responsibility for areas related to the dimensions of competitive scope and growth for their respective organizations, with the two other raters being MBA students. Four items were used to measure the competitive scope of each

IPO. These were: (1) range of products, (2) range of technologies, (3) broadness of market segments (i.e., diseases), and (4) places on its value chain (i.e., research and development to commercialization). Four items were used to measure the strategic dimension of growth. These were: (1) internal development of proprietary technology, (2) acquisition of technology, (3) acquisition of external property rights, and (4) acquisition of other firms. We provided a copy of Williams'[13] typology paper to the raters and a few sample examples of how one might rate these statements. Definitions were provided and a seven point Likert scale was used for each measure (See APPENDIX A). Overall reliability was deemed acceptable ($\alpha = .89$), with reliability for each item also found acceptable (i.e., each question's $\alpha > .60$). We used the means from the raters' responses for each item in the analysis.

We use the age, size (total assets), initial amount sought to be raised by the IPO, percentage of equity held by pre-IPO owners after the IPO, stage of development of the most advanced product (i.e., clinical trials), number of patents owned by the IPO, lead underwriter reputation, and venture capital investment—all at the time of the IPO—as external variables to further validate the groupings. These data are found primarily in the IPOs' prospectuses or annual (10K) filings (and their amendments). For venture capital investors, we cross-matched individuals and firms found in the firm's prospectus with Pratt's Guide to Venture Capital Sources (1996-2003 eds.).[59] We use the "tombstone" underwriter reputation ranks provided by Carter, Dark, and Singh.[60] For the few underwriters within our study that are not ranked by Carter, Dark, and Singh, [60] we use the Carter and Manaster[61] tombstone method to determine the underwriter's ranking.

Consistent with Prahalad's[12] coalition view and Lerner and Merges[50] observation, our measure for market influence is number of strategic alliances with pharmaceutical firms. This variable is found in the biotechnology firm's prospectus, specifically in the Collaborative Arrangement, Sources of Revenue, and Dependence of Collaborative Partners sections.

ANALYTICAL METHOD

We performed a finite mixture model (latent class analysis) using the eight items as possible indicators of discrete groups of firms. Finite mixture modeling is a probabilistic, model-based clustering approach used for identifying mutually exclusive categorical latent groups within a population based on the patterns of responses for a set of observed measures.[62] We chose finite mixture modeling as it provides a more principled statistical approach than other clustering methods,[63] and can be used as an exploratory or confirmatory procedure that accommodates observed indicators that are continuous, ordered or unordered categorical, counts, or any combination of these metrics.[64] Additionally, an important use of latent class analysis has been the analysis of typologies.[64]

Our goal was to assess how well the eight different rating items could identify distinguishable groups of firms. The firms identified as belonging to each identified group are considered relatively similar (homogeneous) with respect to how they were rated on the eight indicator items. We expected that across the identified groups there would be statistically significant differences with respect to how they were rated on each indicator. We used the Mplus statistical program to perform the analysis.[65]

RESULTS

TABLE 1 provides the means, standard deviations, and correlations among the variables.

Insert TABLE 1 About Here

We ran a series of models consisting of different groupings. Several fit criteria were used to evaluate these models and to assess the utility of the different indicators. The fit statistics including the Log Likelihood (LL) and Bayesian Information Criterion (BIC) for models consisting of 3 or 4 latent groups were found to be reasonable. The model with four groups provided a better fit to the data. All indicators except internal development of proprietary technology (Q5) were statistically significant as differentiators of firm groups. We therefore discarded Q5 and re-ran the series of models. We again found that the 4-group model provided the best fit to the data; however, this model was not appreciably different from a model consisting of three groups. Because the distribution was very uneven with the 4-group model (i.e., there were only six firms in the fourth group), we decided to retain the 3-group model. We examined model diagnostics to evaluate the required assumption of conditional independence (i.e., all indicators are uncorrelated given group membership), and made a small number of modifications to the model (i.e., we allowed the error variances for four variables to vary). These changes provided a final model that fit the data well in terms of having the lowest BIC and LL. TABLE 2 presents the findings from the 3-group model

related to the fit of the model. TABLE 3 presents the findings related to the 3-group model‟s indicators and covariates.

Insert TABLE 2 About Here

Insert TABLE 3 About Here

From the “Classification Table” within TABLE 2 and the “Group Size” within TABLE 3, it is apparent that there are three groups of firms confirming our first hypothesis that there is a difference among the firms. The “Group Size” from TABLE 3 shows that 39 of the 84 firms (or 45 percent) belong to Group 1; 32 firms (or 38 percent) belong to Group 2; and 13 firms (or 17 percent) belong to Group 3. The “Classification Table” (within TABLE 2) shows the modal assignment and the probabilistic assignment. This section depicts that it is possible to have some probability of firms belonging to different groups As this section shows, this is not a significant issue for these firms and groupings.

Within TABLE 3, and in each group column, is the mean rating for each “Indicator” for the firms in that group. Within this method, it is always important to consider the entire pattern with respect to these variables. The ratings for firms in Group 3 shows a

profile that reflects higher average ratings for almost every indicator item (all except Q7—acquisition of external property rights). Conversely, the profile of firms in Group 1 reflects average ratings that are, with the exception of Q3 (broadness of market segments), the lowest. Group 2 has average ratings that generally fall between the two extremes (except for Q7 where firms in this group have the highest rating and for Q3 where they have the lowest average ratings). FIGURE 2 represents the "rescaled" means for the indicator questions and provides a graphical representation of the three groups across the indicators.

Insert FIGURE 2 About Here

To link with Williams[13] typology, we averaged the individual indicators for each of our dimensions (e.g. competitive scope and growth) by group, noting that we had deleted one of our measures (Q5) from our final results. We then plotted these dimensional averages using the dimensions of growth and competitive scope. In taking the mean of the dimensions collectively, we found similar results to the above in that Group 1 has relatively low average indicators for both growth via acquisitions and competitive scope. Group 2 has relatively low average indicators for competitive scope but high growth via acquisition indicators. Group 3 has relatively high average indicators for competitive scope but relatively low growth via acquisition indicators. In examining the overall averages of these indicators, we associate Group 1 with Sowers, Group 2 with Collectors, and Group 3 with Appliers. Under the heading of "Covariates" within TABLE 3 are the conditional means for quantitative variables (i.e., given group

membership) or probabilities for a qualitative/categorical variable of having different values (being in different categories) for the categorical variable. For example, the conditional probability of a value of 1 for venture capital involvement for Group 1 is 78% whereas the probability of a value of 0 is 1-78% or 22%. We compare these probabilities across groups and see differences between the groupings and covariates. This principle also applies when there are more than two categories. These covariates act as external variables providing additional validity to the distinctiveness of our groupings. In other words, the more differences there are between groups and covariates the more assurance we can have that different groups exist. We can use Group 1 which has limited competitive scope and grows primarily through internal means as the comparison group (i.e., it has low mean indicators for both dimensions compared to the other two groups). At a minimum, firms in Group 2 are pursuing greater growth by acquisitions and firms in Group 3 are pursuing greater competitive breadth. From this perspective, the biggest effects when comparing Group 1 to the other two groups are in the areas of venture capital involvement, age (1^{st} and 4^{th} quartiles), total assets (> 10,000,000), amount to be raised (> 60,000,000), number of patents (0, 1; and >10), and underwriter reputation. Finally, we hypothesized that groups pursuing broader competitive scope and growth via acquisition would attract a greater number of strategic partners. Our findings indicate that firms in Group 3 have a 38 percent probability of having four or more strategic alliance partners. This compares with 23 percent for Group 1, but also 40 percent for Group 2. If we look at Group 3, we can also see that there is nearly a 60 percent probability of this group"s members having 3 or more partners compared to 46 percent for Group 2 and 43 percent for Group 1. Thus, when the three groups and covariates are

compared collectively, the findings confirm the second hypothesis with Groups 2 and 3 attracting more strategic alliance partners than Group 1.

DISCUSSION

Overall, our results provide modest support for the typology. We found three distinct groupings, confirming the assumptions that biotechnology IPOs differed based on the dimensions of growth and competitive scope. We also validated these groupings using external variables. In addition, these groupings had different relationships with strategic alliances, with groups that competed on a broader competitive scope and eternal acquisitions basis having a greater probability of attracting strategic partners.

Not surprisingly, we found groups that we associate with Williams‟[13] Appliers and Collectors having a greater probability of: (1) being older, (2) having greater size, (3) seeking a larger amount of funding at the IPO, and (4) having more patents. Interestingly, Sowers had a greater probability of having venture capital investors than both Appliers and Collectors. This is especially fascinating in light of the fact that Sowers also have the least probability among the three groups of attracting three or more strategic partners. An interpretation of this result might be that venture capitalists are supplying their own funds, limiting the influence of strategic alliance partners, and seeking to exit the venture by way of the IPO.

Our final 3-group model did not provide any Scavengers, those firms with broad competitive scope and a desire to acquire other technologies and firms. This may be because the capital requirements to become such may be too great at this stage of the firm‟s life cycle. Akin to this, we found the Collectors‟ stated desire to pursue acquisitions of technology, property rights, and other technology firms to be modest.

Taken together, this suggests that there may be greater interplay between the communications with strategic partners and those of future investors associated with an IPO than initially stated in the Williams[13] typology. In other words, IPOs simultaneously have to attract both strategic partners (i.e., pharmaceutical and other biotechnology firms) and also other investors such as private investors, venture capitalists, and equity investors. Whereas, private investors may wish to see acquisitions as part of a firm‟s strategic intent, pharmaceutical firms may not, knowing that that they (the pharmaceutical firm) can also act in this capacity. Therefore, there may be a balancing act with respect to communicating strategic intent related to acquisitions to alliance partners and other investors. This may also be related to these firms‟ relationships with venture capitalists as described above.

We found that Appliers and Collectors had a greater probability of attracting those underwriters with a greater reputation. This is significant from the perspective that underwriter reputation also could be used as a measure of market influence. Underwriter reputation has been shown to correlate with stock price, with the selection of underwriters usually occurring relatively close to the time of the IPO.[69] This is especially interesting in light of our findings related to venture capital involvement (i.e., Sowers have a greater probability of attracting venture capitalists) and the extant research that has shown firms with venture capital investment typically attract those underwriters with greater reputations. This seems to indicate that underwriters that are more prestigious are attracted to Collectors and Appliers, whereas venture capitalists are more attracted to Sowers. From the biotechnology strategist‟s perspective, this may be a critical finding and area of further research interest for the strategist and entrepreneur. As Williams,

Duncan, and Ginter[70] have shown, firms with venture capital investment typically lessen the influence of the founding entrepreneurs in terms of board involvement and replacing the chief executive officer/entrepreneur. Consistent with this, our findings may suggest that venture capital involvement also limits the strategic intent of these firms. Thus, we think that these groups and their characteristics are important to not only researchers in their understanding of the general dynamics of this market-sector, but to entrepreneurs as well.

Our study has several limitations. As Ketchen et al.[71] note, "configuration research may be most useful as an intra-industry concept." We do not know if our findings are generalizable to other industries, firms in industries at different stages of their life cycle, or firms in an industry that is expected to develop a standard. Our study was also limited to a seven-year timeframe; thus, we do not know whether our characterizations apply to biotechnology firms that went public in other timeframes. Hence, we do not know if our results apply to the first biotechnology firms that went public in the fifteen-year period between 1980 and 1995.

In addition, this setting lends itself to at least six other areas of further research. First, researchers need to know the long-term consequences of these different groups. In other words, are there long-term performance differences (e.g. survival, product/technological development, financial performance) between Sowers, Appliers, Collectors, and Scavengers? Second, research is needed with regard to migration within these types. For example, we do not know to what extent (or with what ease/difficulty) Sowers become Appliers and the like.

Third, it would be useful to understand the differences between groups and their ability to control intellectual property rights (which may be yet another measure of market influence). Lerner and Merges[50] observe that the appropriate allocation of control rights is especially critical in coalitions between firms seeking to develop new technologies, with these control rights being a "central issue in the negotiations of alliances." Given this phase of industry development and the predominance of coalitions within this market-sector (e.g. bio-pharmaceuticals), the ability to control property rights within these alliances may be another (set of) indicator(s) of market influence.[72] Fourth, it would be interesting to know if as this industry matured, if more or less strategic groupings developed—when do Scavengers appear in greater numbers.

Fifth, we do not know if these groups attract different types of investors and strategic alliance partners. In addition to filling in gaps in specific disease categories, pharmaceutical firms may invest in biotechnology firms for different reasons. For example, a pharmaceutical firm without any core competency in biotechnology and that has been "late" in entering into strategic alliances with biotechnology firms may pursue Appliers and Collectors as opposed to Sowers. This contrasts with those pharmaceutical firms that have been investing in biotechnology firms for some time and that may be looking only to invest in Collectors based on a lack of a given core competency or technique. And similarly sixth, we have limited knowledge about how firms in an existing industry (e.g. pharmaceuticals) absorb and survive disruptive innovations, firms, and industries. Are there different mechanisms employed by (and perhaps "types" of) existing firms to deal with disruptive innovations? Attention to these issues will further our understanding of the typology, groupings, and market-sector.

In conclusion, the present findings verify the existence of distinct groupings of biotechnology firms that have filed for a public offering of their stock. We have argued and found support for differences in these groupings and their ability to attract strategic alliance partners. Thus, in general, this study adds to our knowledge of firms in an emergent, disruptive technology industry; and specifically to our knowledge of the U.S. bio-pharmaceutical market-sector and the ability of different firms to attract strategic partners (and influence the market) based upon their group membership.

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65. To validate our findings further, we also tested the data using cluster analysis and factor analysis. We followed Ketchen and Shook“s[66] suggestions regarding cluster analysis in strategic management research. Specifically, the selection of our variables was derived deductively. We used a two-stage approach to cluster analysis. First, a hierarchical algorithm was performed using Ward“s method with the squared Euclidean distance. Ward“s method was selected as it is an effective tool for identifying distinct groups for a relatively small sample size (n<200).[67] We examined both the dendogram“s “branches” and changes in the coefficients (and graphed the amalgamation coefficients looking for a flattening of the graph, which is “analogous to the „scree test“ of factor analysis”)[68] We determined that there were 3 or 4 groups. Then a non-hierarchical algorithm was used with the number of groups specified based on our hierarchical analysis. This also produced 3 or 4 groupings, with a similar small number of firms in a fourth grouping as with our finite measure model. A principal component analysis was performed. We found three factors with eigenvalues greater than 1.00, with these three factors explaining over 75 percent of the total cumulative variance. Based on these analyses and the finite measure model, we concluded that there were three distinct groups.
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FIGURE 1
Williams' Typology

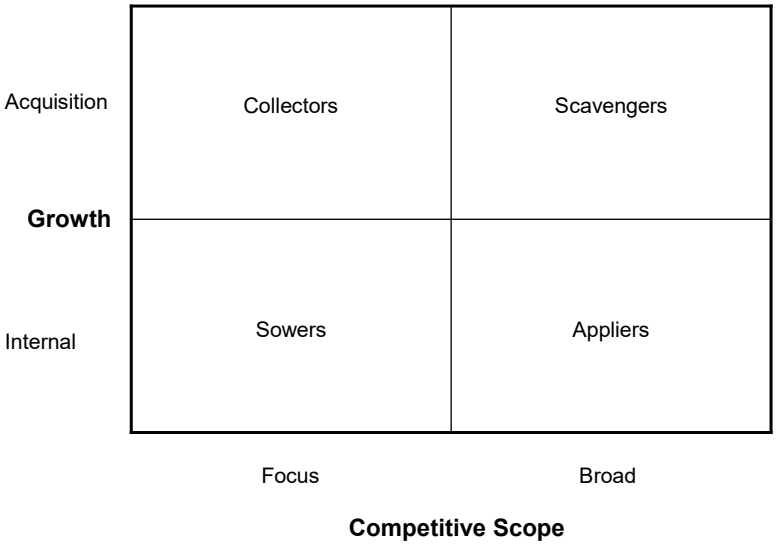
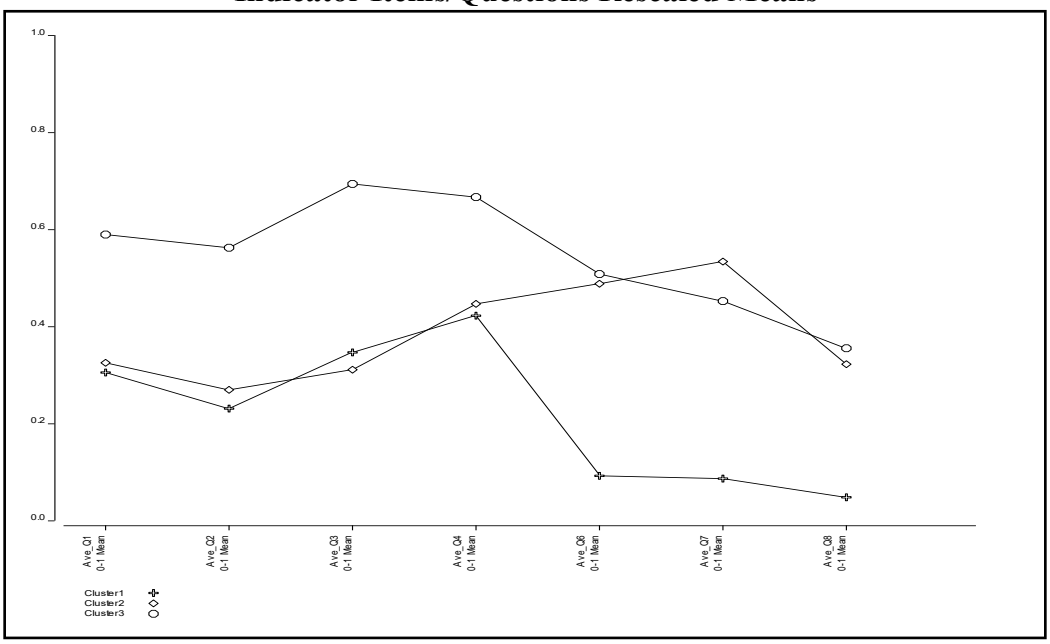


FIGURE 2
Indicator Items/Questions Rescaled Means



Q1 = Range of Products
Q2 = Range of Technologies
Q3 = Broadness of Market Segments
Q4 = Places on the Value Chain
Q6 = Acquisition of Technology
Q7 = Acquisition of External Property Rights
Q8 = Acquisition of Other Firms

TABLE 1
Means, Standard Deviations, and Correlations

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	*(16)*
Range Products (1)	2.85	.96	--															
Range Technologies (2)	2.40	.68	.621**															
Broadness Market Segments (3)	3.35	1.12	.523**	.519**														
Value Chain (4)	3.87	1.05	.385**	.447**	.279*													
Development Proprietary Technologies (5)	5.49	.92	-.016	-.062	-.210	.054												
Acquisition Technologies (6)	2.56	1.21	.202	.301**	.136	.097	-.174											
Acquisition Property Rights (7)	2.65	1.33	.240*	.219*	.039	.105	-.147	.894**										
Acquisition Firms (8)	2.01	1.11	.139	.313**	.111	.150	-.069	.734**	.645**									
Age (9)	7.25	5.97	.011	.047	.090	-.060	-.205	.192	.104	.224*								
Assets (10)±	29264	64682	.088	-.065	.041	.076	.025	.140	.090	.194	.452**							
Percentage Equity (11)	73.97	9.61	.166	.081	.026	.187	.238*	-.055	.029	-.133	-.063	.193						
Clinical Trial Stage (12)	1.02	1.23	.072	-.100	-.185	.166	-.087	-.054	.027	-.042	-.084	-.110	.023					
Amount Raised (13) ±	58204	51432	.130	.081	.179	.089	.032	.306*	.212	.126	.330**	.349**	.193	-.076				
Number of Patents (14)	46.67	327	.058	-.056	.033	.065	.045	.153	.131	.224*	.216*	.825**	.168	-.086	.154			
Underwriter Reputation (15)	7.39	2.11	.208	.163	.133	.255*	.134	.182	.239*	.078	.011	.135	.423**	.002	.255*	.082		
Number Strategic Alliance Partners (16)	2.66	2.32	.257*	.169	.153	.202	.115	.112	.162	-.066	-.054	.103	.222*	-.208	.168	.166	.155	--

N = 84 * Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed) ± Mean and SD in thousands (000s)

TABLE 2
Fit Statistics

Log-likelihood Statistics				
Log-likelihood (LL)	-625.2958			
Log-prior	-20.4370			
Log-posterior	-645.7328			
BIC (based on LL)	1472.1325			
AIC (based on LL)	1350.5917			
AIC3 (based on LL)	1400.5917			
CAIC (based on LL)	1522.1325			
Classification Statistics	Groups			
Classification errors	0.0242			
Reduction of errors (Lambda)	0.9555			
Entropy R-squared	0.9249			
Standard R-squared	0.9354			
Classification log-likelihood	-631.7485			
AWE	1856.5786			
Classification Table	Modal			
Probabilistic	Group 1	Group 2	Group 3	Total
Group 1	38.0548	0.2043	0.0250	38.2841
Group 2	0.8017	30.9827	0.0452	31.8295
Group 3	0.1435	0.8130	12.9298	13.8863
Total	39.0000	32.0000	13.0000	84.0000

TABLE 3
Indicators and Covariates

	Group 1	**Group 2**	*Group 3*
Group Size	0.4543	0.3784	0.1673
Indicators			
Range of Products Mean (Q1)	2.6036	2.6950	3.9134
Range of Technologies Mean (Q2)	2.1233	2.2746	3.4502
Market Segments Mean (Q3)	3.1294	2.9537	4.8665
Value Chain Mean (Q4)	3.6570	3.7612	4.7299
Acquisition of Tech. Mean (Q6)	1.6061	3.3438	3.4336
Acquisition Prop Rights Mean (Q7)	1.5943	3.6573	3.2804
Acquisition of Firms Mean (Q8)	1.2389	2.6100	2.7722
Covariates*			
Percentage Equity Mean	72.8490	75.0999	74.5080
Venture Capital Involvement			
0 (No)	0.2216	0.3376	0.3437
1 (Yes)	0.7784	0.6624	0.6563
Stage of Clinical Trials			
0 (number)	0.5344	0.4948	0.4892
1	0.1303	0.1236	0.2217
2	0.2000	0.1982	0.1464
3	0.0832	0.1825	0.0726
4 stage	0.0521	0.0009	0.0701
Age of IPO			
1st quartile	0.3413	0.3655	0.0936
2	0.3229	0.3331	0.2186
3	0.1289	0.0914	0.2994
4th quartile	0.2070	0.2100	0.3883
Total Assets			
1 (< 1mil)	0.0773	0.0528	0.0259
2 (>1 mil-10mil)	0.3902	0.2515	0.2921
3 (>10mil-50 mil)	0.4548	0.6016	0.6079
4 (>50mil)	0.0777	0.0941	0.0740
Amount to Be Raised at IPO			
<30,000,000	0.3886	0.3692	0.1709
30,000,000-60,000,000	0.3279	0.2247	0.3091
>60,000,000	0.2835	0.4061	0.5200
Number of Patents Held by IPO			
0, 1	0.4849	0.5056	0.2407
2—10	0.2049	0.2882	0.3587
>10	0.3102	0.2061	0.4007
Underwriter Reputation			
Mean (orig scale)	7.0367	7.4719	8.2233
Number of Strategic Alliances			
0	0.2081	0.1552	0.2227
1	0.1760	0.2271	0.0743
2	0.1792	0.1477	0.1034
3	0.2066	0.0661	0.2151
>=4	0.2301	0.4038	0.3843

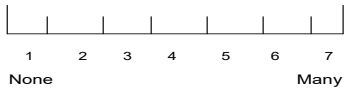
* Many of these covariates are recoded or rescaled

APPENDIX A
Indicator Items or Questions

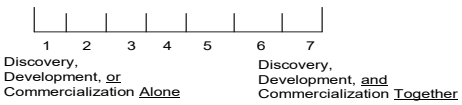
Range of Products: The range (i.e., number) of different, distinct products that the IPO is either now or intends in the future to discover, develop, and/or commercialize (i.e., produce).

Range of Technologies: The range (i.e., number) of different, distinct technologies that the IPO is now or intends in the future to discover, develop, and/or commercialize (i.e., produce).

Market Segments (Diseases): The range of diseases or treatment areas that the IPO either now or in the future intends to discover, develop, and/or commercialize (i.e., produce).

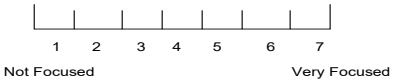


Value Chain Breadth: The places on the value chain that the IPO either now or in the future intends to compete (i.e., discovery, development, and/ or commercialization).



Development of Proprietary Technology: How focused (i.e., committed) is the IPO either now or in the future to developing its own, internal technology.

Acquisition of Technology: How focused (i.e., committed) is the IPO either now or in the future to buying technology from other firms.



Acquisition of External Property Rights: How focused (i.e., committed) is the IPO either now or in the future to buying property rights to technologies, drugs, etc. from other firms.

Acquisition of Other Firms: How focused (i.e., committed) is the IPO either now or in the future to buying other firms).