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Do Investors View Excess Capacity as a Determinant of Mergers and Acquisitions in the Pharmaceutical and Biotechnology Industry?

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DO INVESTORS VIEW EXCESS CAPACITY AS A DETERMINANT OF MERGERS AND ACQUISITIONS IN THE PHARMACEUTICAL AND BIOTECHNOLOGY INDUSTRY?

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Abstract

I examine investors' reaction to the announcement of mergers and acquisitions in the pharmaceutical and biotechnology industry from 2002 to 2008. Over this period, investors anticipate the announcements, as demonstrated by the fact that the cumulative abnormal returns are not statistically significant. In addition, I test to determine the effect of excess capacity on investors' reactions. From 2002 to 2004, investors do not recognize acquisitions as a response to excess capacity, as the excess capacity measures utilized have no effect on the size of the cumulative abnormal return. From 2005 to 2008, however, excess capacity measures have a positive effect on cumulative abnormal return, indicating that investors started to recognize the threat of excess capacity and acquisitions as a response to that threat.

Introduction

Since the birth of the industry, big pharmaceutical and biotechnology companies have been fully integrated machines, motivated by the search for the next blockbuster drug (defined as a drug whose sales exceed $1 billion). As described by former GlaxoSmithKline CEO, Jean-Pierre Garnier, the business model is simple – "new products are discovered, developed, launched, and protected by various patents" (Garnier, 2008). Typically, products are protected for ten to twelve years before the patent expires and products face competition from generic drugs. At this point, revenues from the drug drop off and the search for the next blockbuster commences (Garnier, 2008). Big pharmaceutical and biotechnology firms are forced to focus on constant replacement of their pipeline. This is an incredibly difficult task, as product success is not just a function of enormous firm investment – compounds are subject to extensive clinical trials and Food and Drug Administration (FDA) approval.

The past decade appears to have been a successful period for the industry, as "average sales for a recently launched drug grew by nearly 50%, and more than 30 achieved coveted 'blockbuster' status" (Booth *et al.*, 2004). However, the past decade has also demonstrated how unsustainable the big pharmaceutical and biotechnology business model has become. Research and development productivity, the ratio of research and development expense to the number of approved drugs, is at an all-time low. The industry's research and development investment has grown from $2 billion in 1980 to $43 billion in 2006. Over the same period, however, the number of drugs approved by the FDA has remained the same (Garnier, 2008). It is expected that the blockbuster drug

model will deliver a weak 5% return on investment, with only one out of six new drugs likely to deliver returns above their cost of capital (Gilbert *et al.*, 2003).

Many factors have been identified as the cause of this serious decline in research and development productivity. Most importantly, research and development costs have mushroomed – it has been estimated that the average drug, including its launch, costs close to $1.7 billion (Gilbert *et al.*, 2003). Every aspect of drug development has become more expensive, from the construction of laboratories to the discovery of new chemical compounds (Booth *et al.*, 2004). In addition, it is simply more challenging to develop drugs for the diseases that have not been addressed thus far. Clearly, the diseases that are most easily cured have already been overcome (Garnier, 2008). Certainly this issue is related to the previous mention of increased costs – the more difficult compounds to discover are also those that are more expensive to discover. The industry believed the advances made in genomics would greatly mitigate the issue of discovery (Booth *et al.*, 2004). However, this advancement has not proven to deliver significant results. This issue can only be tackled by substantially more efficient discovery practices.

Finally, the passing of the Hatch-Waxman Act of 1984 greatly simplified the procedure competing firms must go through to develop generic drugs (Garnier, 2008). These firms only need to prove bioequivalence (that the active ingredient in the generic drug is absorbed at the same rate as the brand-name drug) in order to be approved by the FDA (Higgins *et al.*, 2006). This dramatically decreased the cost and time it took to seek FDA approval for generic drugs. Before the passing of the Act, "only 35% of top-selling drugs with expired patents faced generic competition. By 1998, that number was close to 100%" (Higgins *et al.*, 2006). Since the enactment of Hatch-Waxman, when patents

expire, firms have started to lose their market share immediately. This has posed an enormous threat to the "blockbuster model" (Gilbert *et al.*, 2003).

The threats to the pharmaceutical and biotechnology industry have caused industry-wide excess capacity. Large firms face increased danger when patent cliffs approach and pipeline gaps widen. They have started to respond by participating in a large number of mergers and acquisitions. The big pharmaceutical and biotechnology firms are acquiring smaller firms in order to fill in their product line and fend off excess capacity (Austin, 2008).

I seek to determine whether or not investors are aware of the significant threat of excess capacity and if they view mergers and acquisitions as a solution to the problem. I will determine whether or not cumulative abnormal returns exist in a 5 day window around the day of the announcement of 194 deals from 2002 to 2008. I will then test to see the effect of financial measures of excess capacity on the cumulative abnormal returns. I predict that investors will respond positively to the news of a merger or acquisition. Investors will identify excess capacity as a problem facing the acquirer and respond positively when they hear that the firm is taking action to address the gaps in its pipeline. Therefore, I predict that excess capacity measures will have a positive effect on cumulative abnormal returns.

The paper is organized as follows: Section 2 provides a discussion of previous literature related to mergers and acquisitions in the pharmaceutical and biotechnology industry, and in general; Section 3 describes the collection and use of data; Section 4 discusses the methodology used in testing my hypothesis; Section 5 presents my empirical results; Section 6 discusses the implications of my results; Section 7 concludes.

Literature Review

2.1 Excess Capacity Theory

Andrade and Stafford (2002) examine the economic role of mergers across multiple industries (not including the pharmaceutical and biotechnology industry). In particular, they test whether or not mergers occur during times of industry-wide excess capacity, as is the case with the pharmaceutical and biotechnology industry today. The authors' measure of excess capacity is the percentage of total industry capacity that is actually utilized. Andrade *et al.* regress industry-wide capacity utilization against merger and non-merger investment and determined that a decrease in capacity utilization leads to an increase in merger activity across industries. Therefore, it appears that excess capacity has long been a determinant of merger activity.

2.2 Pharmaceutical and Biotechnology Industry Excess Capacity

Excess capacity is commonly proposed as a reason for pharmaceutical and biotechnology firms to engage is merger activity. Mergers and acquisitions are viewed as a response to the trend of decreasing research and development productivity across the industry. Danzon, Epstein and Nicholson (2007) test this theory in a two-stage analysis by first analyzing the propensity for firms to merge and then examining a merger's effect on firm performance. Danzon *et al.* test the effects of Tobin's Q, lagged sales growth and the number of marketed drugs in a firm's pipeline (along with other excess capacity measures) on the propensity of a firm to engage in merger activity. The authors also divide the sample by firm size. They find that large firms have a higher propensity to undertake acquisitions if the firm has excess capacity characteristics. For small firms, the authors determine that merger activity is typically an exit solution for financially unstable

firms that do not exhibit characteristics of excess capacity. Danzon *et al*. also test the effect of a merger on various measures of firm performance, such as operating profit, sales and enterprise value. They find that performance is not different between firms that do and do not undertake acquisitions.

Higgins and Rodriguez (2005) also test the effect of excess capacity on the likelihood of acquisition in the pharmaceutical and biotechnology industry. First, the authors create a desperation index for each firm in their sample. The index is created based on the exclusivity horizon of the firm's pipeline and on a score of the "health" of their pipeline. A healthy pipeline is one that has many compounds in later stages, such as Phase II or Phase III, of development. The authors use the desperation index, along with other measures of excess capacity, such as research and development intensity and the number of alliances formed in a particular year, to determine its effect on the likelihood that a firm undertake an acquisition. Higgins *et al.* find that firms that are more desperate and have unhealthy pipelines are more likely to engage in merger activity. The authors also consider the effect of alliances on the cumulative abnormal return over a three day window around the announcement. It is hypothesized that the increase in access to information that results from an alliance would make the acquisition more beneficial. Indeed, Higgins *et al*. find that a previous alliance with the target leads to a larger cumulative abnormal return for the acquirer. The authors demonstrate that excess capacity, in the form of an unhealthy pipeline, causes firms to essentially outsource their research and development through the acquisition of smaller pharmaceutical and biotechnology firms.

In his working paper, Ornaghi (2005) examines the effect of mergers in the pharmaceutical industry on not only firm performance, but also innovation in the merged firm and its competitors. Specifically, he tests the effects on research and development intensity, research productivity (the ratio of the number of patents to research and development expense) and returns to shareholders post-acquisition. He finds that mergers have a negative effect on each firm characteristic previously mentioned. The author concludes that mergers in the pharmaceutical industry actually decrease research and development productivity. Based on this evidence, pharmaceutical firms may be exacerbating the problems that affect the industry as a whole by participating in horizontal mergers. If we consider the possibility that pharmaceutical and biotechnology firms are responding to excess capacity and decreasing research and development productivity by merging, and that this activity may be further decreasing research and development productivity, we would expect to see investors to react negatively to the announcement of mergers.

2.3 Cumulative Abnormal Returns

Healy, Palepu and Ruback (1992) investigate the improvements in performance after mergers in the 50 largest US mergers between 1979 and 1984. In particular, the authors test to determine if abnormal returns at the announcement of the merger are a predictor of future improvements in post-acquisition performance. Healy *et al.* find a very positive relationship between abnormal returns at the announcement of a merger and an increase in operating cash flows after the merger. In addition, the authors found an even stronger relationship if the acquirer and target were in overlapping businesses. These results indicate that investors, in fact, anticipate the improvement in performance as a

result of a merger, especially if the acquirer and target are in the same business sector. In my sample, I only consider targets and acquirers in the pharmaceutical and biotechnology industry. According to Healy *et al*. it is possible that I will find higher abnormal returns on the announcement date because of my restricted, same-industry deal list.

Prabhala (1997) analyzes the traditional and conditional methods in event studies. While describing the intuition behind conditional models, Prabhala notes the difference between the fact and the information the announcement reveals. In particular, the author notes that an announcement of acquisition from a firm with a history of acquisitions would not surprise investors. Therefore, abnormal returns are not expected in this case. It is when unexpected information is revealed in an announcement that abnormal returns are observed. In the case of my sample, if investors believe the firm should respond to, for example, excess capacity by undertaking an acquisition, abnormal returns are not expected. In addition, many pharmaceutical and biotechnology companies made multiple acquisitions in my sample period. According to Prabhala, this would decrease the likelihood of observing abnormal returns.

Together, these studies address the questions surrounding the motivations behind mergers, the effects of mergers on firm performance and the expected reactions of investors upon the announcement of a merger. However, the existing literature does not address the actual reactions of investors, given all of this information, upon the announcement of a merger. There has been no research with data past 2004 to identify whether or not investors have responded to the emerging trend of merger activity positively or negatively. For example, investors may have reacted negatively to the news of an acquisition before the threat of excess capacity became readily apparent. Now,

however, they may have identified the problem and view acquisitions as a good solution to excess capacity. I examine the reactions of shareholders to the announcement of mergers in my sample of 194 deals between 2002 and 2008. I then determine whether or not the threat of excess capacity is recognized by the typical investor and what effect (positive or negative) it has stock return. Do investors expect pharmaceutical and biotechnology companies to merge if they face the risk of excess capacity?

Data

3.1 Acquisition Identification

I identify acquisitions using Bloomberg's Mergers and Acquisitions Advanced Search feature. I search by Deal Type, Date Range, Region/Country, Sector/Industry and Public/Private. My initial list includes company takeovers announced between January 1, 2002 and December 31, 2008, where the acquirer is a US-based, public firm, and both the acquirer and the target company are in the pharmaceutical and biotechnology industry. Bloomberg identified 483 deals that met these search criteria. I then eliminate any deals classified as a divestiture, as I will not be able to collect pre-merger excess capacity measures (described in detail below) on subsidiaries of firms. I also do not consider firms with multiple acquirers because it would be impossible to determine how the target is divided among the acquirers. Finally, I search each acquiring firm and delete those who were considered to be in the pharmaceutical or biotechnology industry by Bloomberg, but do not fit the type of firm I am considering. For example, several firms produce nutritional products, owned pharmacies, or were involved in agricultural biotechnology. These firms have different business models and are subject to different regulations in

approval of products than the pure big pharmaceutical or biotechnology firms. Finally, I do not eliminate deals that were terminated after the announcement date, as I want to avoid selection bias. After narrowing down my list of firms, my final list is comprised of 150 firms participating in 194 deals.

3.2 Event Study Data Collection

To complete my event study, I collect daily closing prices for each firm from October 1, 2001 to December 31, 2008 from Bloomberg. I also collect closing prices for the S&P 500 index for the same date range. I then calculate return manually for the individual firms and the S&P 500 index using $(P_1 – P_0)/P_0$. I calculate return manually because for many of the companies, no price was recorded for various trading days. I need the period for which the return is calculated to be consistent across the index and the firm to which it is compared.

3.3 Excess Capacity Data Collection

I also use Bloomberg to collect sales and research and development expense for each firm from three years before the announcement of the acquisition to the year of the announcement. I use research and development expense divided by sales as a measure of research and development intensity. In addition, I use sales growth as a measure of excess capacity. Finally, I collect the book value of assets, long term debt and market value of equity for each firm the year before the announcement. I then calculate Tobin's Q for each firm, using the equation, (long term debt + market value of equity)/(book value of total assets) (Danzon *et al.*, 2007).

Methodology

4.1 Event Study

To determine the effect of the announcement of a merger or acquisition on the pharmaceutical or biotechnology firms in my sample, I run an event study and calculate the abnormal return on the day of the announcement. I follow a typical event study as explained by the Data and Statistical Services at Princeton University and edited by Professors Henrik Cronqvist and Darren Filson. I use the announcement of the merger as the event date and the S&P 500 index as the market returns to which the returns of each individual firm will be compared. I start by calculating the event window for each firm, which includes a total of five days – two days before the event, the day of the event and two days after the event. I use a small event window because I do not want to inadvertently consider events besides the announcement of the merger or acquisition. I then calculate the estimation window for each firm, which includes sixty days before to ten days before the event date for the firm returns and the market returns. I set up the estimation window in order to compare the firm returns to market returns and find the correlation between the two. I am then able to estimate the market model and predict firm returns.

I predict the firm returns from the market model in order to determine whether or not the returns actually observed on the event date were expected. If there is no difference between the returns observed on the event date and the returns predicted by the market model, then the announcement of the acquisition did not cause any abnormal returns for shareholders. That is, the announcement of the merger did not increase or decrease value for the shareholders of the firm in the form of unexpected stock returns.

After predicting the firms' returns, I compute the abnormal return by comparing the actual return to that predicted by the market. I then calculate the t-statistic for each event and across all events. I finish my event study with cumulative abnormal returns (CARs) and a t-statistic for each event and for all of the events together.

4.2 Excess Capacity Measures

I use three financial measures that indicate excess capacity in a pharmaceutical or biotechnology firm, as used by previous research (Higgins *et al.*, 2005 and Danzon *et al.*, 2007). First, I consider the intensity of a firm's research and development, as measured by the firm's research and development expense as a percent of sales. As mentioned previously, research and development productivity in the pharmaceutical and biotechnology industry has largely declined over the past decade. Therefore, it is safe to make the assumption that a firm with large research and development investment is at higher risk for research and development deterioration, causing the firm to look to acquire new compounds and products in order to develop and fill the pipeline. As proven by Higgins *et al.*, firms with higher research and development have a higher propensity to undertake acquisitions.

Second, I use the change in sales growth from three years prior to the announcement to one year prior to the announcement as a measure of excess capacity. As patent cliffs arrive for pharmaceutical and biotechnology companies, they face increased competition from generic drugs. The generics rapidly gain market share and diminish sales for the original producers of the brand-name drug. Therefore, a consistent decrease in sales can be an indication of excess capacity for a pharmaceutical or biotechnology firm. The firms no longer have patent protection and have gaps in their product pipelines.

Danzon *et al.* use lagged sales growth as a measure of excess capacity to demonstrate that, regardless of the size of the firm, slower growth of sales greatly increased the propensity for a firm to merge as a response to distress on the firm from excess capacity.

I use Tobin's Q (market value of assets to book value of assets) as the final measure of excess capacity. Tobin's Q is sensitive to changes in the value of intangible assets and, therefore, is a good measure of excess capacity for pharmaceutical and biotechnology firms. As the firms face competition from generics and their patent cliffs arrive, the value of their patents and compounds decrease. This should change the market value of their assets, which would be reflected in the Tobin's Q. Both Higgins *et al.* and Danzon *et al.* both use Tobin's Q as a measure of excess capacity and find that a lower Tobin's Q is associated with a firm undertaking an acquisition.

Results

5.1 Cumulative Abnormal Returns

I estimate predicted returns for the pharmaceutical and biotechnology firms in my sample by comparing stock returns to market returns from sixty days to ten days before the announcement of an acquisition. I then regress actual returns on the returns I predict for each firm during the event window. Tables 2.1-2.3 report summary statistics for the cumulative abnormal returns calculated. Across all events, the average cumulative abnormal return was -0.00587% with a standard deviation of 0.127%. Cumulative abnormal returns range from -0.481% to 0.652%. From 2002-2004, the average cumulative abnormal return was 0.000809%, and from 2005-2008, the average cumulative abnormal return was 0.0108593%. While cumulative abnormal returns are not

significant across all of the events in my sample, I still use them to test excess capacity measures. It is possible that there is cross-sectional variation in my sample due to excess capacity. Therefore, the cumulative abnormal returns' lack of significance does not matter in this case.

One possible error in my event study is the fact that the beta estimated by the estimation window can clearly be incorrect. In that case, all of the abnormal returns calculated based on predicted returns could also be incorrect. Brown and Warner (1985) test to see how the characteristics specific to daily returns affect the results of event study. The authors determine that standard methodologies (such as the one utilized in this paper) are so well-specified that daily data generally have no effect on results. Therefore, the worry of a false beta is mitigated by the fact that I use daily data for a short-run event study.

5.2 The Effect of Excess Capacity on Cumulative Abnormal Returns

Table 4 reports the effect of excess capacity measures on the cumulative abnormal returns calculated in my event study. The results support the hypothesis that investors respond positively to an acquisition undertaken as a response to excess capacity. I use three different variables to measure excess capacity: R&D intensity (research and development as a percent of sales) for three years before, two years before, one year before and the year of the announcement, sales growth from three years before to one year before the announcement, and Tobin's Q for one year before the announcement. For the entire sample, all deals announced between January 1, 2002 and December 31, 2008, R&D intensity and Tobin's Q the year of the announcement are significant. A 100% increase in R&D intensity two years before the announcement leads to a 0.00120%

increase in cumulative abnormal returns. The average R&D intensity two years before the announcement is 499%. Assuming sales for that average firm is constant at $100,000 and research and development expense is about $50 million, an increase in research and development expense of $10 million (to $60 million) would increase cumulative abnormal return over the event window by 0.00120%. In addition, a 100% increase in Tobin's Q the year of the announcement leads to a 0.000747% increase in cumulative abnormal returns.

Investors recognize the danger big pharmaceutical and biotechnology companies face when they exhibit characteristics of excess capacity and do not respond to them. When a firm's sales slow, they are most likely facing increased competition from generic drugs. Investors have started to recognize this characteristic of excess capacity and reward the firm when they respond by acquiring new compounds.

While the excess capacity theory suggests that Tobin's Q should have a negative relationship with cumulative abnormal returns, a positive correlation does not necessarily contradict the theory. A large Tobin's Q is an indication that a firm can finance an acquisition due to its relatively high stock price (Danzon *et al.*, 2007). Therefore, a positive relationship can simply indicate that the financing effect of Tobin's Q is outweighing the excess capacity effect of the measure.

Tables 5 and 6 report the effects of excess capacity on cumulative abnormal returns in the first and second half of the sample (2002-2004 and 2005-2008), respectively. I divide the results by period in order to determine whether or not investors begin to recognize excess capacity as reason for a merger. Especially given the fact that the results across the entire period are somewhat inconclusive, it is necessary to see if

investor behavior changes as more mergers are announced and as time passes to determine whether or not these mergers actually improve firm and shareholder value.

When broken down by period, I receive different results for the excess capacity measures I consider. For the early period, deals announced between January 1, 2002 and December 31, 2004, only sales growth and Tobin's Q are significant in the final regression. In addition, there is a positive relationship between sales growth and cumulative abnormal return. Specifically, a 100% increase in sales growth means an increase of 0.00178% in cumulative abnormal return. The average sales growth for firms announcing deals between 2002 and 2004 is 526%. Assuming sales for this average firm in year t-3 is constant at $1 million and sales in year t-1 is $6.26 million, then an increase of $1 million in sales (to $7.26 million) would increase cumulative abnormal return in the event window by 0.00178%. This contradicts the excess capacity theory, as an increase in sales growth indicates that new products are being marketed and that generics have not begun to decrease market share. Tobin's Q is positively correlated with cumulative abnormal returns, which also contradicts the excess capacity theory. A 100% increase in Tobin's Q leads to a 0.00159% increase in cumulative abnormal return. As mentioned previously, Tobin's Q can be reflective of not only excess capacity, but also ability to finance acquisitions. These results suggest that from 2002 to 2004, investors did not acknowledge mergers and acquisitions as an appropriate response to excess capacity issues. This is not to say that investors did not recognize the rapid research and development deterioration and decrease in research and development productivity that plagues the pharmaceutical and biotechnology industry. Instead, investors did not see mergers and acquisitions as a solution to the problem. It is worthwhile to note that while

results do change for the years 2005-2008 (as explained below) I am not suggesting that acquisitions in response to excess capacity do, in fact, add value.

As displayed in Table 6, the results for deals announced between January 1, 2005 and December 31, 2008 support the theory that investors reward firms for responding to excess capacity with mergers and acquisitions. Larger research and development intensity increases cumulative abnormal return. A 100% increase in research and development intensity (research and development expense as a percent of sales) increases cumulative abnormal returns by 0.00125%. The average research and development intensity in year t-2 for firms announcing deals between 2005 and 2008 is 460%. Therefore, for the average firm, assuming research and development expense in year t-2 is $46 million and sales is constant at $100,000, an increase in research and development expense of $10 million (to $56 million) would lead to an increase in cumulative abnormal return during the event window of 0.00125%. In addition, a decrease in sales growth from three years before the announcement to one year before the announcement increases cumulative abnormal returns upon the announcement of an acquisition. A 100% decrease in sales growth during this time period increases cumulative abnormal returns by 0.000541%. The average sales growth for firms announcing deals between 2005 and 2008 is 450%. Therefore, assuming that sales in year t-3 is $1 million and in year t-1 is $5.5 million, a decrease in sales of $1 million in year t-1 (to $4.5 million) would lead to an increase in cumulative abnormal return over the event window of 0.000541%. When investors acknowledge that a firm suffers from excess capacity, they respond positively to the announcement of an acquisition.

Discussion

When considering my sample as a whole, it is difficult to draw conclusions as to the effect of excess capacity on cumulative abnormal returns. While research and development intensity appears to play a role in increasing cumulative abnormal return over the event window around the announcement date, the positive relationship between Tobin's Q and cumulative abnormal return sheds some doubt on the real impact of excess capacity. However, a larger Tobin's Q can demonstrate a firm's ability to finance an acquisition. Therefore, it appears that investors respond positively to the announcement of a merger when a firm demonstrates excess capacity characteristics and is able to finance the acquisition.

After dividing the sample by date, it appears that investors' recognition of acquisitions as a response to excess capacity changed from 2002 to 2008. In the first half of the sample, from 2002-2004, investors do not appear to react to the announcement of acquisitions as a firm's response to excess capacity. Instead, the results demonstrate that if the firm has the ability to finance an acquisition, as seen through positive sales growth and a large Tobin's Q, investors react positively to the announcement of the acquisition. On the other hand, from 2005-2008, excess capacity does appear to have an effect on cumulative abnormal return. Research and development intensity is positively correlated with cumulative abnormal returns. Investors acknowledge that a higher research and development investment leaves the firm at a higher risk and likelihood of deterioration. Sales growth is negatively correlated with cumulative abnormal returns, again demonstrating that when investors acknowledge a firm's excess capacity they react positively to the announcement of a merger, as it serves as a solution for the firm. Again,

it is hypothesized that the acquirers in my sample face the threat of excess capacity and do not have the pipeline to maintain sales. Therefore, they respond by acquiring smaller firms whose assets, such as their compounds and discovery technologies, will help fill in the acquirers' gaps. The results demonstrate that over the period of 2002 to 2008, investors began to realize that acquisitions were, in fact, a response to excess capacity. Therefore, from 2005 to 2008, investors react positively to the news of an acquisition when they observe characteristics of excess capacity in the firm.

While these trends are supported by the results, the cumulative abnormal returns are not significant across all events. This means that the announcement of an acquisition by a big pharmaceutical or biotechnology firm was anticipated by investors. Previous literature has consistently proven that excess capacity increases a firm's propensity to participate in merger activity. Danzon *et al.* and Higgins *et al.* use the same excess capacity measures to predict the probability that a firm will acquire a company. My results demonstrate that investors now expect that firms respond to excess capacity by acquiring firms and filling in their pipeline gaps.

Conclusion

I analyzed investors' reaction to the announcement of an acquisition in pharmaceutical and biotechnology deals from 2002 to 2008. I used an event study to determine the size of the reaction to the news of the event and calculated cumulative abnormal returns. I then tested whether or not the threat of excess capacity in a firm had an effect on cumulative abnormal returns. I investigated how the investors reacted when

they recognized this excess capacity threat using financial measures, such as Tobin's Q, sales growth, and research and development intensity.

Across all events, cumulative abnormal returns were not different from zero. This indicated that from 2002 to 2008, investors anticipated the announcement of an acquisition from the firms in my sample. When testing to find the effect of excess capacity on the cumulative abnormal returns, I found that it was not clear whether a relationship existed or not. However, when breaking the sample into an early and late period, a trend in investor behavior appeared. From 2002 to 2004, investors reacted to the announcement of an acquisition as if the threat of excess capacity was not recognized. That is, if the firm demonstrated the financial ability to fund an acquisition, investors responded positively. Excess capacity measures were not statistically significant in this period. However, from 2005-2008, investors responded positively to the announcement of an acquisition when the firm faced excess capacity. This indicates that investors began to recognize that firms were responding to gaps in their pipelines and the approaching of patent cliffs by acquiring smaller firms and their products.

No determination can be made from these results about the actual value added to the firm and its shareholders after the acquisition occurred. In addition, the trend of excess capacity recognition apparent from 2005 to 2008 does not mean that the acquisitions that took place between 2002 and 2004 were successful in mitigating the effect of excess capacity. My results simply demonstrate that investors begin to acknowledge the threat of excess capacity and react differently to the announcement of an acquisition.

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Appendix

Table 1 – Definition of Variables

List of Variables

Variable	Definition
cumulative_abnormal_return	Cumulative abnormal returns
rdt3	R&D as a percent of sales three years before the announcement
rdt2	R&D as a percent of sales two years before the announcement
rdt1	R&D as a percent of sales one year before the announcement
rdt	R&D as a percent of sales the year of the announcement
change_sg	Sales growth from three years before to one year before the announcement
qt1	Tobin's Q one year before the announcement
mc	Market Capitalization the year of the announcement

Table 2.1 – Summary Statistics 2002-2008

Variable	Obs	Mean	Std. Dev.	Min	Max
cumulative_abnormal_return	194	-0.0058674	0.1270811	-0.4806167	0.6520224
rdt3	193	6.650784	33.56538	0	317.7097
rdt2	194	4.898271	25.82638	0	269.5548
rdt1	192	6.472064	56.2134	0	774.925
rdt	184	6.50223	46.80435	0	567.0787
change_sg	194	4.827146	27.80351	-1	296.9107
qt1	194	20.97949	24.86845	0.2359125	193.1889
mc	189	26938.52	48999.22	0.2211089	200949

Table 2.2 – Summary Statistics 2002-2004

Variable	Obs	Mean	Std. Dev.	Min	Max
cumulative_abnormal_return	83	0.0008085	0.1467298	-0.3240206	0.6520224
rdt3	83	7.564609	35.23176	0	310.4546
rdt2	83	5.296048	29.78497	0	269.5548
rdt1	82	3.372066	8.254612	0.0269495	46.68085
rdt	78	5.058296	28.29142	0.0279523	250.0899
change_sg	83	5.261908	25.6838	-0.9756	170.7039
qt1	83	22.7243	27.82509	0.520613	193.1889
mc	80	18871.9	42941.21	5.48555	200949

Table 2.3 – Summary Statistics 2005-2008

Variable	Obs	Mean	Std. Dev.	Min	Max
cumulative_abnormal_return	111	-0.0108593	0.1105762	-0.4806167	0.4306238
rdt3	110	5.961262	32.39769	0	317.7097
rdt2	111	4.600834	22.5555	0	219.8401
rdt1	110	8.782972	73.98581	0	774.925
rdt	106	7.564748	56.81842	0	567.0787
change_sg	111	4.502054	29.39952	-1	296.9107
qt1	111	19.67481	22.44791	0.2359125	163.4788
mc	109	32858.97	52411.79	0.2211089	184511.6

Table 3 – Correlation Matrix

	CARs*	**rdt3**	**rdt2**	**rdt1**	**rdt**	**change_sg**	**qt1**	**mc**
CARs*	1							
rdt3	-0.0071	1						
rdt2	0.2585	0.2353	1					
rdt1	-0.0754	0.0625	0.0236	1				
rdt	-0.0729	0.2338	0.0499	0.9808	1			
change_sg	-0.1785	0.3684	0.0916	-0.0293	-0.0195	1		
qt1	-0.0932	-0.1253	-0.0905	0.6153	0.5841	-0.1235	1	
mc	0.1084	-0.1185	-0.1185	-0.0769	-0.0845	-0.1179	-0.1953	1

Table 4 – 2002-2008: The effect of excess capacity measures on cumulative abnormal returns.

VARIABLES	(1) cumulative_abnormal_return	(2) cumulative_abnormal_return
rdt3	-0.000315	
	(0.000383)	
rdt2	0.00132***	0.00120***
	(0.000432)	(0.000344)
rdt1	-0.000828**	
	(0.000385)	
rdt	0.000674	
	(0.000469)	
change_sg	0.000785	
	(0.000609)	
qt1	0.00125***	0.000747**
	(0.000414)	(0.000357)
mc	2.05e-07	
	(1.80e-07)	
Constant	-0.0444***	-0.0274**
	(0.0138)	(0.0118)
Observations	183	194
R-squared	0.129	0.075

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5 – 2002-2004: The effect of excess capacity measures on cumulative abnormal returns.

VARIABLES	(1) cumulative_abnormal_return	(2) cumulative_abnormal_return
rdt3	-0.00116	
	(0.00219)	
rdt2	0.00159	
	(0.00214)	
rdt1	-0.000868	
	(0.00197)	
rdt	0.000702	
	(0.000546)	
change_sg	0.00186	0.00178***
	(0.00113)	(0.000581)
qt1	0.00209***	0.00159***
	(0.000621)	(0.000536)
mc	1.73e-08	
	(3.58e-07)	
Constant	-0.0544**	-0.0446**
	(0.0244)	(0.0195)
Observations	78	83
R-squared	0.239	0.177

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6 – 2005-2008: The effect of excess capacity measures on cumulative abnormal returns.

VARIABLES	(1) cumulative_abnormal_return	(2) cumulative_abnormal_return
rdt3	0.000978	
	(0.000960)	
rdt2	0.00124***	0.00125***
	(0.000464)	(0.000470)
rdt1	0.00187	
	(0.00188)	
rdt	-0.00270	
	(0.00259)	
change_sg	-0.00336**	-0.000541
	(0.00154)	(0.000361)
qt1	-7.56e-05	
	(0.000590)	
mc	2.35e-07	
	(1.96e-07)	
Constant	-0.0227	-0.0142
	(0.0180)	(0.0105)
Observations	105	111
R-squared	0.139	0.068

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1