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Evaluating the Target Pipeline in a Pharmaceutical Acquisition

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Abstract

Many firms in the pharmaceutical industry turn to acquisitions when faced with gaps in their drug development pipelines and patent expirations as an alternative to making long-term investments in internal research and development. Investors are generally negative on this strategy, and upon the announcement of a pharmaceutical acquisition the stock of the acquiring firm often drops. This decline in share price creates an opportunity for the investor who can identify the characteristics of a target firm that increase the probability that the transaction will ultimately be a success, as measured by the subsequent appreciation in the acquirer's stock. It is expected that the characteristics of a successful acquisition are related to the target firm's pipeline. Specifically, higher quantities of late-stage drugs in the target's pipeline as well as a focus on developing biotechnology drugs are expected to lead to superior returns for the acquiring firm's investors.

Introduction

Meeting the goal of maximizing shareholder returns in the pharmaceutical industry is predicated on the firm's ability to sustain a pipeline of new and innovative products. In attempting to strengthen their product pipelines, pharmaceutical firms can essentially pursue two distinct strategies. The first potential course of action involves making long-term investments in internal research and development. The second strategy is to strengthen the pipeline by engaging in mergers and acquisitions in order to acquire another firm's pipeline of drugs. While the focus of this paper is the merger and acquisition strategy, it is helpful to begin with a discussion and

analysis of some of the major problems associated with the process of maintaining a strong pipeline through internal drug development.

The Challenges of Internal Growth

Investing in internal research and development presents many challenges with no guarantees of developing a successful new drug. The process of bringing a new drug to the market is a long and expensive one, and the risk of failure is present at every stage of this process. The heavy financial commitment that research and development demands also prevents resources from being devoted to other means of growing the company and increasing shareholder value that could have more of an immediate impact, such as additional expenditures on advertising the company's drugs currently on the market or increasing the dividends paid out to shareholders. Despite these drawbacks, pharmaceutical companies are constantly striving to develop the next blockbuster drug through organic research and development.

Regulatory Process

When a pharmaceutical company decides to make a major investment in hopes of developing a new drug, there is always a great risk that the drug may fail to gain the approval of the Food and Drug Administration (FDA) and thus potentially become nothing more than a major sunk cost. The FDA is an agency that is part of the United States Department of Health and Human Services, and it is charged with protecting the health of the American public. One of the major responsibilities this entails is determining if and when a new drug is safe to be marketed and sold to the

public. The FDA has received some scathing criticism for over-regulating from economists such as the great Milton Friedman, who said that "The FDA has done enormous harm to the health of the American public by greatly increasing the costs of pharmaceutical research, thereby reducing the supply of new and effective drugs, and by delaying the approval of such drugs as survive the tortuous FDA process" (Klein 2000). Despite criticisms such as these, the FDA does play an important role in bringing a new drug to market and they will continue to intensely scrutinize any drug before it reaches the public. This inevitably results in a long and costly process

There are seven stages involved in bringing a new drug to market (Kellog and Charnes 2000). The first stage is discovery, where researchers identify promising new molecular entities (NMEs). If the compound has promise it then enters the regulatory process. The process of gaining FDA approval starts with pre-clinical trials. In stage two of the process the compound is closely scrutinized and tested *in vitro*, which literally translates to "in the glass." At this stage additional tests are done, generally in test tubes or petri dishes. If this part of the pre-clinical trial goes well, they enter stage three where animal testing will begin to determine if the drug is safe to proceed to the clinical trial stage (stage four). Less than 1% of the compounds that enter the pre-clinical trials make it to the human testing that takes place in the clinical stage (Grabowski 2002).

For those drugs that do manage to survive these pre-clinical trials, there is an even more intense process ahead in the stage three clinical trials. There are three phases in the clinical trial process. Phase I of the clinical trials entails giving a small dose of the compound being tested to a very small sample size of humans. Generally,

the sample size in Phase I consists of healthy adults, and the purpose is to determine the appropriate dose that should be given as the effects the drug has on the body. If the Phase 1 tests do not raise any red flags, the compound proceeds to Phase II. Phase II is where the majority of failures occur, as it is the first time that the full dose is given to humans, and the sample size is again increased. The sample in this phase usually consists of adults who have the condition the drug is intended to treat. For those compounds that do survive Phase II, Phase III is the most expensive stage, a result of the length and intensity of the trials in the phase. The sample size is enlarged in an attempt to increase the chances that the benefits will be determined to be statistically significant. If all goes well in Phase III, the company submits a New Drug Application (NDA) to the FDA, who will inform the developing company if they may begin to market the drug to the public. This clinical trial process is both expensive and time consuming, and only 22% of the compounds that enter this process ultimately succeed in gaining the FDA's approval (Grabowski 2002). Once the drug can finally be marketed, the company enters the final post-approval stage, where they continue to monitor and research the newly approved drug.

This demonstrates that researching and developing a new drug and successfully bringing it to market is extremely difficult, and in this process the stakes are high. This is because developing a new drug is an extremely costly endeavor. Joseph DiMasi, Ronald Hansen and Henry Grabowski (2003) found that the average out-of-pocket cost of developing a new drug is $403 million (DiMasi et al. 2003). This figure is before expenditures for marketing and other costs associated with finally bringing a new drug to the market, assuming it is one of the fortunate few that

ever make it that far. For those select drugs that are eventually marketed and distributed to the public, the total cost is, on average, in excess of $800 million.

For those new drugs that do succeed in gaining the FDA's approval and make it to market, there is a limited window in which these drugs can really produce strong revenues for the developing firm. This is because on average these new drugs only enjoy an eight year effective patent life in which to recoup the costs of development and make the firm profitable. A drug's effective patent law life is the time that drug is under patent protection after reaching the market. Although patents for new pharmaceuticals generally last for twenty years, the time that it takes to test and develop those drugs counts against the patent's life. Since it takes on average twelve years to bring a drug to market, that drug is only on the market and enjoying patent protection for eight years before generic competition is allowed to enter the market. This generic competition forces the developing firm to drastically reduce their prices, since once other firms can just copy the compound it is extremely cheap to manufacture the drugs.

Decision for Internal Development

As the FDA approval process suggests, the decisions facing a pharmaceutical firm present a complex capital budgeting problem. Kellogg and Charnes (2000) developed a model that can help value drug development projects. They calculated that the expected net present value (ENPV) of a drug is

$$\mathrm{ENPV} = \sum_{i=1}^{7} p_i \sum_{t=1}^{T} \frac{DCF_{it}}{(1+r_d)^t} + p_7 \sum_{j=1}^{5} q_j \sum_{s=1}^{T} \frac{CCF_{js}}{(1+r_c)^s} \qquad (1)$$

The NPV estimation has two distinct cash flows: the first is where the pharmaceutical is making cash outlays during the development stage (DCF) of the drug and the second is where the pharmaceutical is receiving cash inflows from commercial success (CCF). At each stage ,where i is an index of the seven stages of drug development, there is the conditional probability ρ_i that the drug will succeed at the end stage for a drug that is in stage i-1. q_i is the probability of success once the drug makes it to market. Kellogg and Charnes divided the degrees of success into five categories ranging from "dog" to "breakthrough." T is when all future cash flows falls to zero. In the DCF this happens when the drug reaches the next stage, while in the CCF this occurs at the expiration of the patent. Each period has its own discount rate. r_d is the discount rate for development cash flows while r_c is the discount rate for commercialized cash flows. Kellogg and Charnes used six and nine percent for the discount rate for the development and commercialized stages, respectively. As Kellogg and Charnes discuss, this model can be used to value each of the projects in a potential target's pipeline, which can then lead to a valuation of the firm as a whole.

For the purposes of this paper, it will be helpful to modify the equation presented by Kellogg and Charnes. This modification will allow us to analyze a project in a firm's pipeline during the patent stage and during the post-patent stage separately. This will take into account that just because a drug loses its patent protection, the revenues a firm derives from that drug do not fall to zero. Prices often are dramatically slashed, but the firm will often to continue to produce that drug and

sell it under the same name, albeit at a great discount. The second term of equation 1 above is modified and presented below.

$$ENPV = \rho_7 \sum_{t=1}^{5} q_j \left(\sum_{t=1}^{T} \frac{CCF_P}{(1+r)^t} \right) + \left(\sum_{g=T+1}^{N} \frac{CCF_G}{(1+r)^g} \right)$$

(2)

Where CCF_P is the cash flow during the patent life and CCF_G is the cash flow during the generic period.

As a drug in the pipeline completes a stage of development, it becomes more valuable, as the probability of it ultimately reaching the market increases. This has the effect of enhancing the overall value of the firm, as the value of a pharmaceutical company is ultimately derived from the value of its future drugs. Through valuing an entire firm's pipeline, it is possible to attempt to value the entire firm. This helps offer the firm some guidance and certainty when trying to determine how much they should be willing to pay to make a potential deal worthwhile for their investors.

Clearly, for pharmaceutical companies looking for future sources of revenue, investing in research and development in hopes of bolstering the firm's own pipeline is not always a reliable strategy. The process of developing new compounds and getting them approved can take fourteen years or longer and is extremely expensive. Further, failures, particularly in the later stages, can lead to gaps in the pipeline which will disrupt a firm's revenue stream as other drugs come off patent. These factors make growing revenues at a consistent rate and increasing shareholder value extremely difficult.

Given the many problems associated with investments in research and development, it is not surprising that pharmaceutical companies have often looked for other ways to compensate for gaps in the pipeline and to help maintain their expected revenues. All indications are that mergers and acquisitions will remain a key strategy in the pharmaceutical sector for the foreseeable future.

Mergers and Acquisitions in the Pharmaceutical Industry

The pharmaceutical industry is an ideal industry in which to study mergers and acquisitions. This is because it is an important international industry compromised of many firms engaged in fierce competition, and they develop extremely important products with the potential to save and improve countless lives. There is also great diversity with regard to the size of these firms, as sizes range from some extremely small firms which operate mostly locally and are privately held to enormous international firms such as Pfizer, Inc., which has global revenues of nearly $50B. Most importantly for the purposes of this paper, these firms constantly face pressure to innovate and bring new drugs to the market. One of the results of this pressure is that firms of all sizes in the pharmaceutical industry have frequently engaged in mergers and acquisitions as a way to maintain their revenue streams and increase shareholder value.

The pharmaceutical industry is also an extremely complex sector that is constantly faced with both short-term and long-term challenges and uncertainties. The expiration of a key patent on a blockbuster drug and the subsequent generic competition can devastate a firm's previously most reliable source of revenue.

Maintaining a pipeline of drugs that will drive revenues in the future is far from guaranteed. As discussed previously, new drugs are costly and time-consuming to develop, and the vast majority of potential new drugs fail to gain the Food and Drug Administration's approval and thus never reach the market. From the start of the development process it takes a new drug over ten years to reach the market, and less than one out of every hundred compounds that are studied in the preclinical stage ever make it to human testing. Further, only one in five of the drugs that do make it to human testing succeed in gaining FDA approval (Grabowski 2002). A failed drug leaves the firm with nothing to show for their time and resources invested in the project.

The industry also experiences seemingly endless political uncertainty, as "big pharma" and their allegedly outrageous profits is always an easy target for grandstanding politicians. These political attacks increase the uncertainty regarding the potential for future drugs currently being researched and developed to provide strong revenues if and when they ultimately reach the market. The current healthcare reform debate is merely the latest in a long line of government attempts to get more involved in the healthcare system to the detriment of pharmaceutical companies. These debates always increase the doubt about whether the drugs currently in a firm's pipeline will be adequate to meet analysts' and investors' expectations even if there are no unexpected failures. This added uncertainty further pressures pharmaceutical companies to have a strong pipeline of drugs that will reach the market and succeed.

Acquisition Theories

There is a great deal of literature that discusses the motivations for acquisitions in the pharmaceutical industry and offers various explanations for why there are so many pharmaceutical mergers and acquisitions. Some of this literature argues that the synergies that can be created from bringing two firms together are a driver of merger activity. For example, William Pursche, an advisor to companies in a variety of sectors and a veteran of over three hundred mergers and acquisitions, argues that in the pharmaceutical industry, "for companies that can capture cost synergies through acquisitions there are considerable opportunities to create value" (Pursche 1996). This can indeed be the case, although most of the benefits that come with synergies are recognized in the short term. However, there can also be some serious inefficiencies when the two firms first come together that can have the effect of offsetting some of the benefits from shorter term synergies.

There is some management literature that argues that manager's egos can be a reason for all the mergers. The argument is that top executives want to run the largest and most powerful company possible. This desire can cloud a manager's judgment and lead them to believe that they will be able to succeed where many merging pharmaceutical firms before them have failed. In criticizing the merger talks between GlaxoWellcome and SmithKline Beecham that would ultimately create GlaxoSmithKline, *Fortune* ran an article in which Glaxo COO Sean Lance criticized the process, declaring that "megalomania seems to be the driving force of these mergers. Egos are taking precedence over future strategies" (Guyon 1998). Given this, it is not surprising that the GlaxoWellcome and SmithKline Beecham merger has

been roundly criticized for creating a larger but less successful company which has failed to produce higher shareholder returns (Heracleous and Murray 2001).

Other scholars believe that firms in this industry merge to diversify the drugs which are providing the bulk of their revenue. Pfizer Chief Executive Officer Jeff Kindler explained his company's $68B acquisition of Wyeth by saying that, "this deal is about transforming our company into a more diversified business, and to providing [sic] real focus and accountability across those businesses" (Chiang 2009). Mergers can be a valuable way to prevent a firm from becoming overly dependent on one blockbuster drug, and therefore the firm will be in a position to better handle the inevitable patent expiration and subsequent generic competition that one key drug will eventually face. Further, Vasudevan Ramanujam and P. Varadarajan explain that "the rising cost of internal development... has rendered acquisition-based diversification increasingly attractive to firms" (Ramanujam and Varadarajan 1989).

While all these theories seem to make some sense, the one key motivation for mergers and acquisitions in the pharmaceutical industry are pipeline related. In this industry, a firm's pipeline is absolutely critical. The pipeline receives intense scrutiny from analysts and rating agencies, because the quality of the pipeline is extremely significant in knowing if the company will be able to pay back its debts and grow their revenue in the future when their key current drugs come off patent. Therefore, firms in this industry turn to mergers and acquisitions when there are gaps in their pipeline due to late-stage and unexpected failures. As Simon Frantz explained, pharmaceutical mergers are "driven by losing major patents and not having enough drugs in their pipelines to fill the gaps" (Frantz 2006).

Advantages and Drawbacks of Acquisitions

Acquiring Firm

Given all the problems and potential pitfalls that go along with trying to sustain revenues through internal research and development, it is not surprising that pharmaceutical companies often engage in mergers and acquisitions to help maintain strong revenue streams and profits. Bringing two companies together can provide an immediate boost to the acquiring firm's pipeline. This strategy is also the best way for a firm to circumvent the long and costly process of developing a drug from the start of the process discussed above through acquiring the promising pipeline of another firm. Since some of the drugs in a target firm's pipeline should be in the later stages of testing, there will be a much higher probability of these drugs reaching market then if the target had to start from the beginning of the process. These drugs, if they do indeed gain FDA approval, will obviously be able to reach the market much sooner than if a drug was just starting the process, and thus can help compensate for whatever patent expirations or late stage failures the acquiring firm has experienced.

One of the challenges for a firm looking to make an acquisition is determining how much a potential target is worth. As a result of the uncertainty that a drug making its way through the development process will make it to market, it can be difficult to value a firm's pipeline in order to ultimately determine how much the acquirer should be willing to pay, even with the model created by Kellogg and Charnes (2000) discussed above.

Target Firm

Although this all sounds good for the acquiring firm, it raises an obvious question: Why would these target firms with such promising pipelines want to be acquired by another firm troubled with patent expirations and/or pipeline failures? On the surface, it would seem as though a firm with strong future prospects would be better off remaining on its own in order to reap all the benefits when their drugs do reach the market. However, there are several reasons why a small firm with a seemingly bright future would want to be acquired. First and foremost, the acquiring firm generally has to pay a significant price to complete the acquisition (Snellgrove 2001). This allows the target firm and its shareholders to receive a substantial return on their investment. Depending on how the deal is structured, if the shareholders of the target firm receive shares of the acquiring firm, they still have the opportunity to benefit from the new and presumably stronger company. If they receive all cash for their stock in the target firm, then they got a solid return on their investment without the risk that they will lose money if there is an unexpected failure in the pipeline. This risk is always an inherent part of investing in the pharmaceutical industry. Further, they always have the option of buying shares in the acquiring firm in the open market if they so choose.

Target firms are also sometimes motivated to be acquired if they are having difficulty accessing credit. This problem is exacerbated during difficult economic times, and can lead to smaller firms actively looking for another firm that would be interested in acquiring them (Schmidt 2008). If a target firm currently does not have strong revenues and is not yet a well-established company, they may have problems

getting the funds necessary to continue investing in research and development even during normal economic times, regardless of how promising their pipeline may be. This is the result of the inherent uncertainty of attempting to bring a drug to market, no matter how much revenue that drug might produce if and when it actually reaches the public. For firms in this difficult situation, their best option may very well be to be acquired by a larger, more established company that has a good deal of cash on hand and can more easily access credit. These larger firms generally offer the additional benefit of having a stronger system to manufacture and distribute a new drug to the public once it is approved by the FDA than the target firm would have on its own, as a result of their having gone through the process many times before.

Drawbacks

Despite these benefits for both the acquiring and target firms in a pharmaceutical merger or acquisition, there are also several potential drawbacks to this strategy that an acquiring firm should be wary of. The most significant drawback is that the time and effort it takes to bring two different companies together can take the focus away from research and development, which can hurt the long-term potential of the pipeline. Mergers can also be extraordinarily expensive, which means that significant financial resources will have to be committed in order to make the merger happen. These are financial resources that might otherwise be devoted to research and development that would ensure the future strength of the pipeline. Further, bringing two distinct teams of researchers from their own distinct cultures can disrupt innovation, which obviously has a negative effect on the pipeline.

These drawbacks have doomed many mergers in the pharmaceutical industry. These failures have ranged from deals between relatively small firms to some of the largest and most high profile mergers that have occurred in recent years. These failures have led many scholars to question if mergers and acquisitions are actually an effective or even an appropriate strategy for firms hoping to grow revenues and increase shareholder value in this industry. One study found that "despite the attractiveness of mergers in the pharmaceutical industry, [they found] no abnormal returns from mergers for acquiring companies" (Hassan et al. 2007). Another study goes even further, stating that "there is a general background of evidence to show that mergers frequently destroy shareholder values. The pharmaceutical sector is no exception" (Heracleous Murray 2001).

Biotechnology Firms and Acquisition Value

While many studies have examined mergers and acquisitions in the pharmaceutical industry, this study will be examining the characteristics of drugs in the target firm's pipeline. Specifically, the effect of biotechnology drugs in the target's pipeline will be closely scrutinized. Biotech drugs, unlike traditional pharmaceuticals, are produced from living organisms, and thus are more expensive to manufacture and distribute than traditional pharmaceuticals. The biotech field is currently the fastest growing and most promising area of pharmaceutical research. Biotech drugs are a relatively new area of pharmaceutical discovery, and as Henry Grabowski (2002) explains, they may in the near future be able to reach the market faster and achieve higher success rates. This fact, coupled with biotech's potential to

effectively treat a wide range of serious conditions, has led to heavy investments in the development of biotech drugs. However, Grabowski concedes that presently, the costs of development are no lower and sometimes even higher, and the likelihood of a drug reaching the market are no better for biotech drugs than for traditional drugs (Grabowski 2002). This is possibly why we do not presently see an ever greater percentage of biotech drugs in pharmaceutical pipelines.

The production of these biotech drugs can be extremely complicated. Although the process by which these drugs come to the market after being scrutinized by the FDA does not differ materially from the process traditional pharmaceuticals undergo, the actual production and manufacturing of these drugs is much different. One scholarly article concluded that the result of the complexity of manufacturing biotech drugs is higher barriers to entry, which will help reduce the competition once the drug loses patent protection (Grabowski et al. 2006). This would make biotech drugs in a target firm's pipeline extremely attractive to pharmaceutical companies looking to make an acquisition, as their traditional drugs are constantly threatened by generic competition.

The biotech field is an area that holds immense promise and is getting significant attention. Due to the incredible potential biotechnology drugs have to treat a host of ailment from Alzheimer's to diabetes, there is a belief that these drugs will be major revenue drivers in the future. As it was reported in *BusinessWeek* in 2005, it seems that "Biotechnology has finally come of age." Pharmaceutical firms are making heavy bets that this will indeed be the case, and that biotechnology is the future of the industry. This is reflected in the fact that "Biotech increasingly

dominates the pipeline (44% of all discovery stage candidates) and has a growing share of drug applications (about one in ten of filings)" (Lawrence 2005). Indeed, numerous small firms, and even some very large firms such as Amgen (the largest player with revenues in excess of $14.7B), have been started that focus solely on the development of biotech drugs (Mulligan 2001). These firms, with promising biotech drugs in their pipelines, are increasingly becoming attractive targets for pharmaceutical companies looking to merge, and pharmaceutical companies are increasingly willing to pay a high price for these biotech companies. Indeed, pharmaceutical companies "paying a large premium is fast becoming the industry standard and again reflecting the high demand for biotech companies" (Malik 2009).

Hypotheses and Relevance for Investors

If biotech firms do command a premium, investors will want to anticipate the merger prior to the announcement when abnormal returns appear to occur. A positive market reaction would result in investors in the acquiring firm achieving superior returns around the time of the announcement. Previous research has not examined the pipeline composition, and it is expected that a close analysis of the target pipeline could also help predict the likelihood that the acquisition will be well received by market.

Higher numbers of drugs in the later stages of development in a target firm's pipeline would also be expected to increase the returns of the acquiring firm's investors because these drugs are close to reaching the market and generating revenue for the acquirer. It is true that there is still no guarantee of a drug in later stages

reaching the market and ultimately being successful. However, there is much less uncertainty regarding potential to reach the public for a drug that has already been tested on humans and achieved some good results than there would be with a drug still in the pre-clinical stage. Those drugs that are in the early stages of the process are longer duration projects, and as Bradford Cornell explains, "longer duration projects are 'riskier,' by the sheer fact of their longer duration and, therefore, should be discounted at higher rates" (Cornell 1999). This fact makes those drugs in the later stages much more valuable than those in the beginning stages of gaining FDA approval.

Potentially even more significant than late stage drugs in the target firm's pipeline for predicting the likelihood of success in a pharmaceutical merger is a biotechnology focus in a target, resulting in biotech drugs in the target firm's pipeline. As discussed above, there is incredible potential for major profits would come with the development of a new biotechnology drug. Given this, it would be expected that a biotech focus in a target firm would lead the market to respond positively to a biotech acquisition announcement and thus increase the returns realized by the acquiring firm's investors.

Finally, some financial data will also be included to see if this information can help predict the market's reaction to an acquisition. The target's research and development expenditures for the year prior to the acquisition will be recorded and compared to the firm's total assets. Dividing the research and development costs by the total assets will reveal how focused on organic pipeline development the target firm was. Firms value research and development expenditures because it shows a

commitment to the development of successful new drugs and lays the foundation for future revenues. It is believed that targets that put proportionately more of their resources into development will be more favorably received by the market.

Empirical Methodology and Analysis

In order to test if a biotechnology focus, late stage drugs in the target firm's pipeline and strong investments in research and development will indeed lead to higher returns for the acquiring firm's investors, a two step empirical methodology will be used. The first step is known as an event study, a study where the market's response in the trading days surrounding a major event is studied. The second step is analyzing the residuals from the event study to see if it can be determined what is driving the residuals. The following sections will discuss in detail the various tests run and will analyze the results.

Step One: Event Study

Testing the hypotheses put forth in this paper required performing an event study, which is any study that measures the impact of a specific event on the valuation of a company. There are numerous possibilities for events to be studied. The possibilities include earnings announcements, the sale of new stock or changes in management. In this study, the event will be the official announcement of the acquisition. Event studies are helpful, because "given rationality in the marketplace, the effect of an event will be reflected immediately in asset prices. Thus the event's

economic impact can be measured using asset prices observed over a relatively short period of time" (Campbell, Lo and MacKinlay 1997).

The actual event in this study will be the day the acquisition was officially announced. An *event window* to be examined must also be defined, since rumors of the acquisition could potentially cause abnormal price returns in the trading days leading up to the announcement, and there could be post-announcement drift that results in abnormal returns in the days immediately following the announcement. This window should be adequate to capture all the price action that would be a result of the acquisition. In this study the *event window* will start at the eighteenth trading day prior to the acquisition announcement and end at the close of the twentieth trading day after the announcement.

Prior to the event window the movement of an acquirer's stock price is assumed to follow the general trend of the industry. A 100 day *estimation period* was used to capture the relationship between the target firm and the industry. This is a variant of the market model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it}$$

$$E[\epsilon_{it}] = 0$$

$$Var[\epsilon_{it}] = \sigma^2_{\epsilon i}$$

R_{it} is the return of acquirer *i* at time period t, and R_{mt} is the industry return for the same period. ϵ_{it} represents the zero mean disturbance term, and α_i , β_i, and $\sigma^2_{\epsilon i}$ are the model's parameters. This model shows the expected linear relationship

between the individual acquirer's performance and the broader performance of the pharmaceutical industry (Campbell, Lo and MacKinlay 1997).

Given this "normal" relationship, the model is used to estimate the expected return during the thirty-eight day *event period.* The excess (or "abnormal") returns of the acquirer's stock during event period T is measured

$$E_{iT}^{*} = R_{iT} - E\langle R_{iT} | X_T \rangle$$

Where E_{iT}^{*}, R_{iT} and E(R_{iT}) are the abnormal, actual and normal (expected) returns, respectively for the event time period T. X_T is the conditioning information for the normal performance model. Excess residuals for each firm are average for each day during the event period:

$$\sum_{i=0}^{n} E_{iT}^{*} \text{ x } (\frac{1}{n}) = \bar{E}_T$$

Average residuals are summed over time and denoted as the cumulative average residuals (CARs).

$$\sum_{t=-18}^{T=20} \bar{E}_T = \overline{CAR}_T$$

Step Two: Residual Analysis

Once the CARs are gathered, regression analysis can be utilized to assess the impact of pipeline composition and maturity on CARs. It is expected that the CARs are a function of characteristics of the target firm. The model that will be used is presented below.

$$CAR_i = \beta_0 + \beta_1 \, Preclinical_i + \beta_2 Phase I_i + \beta_3 \, Phase II_i +$$

$$\beta_4 \, Phase III_i + \beta_5 \, Approved_i + \beta_6 \, Biotech_i + \beta_7 \, \frac{R\&D}{Total \; Assets_i} + \mu_i$$

For this study it will be important to control for the type of target and the pipeline composition. Also included in the model is the target's investment in research and development.

Data

Gathering the Data

To test the hypotheses, a list of potential acquisitions was generated with the help of the Mergent Database, which identifies firms which are no longer actively traded. Because of the need for transparency in creating the data set, all targets were publicly traded at the time of the announcement, as was the acquiring firm. All of the acquisitions had occurred fairly recently, as no acquisition on the list had been announced farther back than 1999.[1] The target in each acquisition was classified as either a traditional pharmaceutical firm or as a biotechnology firm based on the company's SIC code.[2] This process produced 23 traditional pharmaceutical targets, representing 56% of the sample and 18 biotech targets, representing 44% of the sample.

Once the list of targets was created and each firm was classified as either a traditional pharmaceutical or a biotech, the pipelines of the targets had to be analyzed. To accomplish this, the Mergent Database was again used, this time to obtain each target's annual report for the full year prior to the year the merger was announced.

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[1] The original sample contained 45 firms. Three traditional targets and one biotech target were excluded from the data set because they showed no statistical significance with the industry index the underlying return following the announcement. Firms used in the study are listed in Appendix.

[2] Those targets with an SIC code of 2834 were classified as traditional pharmaceuticals and those with an SIC code of 2836 were classified as biotechs (Golec and Vernon 2009).

These annual reports provided pipeline information, and the number of approved drugs as well as the number of drugs in development was recorded as well as the stage of development for each drug in the pipeline.

Some relevant financial data for each firm was also recorded. Specifically, the target's research and development expenditures for the year prior to the announcement were recorded to see if firms who had made a heavy commitment to research received any premium. To put the research costs in the proper perspective, the target's total assets were also recorded. This allowed a variable to be created that would take into consideration the different sizes of the targets when determining how significant the investments in research were. For a complete breakdown of the variables collected from the annual reports, see Table-1 below.

Table-1
Description of Variables

Variable	Description
Prec	Number of drugs in the target's pipeline in the preclinical stage of development
p1	Number of drugs in the target's pipeline in phase I of clinical development
p2	Number of drugs in the target's pipeline in phase II of clinical development
p3	Number of drugs in the target's pipeline in phase III of clinical development
App	Number of the target's drugs that have received FDA approval
Biot	Dummy variable where 0 is a traditional pharmaceutical and 1 is a biotech.
Rd	Target's expenditures on research & development for the year prior to the acquisition announcement
Ta	Target's total assets reported for the year prior to the acquisition announcement
Rdta	Target's research & development divided by the total assets

Stock price information for the acquirer as well as for a pharmaceutical index was collected. The index chosen is the AMEX Pharmaceutical Index, which trades under the ticker symbol DRG. This index is designed to mirror the equity performance of the pharmaceutical sector. In collecting stock price data, for both each acquiring firm and the index close prices were recorded for each of the eighteen trading days prior to the announcement of the acquisition, the close price on the day the acquisition was announced and the close price for each of the twenty days after the announcement. The logarithms for the recorded closing prices for both the acquiring firms and the index were then calculated, as these are proxies for asset returns.

Descriptive Statistics

The mean for drugs in the pipeline in the preclinical stage of development was slightly over three, while the average number of approved drugs was under two. It is also interesting to note the wide range in research and development expenditures and total assets observed in the sample. The ratio of research and development to total assets also speaks to the wide variation in the size of the targets. The target with the highest ratio spent a staggering 32 times more on research and development than the firm had in total assets. This reflects the fact that the sample captured firms of greatly different sizes. For further details about the data, see the descriptive table for the variables in Table-2, below.

Table-2
Descriptive Statistics

Variable	Mean	Minimum	Maximum
prec	3.22	0	13
p1	2.07	0	9
p2	2.20	0	17
p3	2.02	0	19
app	1.90	0	34
biot	0.439	0	1
Rd (millions)	120.42	7.57	1,259
ta (millions)	692.55	4,500	11,442
rdta	1.134	0.098	32.289

Empirical Results

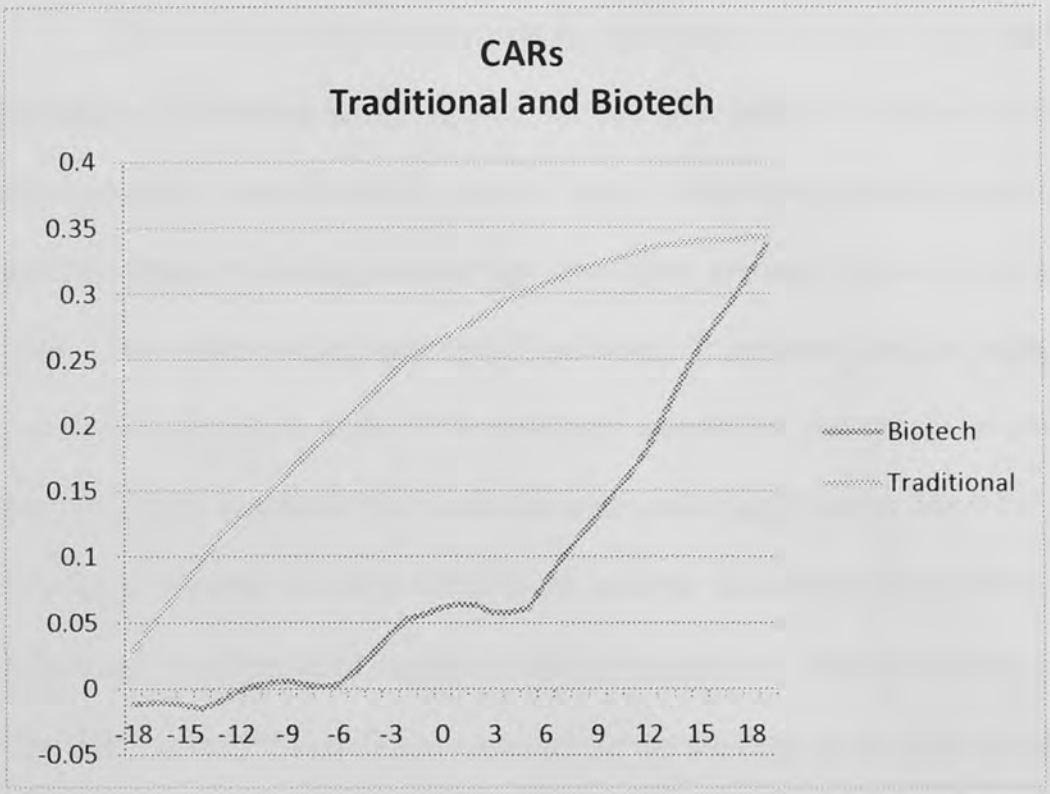
Calculating CAR

To determine how the market is responding to acquisitions in the pharmaceutical industry, the returns in each acquisition had to be compared to the returns observed in the broad pharmaceutical index. This process had several steps. First, the industry index performance was used to predict the performance of each individual acquirer's stock. The deviation in the acquirer's actual performance, called the residual, was then calculated for each day observed. The observations for the acquirers of traditional pharmaceutical targets were then separated from the information on the acquirers of biotech firms. For both of these groups the residuals could then be accumulated so that the net abnormal returns could be analyzed. This was accomplished by simply summing the individual residuals for every day proceeding the day being analyzed. These net abnormal returns are known as the cumulative average residuals.

Once the cumulative average residuals were calculated, the average cumulative average residuals for each day could be calculated for both the traditional and biotech targets. This was accomplished by averaging the cumulative average residuals for each acquiring firm across each day. It is expected that the CARs will be near zero for the days leading up to the event, that is that investors will on average over time will not receive a return other than what is the normal market return. However, these residuals could differ after the announcement depending on the reactions of the market to the information in the announcement. Any significant CARs in the time leading up to the announcement could indicate that investors are trading on rumors of the announcement. It is also expected that the CARs will be higher for firms acquiring biotechs that for those acquiring traditional pharmaceutical firms, since there may be cash flow advantages in the biotech generic market. The comparison will allow us to evaluate how the market is responding to biotech targets as compared to their traditional counterparts. The results are presented in Graph-1 below. [3]

[3] The table of daily average residuals and CARs are presented in Appendix 1.

Graph-1



Interestingly, the graph shows that the CARs begin to trend higher for the firms acquiring traditional targets right away. This suggests that buying on rumors is occurring. There is less of a move before the announcement for the biotech acquirers, perhaps because with some of the smaller biotech firms there is less media scrutiny and fewer rumors are leaked. The strong performance of the traditional acquirers refutes the notion that the market has become generally negative on pharmaceutical acquisitions and will thus knock the stock of the acquiring firm down. However, in the days following the announcement, the performance of acquirers of traditional pharmaceutical firms begins to level off, whereas the biotech acquirers really begin to see positive abnormal returns. By the twentieth day following the announcement, the

abnormal returns for each type of acquirer is similar, suggesting that the acquirers of biotech firms are not seeing higher returns than the acquirers of traditional targets.

The next step in the process was to determine if the results were statistically significant. To determine significance, the available data was used to calculate the standard error. From this the J_1 statistic, used to determine statistical significance, was calculated by dividing the average cumulative average residual by the standard error. The results for the acquirers of traditional firms reveal that the results are statistically significant at the 99% confidence interval for the entire event window. For the biotech acquirers, the results are statistically significant at the 99% confidence interval for the first five days of the event window, then lose their statistical significance until the third day before the announcement. The results then remain significant at the 99% confidence interval for the duration of the event window.

Pipeline Impact on CARs

Four regression models were run in order to see if it could be determined what factors the market values in a target firm when pricing the acquirer. The first of these regressions was for the eighteenth trading day prior to the announcement of the acquisition. The second was the day of the announcement and the third was for the twentieth day after the announcement. The fourth model took the firms' average CARs for the five days immediately after the acquisition was announced. The results are in Table-3 below.

Table-3

Impact of Firm's Pipeline on CARs for Particular Days during Event Window

Variable	-18	-18*	0	0*	20	20*	5 day aver.	5 day aver.*
Intercept	-0.03664	-2.79	-0.7793	-3.23	-1.3546	-2.72	-0.89741	-3.21
Prec	0.00185	0.76	0.01541	0.34	0.04641	0.50	0.02183	0.42
p1	0.0008859	0.19	0.09642	1.14	0.19155	1.10	0.104	1.07
p2	0.00308	0.68	0.10612	1.28	0.20904	1.23	0.13242	1.38
p3	0.01228	2.83	0.26153	3.29	0.43614	2.65	0.30521	3.31
App	-0.00211	-1.14	-0.0746	-2.19	-0.131	-1.87	-0.09088	-2.31
Biot	-0.01166	-0.63	-0.7205	-2.11	-1.7088	-2.42	-0.85229	-2.16
Rdta	0.00118	0.70	0.0497	1.61	0.11006	1.72	0.05814	1.62
Sample	41		41		41		41	
R-sq	0.484		0.641		0.568		0.647	
Adj. R-sq	0.374		0.565		0.476		0.572	

*t-statistics

The first column for each day shows the variable's coefficient while the second column shows its t-value. The results reveal that for the eighteenth trading day before the announcement of the acquisition the model can explain less than 40% of the observed variation. However, the day of the announcement the model's ability to explain the variation jumps to slightly over 56%. The average of the five days after the announcement is the strongest model, predicting just over 57% of the variation. By the twentieth day after the announcement, the model's ability to explain the observed CARs is back below 50%.

In looking at the individual variables, the market seems to value the Phase III drugs, while not valuing projects in the earlier stage of development. The value of the coefficient on the Phase III drugs also continuously rises as it gets later in the event window. This is not surprising, given that Phase III drugs are close to reaching the market and thus face less uncertainty than the drugs in the earlier stages of

development. It is interesting that the market seems to even value Phase III drugs more than drugs already approved, perhaps because the patent on those drugs has already began to run out, while Phase III drugs will enjoy a longer period of protection. Although drugs in the earlier stages of development are not statistically significant, it is interesting to note that the coefficients do grow for each stage of development as the drug gets closer to the market. The coefficients for drugs in the preclinical stage are particularly small, not surprising given the tremendous rate of failure at that stage.

The ratio comparing the target's research and development expenditures to total assets does not have much of an impact on how the market values the acquirer. This does make sense, because the market will value the successes of the research based on the projects, particularly the later stage projects, in the pipeline. The market is not rewarding a commitment to high expenditures on research.

Consistent with the results found in Graph-1, the model shows that the market is not giving a premium for biotech acquisitions. This could possibly be a result of the high price acquirers of biotech firms have to pay since, as discussed above, biotech firms often sell for a premium. This could weigh down the acquirer's performance in the wake of the acquisition announcement.

Conclusion

There is a great deal of room for additional research on this subject. Future studies may want to examine whether the market values acquisitions between two firms who have collaborated on the development of a drug in the past. The market

may value this past collaboration since the firm's are already familiar with each other and have worked successfully in the past, creating a familiarity that may ease the transition that is sometimes difficult.

Future research may also want to consider using a longer time horizon when analyzing an acquirer's performance. The relatively short time horizon utilized in this study was appropriate for an event study, but it would be interesting to see if the pipeline information would have an effect over the longer term performance of the acquirer. Testing this could be made more difficult by firms that frequently make acquisitions. One other possible avenue for future research could be to analyze the therapeutic class of the drugs in development. This would reveal whether the market values firms that focus on developing drugs that treat conditions that tend to be very profitable.

In a fiercely competitive industry such as the pharmaceutical industry, acquisitions will likely remain a key strategy for firms looking to maintain their revenues for the foreseeable future. Given this, it would benefit investors to have more information about what characteristics the market values in a target firm so that they can invest their capital wisely. Hopefully future research will be able to shed additional light on this question.

Appendix-1

Event Day	Traditional			Biotech		
	Individual Day	CAR	J1	Individual Day	CAR	J1
-18	-0.0142020	-0.0142021	N/A	-0.014202069	0.0067042	N/A
-17	-0.015130677	-0.0293327	-38.4162	-0.015130677	0.0114027	5.163583
-16	-0.017891411	-0.0472242	-41.2695	-0.017891411	0.0107209	3.686395
-15	-0.017092019	-0.0643162	-53.1054	-0.017092019	0.0106867	3.325546
-14	-0.016228336	-0.0805445	-56.9067	-0.016228336	0.012289	3.460265
-13	-0.016414787	-0.0969593	-66.3438	-0.016414787	0.0148435	3.74658
-12	-0.017514267	-0.1144736	-71.0741	-0.017514267	0.0096623	1.925208
-11	-0.013035384	-0.1275089	-65.9513	-0.013035384	0.0022185	0.438084
-10	-0.010581326	-0.1380903	-66.1675	-0.010581326	-0.0023179	-0.4566
-9	-0.010967438	-0.1490577	-70.3769	-0.010967438	-0.0047723	-0.84423
-8	-0.01334873	-0.1624064	-76.3568	-0.01334873	-0.0063067	-1.04058
-7	-0.014089228	-0.1764957	-82.2683	-0.014089228	-0.0037703	-0.55904
-6	-0.011811327	-0.188307	-84.9	-0.011811327	-0.0019065	-0.27448
-5	-0.011770587	-0.2000776	-85.5006	-0.011770587	-0.0038999	-0.56965
-4	-0.013558449	-0.213636	-85.3342	-0.013558449	-0.0145586	-2.13856
-3	-0.010114095	-0.2237501	-85.2569	-0.010114095	-0.0278063	-4.09905
-2	-0.011974309	-0.2357244	-84.3494	-0.011974309	-0.0420362	-6.19702
-1	-0.014151906	-0.2498763	-84.5134	-0.014151906	-0.0531999	-7.86152
0	-0.007710816	-0.2575872	-85.8166	-0.007710816	-0.0567263	-8.32509
1	-0.007834152	-0.2654213	-86.743	-0.007834152	-0.0622641	-9.09948
2	-0.007292702	-0.272714	-88.1353	-0.007292702	-0.0644641	-9.38433
3	-0.006727243	-0.2794413	-89.3915	-0.006727243	-0.0637611	-9.37264
4	-0.00811032	-0.2875516	-91.0823	-0.00811032	-0.0578101	-8.58538
5	-0.008302205	-0.2958538	-93.2065	-0.008302205	-0.0584233	-8.79201
6	-0.006883048	-0.3027368	-95.1462	-0.006883048	-0.061737	-9.38253
7	-0.004038273	-0.3067751	-94.0251	-0.004038273	-0.0816071	-11.1241
8	-0.005150245	-0.3119253	-93.6879	-0.005150245	-0.0994207	-12.8783
9	-0.006628577	-0.3185539	-95.5436	-0.006628577	-0.1157829	-14.273
10	-0.003945307	-0.3224992	-95.5941	-0.003945307	-0.130636	-15.767
11	-0.003612651	-0.3261119	-95.4538	-0.003612651	-0.1486653	-17.7732
12	-0.003717322	-0.3298292	-95.8569	-0.003717322	-0.1638315	-19.7051
13	-0.005093876	-0.3349231	-97.5159	-0.005093876	-0.1825062	-21.9234
14	-0.002540888	-0.337464	-97.3696	-0.002540888	-0.209045	-24.5943
15	-0.001329242	-0.3387932	-96.8241	-0.001329242	-0.2347301	-27.0416
16	-0.001334373	-0.3401276	-96.6595	-0.001334373	-0.2584567	-29.3946
17	-0.000457038	-0.3405846	-95.7409	-0.000457038	-0.2777212	-31.4305
18	-0.000204411	-0.340789	-94.2191	-0.000204411	-0.2956295	-33.355
19	-0.002218695	-0.3430077	-94.3336	-0.002218695	-0.3159929	-35.4582
20	-0.000261427	-0.3432692	-93.8397	-0.000261427	-0.3378583	-37.7524

Mergers in the Sample

Label	Acquirer	Target
m1	Abbott Labs	Kos Pharma
m2	Alza	Crescendo
m3	Bristol Myers-Squibb	Medarex
m6	Chiron	Matrix Pharmaceutical
m7	Eli Lilly	Icos
m8	Eli Lilly	SGX
m9	Eli Lilly	Applied Molecular
m10	Genzyme	GelTex Pharma
m11	Genzyme	AnorMed
m12	Gilead	Myogen
m13	Indevus	Valera
m14	Johnson & Johnson	Cougar
m15	Johnson & Johnson	3-Dimensional Pharma
m16	Merck	Sibia
m17	Merck	Sirna
m18	Millennium	COR Therapeutics
m20	Pfizer	Warner-Lambert Co.
m21	Pfizer	Encysive
m22	Pfizer	Vicuron
m23	Pfizer	Coley
m24	Pfizer	Esperion
m25	Shire	New River Pharma
m26	Warner-Lambert	Agouron Pharma
m27	Amgen	Abgenix
m28	Amgen	Immunex
m29	AstraZeneca	MedImmune
m30	AstraZeneca	Cambridge Antibody Tech.
m31	Bristol Myers-Squibb	Kosan Biosciences
m32	Bristol Myers-Squibb	Medarex
m33	Corixa	Ribi ImmunoChem
m34	Elan	Liposome
m35	Eli Lilly	ImClone
m37	Genzyme	Sangstat
m38	Genzyme	Osiris
m39	GlaxoSmithKline	Corixa
m40	GlaxoSmithKline	ID Biomed
m41	Johnson & Johnson	Omrix
m42	MedImmune	Aviron
m43	Merck	Serono
m44	Pharmacia	Sugen
m45	Shire	Transkaryotic Therapies

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